PRECIPITATION PROCESSING SYSTEM

GLOBAL PRECIPITATION MEASUREMENT

File Specification for GPM Products

Version 4.04 TKIO 3.70.8

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1 Introduction

Global Precipitation Measurement (GPM) is an international satellite mission to provide observations of rain and snow worldwide. NASA and Japan Aerospace Exploration Agency (JAXA) launched the GPM Core satellite from Japan on February 27, 2014 UTC (February 28 Japan Standard Time). The data provided by the Core unifies precipitation measurements made by an international network of partner satellites to quantify when, where, and how much it rains or snows around the world.

1.1 Identification

This is the File Specification for GPM Products.

1.2 Scope

This document describes the data file formats for GPM products. Metadata is described in Metadata for GPM Products.

1.3 Purpose and Objectives

The purpose of this file specification document is to define the file content and format for the GPM data products.

1.4 Document Status and Schedule

The file specifications have been reviewed by the algorithm developers. Formats are expected to change for each processing cycle.

1.5 Document Organization

The organization is as follows:

Section 2 LOGICAL FORMAT - This section describes general aspects of the logical format.

Section 3 PHYSICAL FORMAT - This section describes general aspects of the physical format.

Section 4 FORMATTING CONVENTIONS - This section describes the general formatting conventions used in this document.

Section 5 STANDARD GPM PRODUCTS - This section describes the file specifications for the standard GPM products.

2 Logical Format

The logical format of a data product consists of the names, types, dimensions, and organization of the data. The physical format is the implementation of the logical format with an underlying format such as Hierarchical Data Format (HDF). The bulk of this document consists of the logical format of each GPM data product.

GPM data products contain metadata and data. Metadata are small text strings containing label information such as the name, date, and time of the data products. Metadata are often organized into metadata groups.

Data are arrays or scalers. Data are often organized into swath structures or grid structures. Some products have groups outside or inside swath structures or grid structures.

2.1 Swath Structure

The swath structure stores satellite data which are organized by scans. Swath structures are implemented in Levels 1A, 1B, 1C, 2A, and 2B. The swath structure is contained in a group. In this swath group is the metadata group SwathHeader, data group ScanTime, data arrays Latitude and Longitude and other data arrays. In some products there are additional data groups under the swath group. The contents of the metadata group SwathHeader are explained in Metadata for GPM Products.

2.2 Grid Structure

The grid structure stores earth located grids. Each grid is an array of grid boxes, rather than grid points. Grid structures are implemented in Level 3A and 3B products. The grid structure is contained in a grid group. In this group is the metadata group GridHeader and data arrays. In some products there are additional data groups under the grid group. The contents of the metadata group GridHeader are explained in Metadata for GPM Products.

3 Physical Format

The logical format of GPM data products is written in an underlying format such as HDF.

3.1 Heirarchical Data Format

HDF was developed by the National Center for Supercomputing Applications (NCSA) at the University of Illinois at Champaign-Urbana and is the archive format for GPM data. HDF manuals and software may be obtained via anonymous ftp at ftp.ncsa.uiuc.edu

The logical group is implemented in HDF as a Vgroup. The logical array or scalar is implemented in HDF as a Scientific Data Set. Each SDS contains the data array and additional information as attributes: names of dimensions, units, scale, offset, and scale description.

Each metadata group is implemented in HDF as an attribute. Elements within a group are implemented as

ElementName=ElementValue;

If the element has a list of values, the values are separated with a comma:

ElementName=Value1,Value2,...,ValueN;

4 Formatting Conventions

4.1 File Structure Figure

Each data product section has a file structure figure and file contents. The file structure figure show the organization of the data within the file. The File is on the left. Under the file are circles showing swaths or grid structures or boxes showing metadata, groups, or arrays. Group boxes are shaded. Array boxes contain the size of one element with the dimensions to the right of the box. A group has an additional figure showing the contents of the group.

4.2 File Contents

Each array or scaler is described with name in bold, then parenthesis containing the data type and dimensions, and then a description.

4.3 Missing Data and Empty Granules

Missing data are denoted by values equal to -9999.9, -9999.9, -9999, -9999, -9999, -99, 65535, 4294967295, 255, and NULL for for 8-byte float, 4-byte float, 8-byte integer, 4-byte integer, 2-byte integer, 1-byte integer, 2-byte unsigned integer, 4-byte unsigned integer, 1-byte character, and variable length string. Any exceptions to the use of the above standard values are explicitly notes in the description.

If an entire granule is missing, an empty granule may be created. An empty granule is defined by the metadata element EmptyGranule in the metadata group FileHeader. Software reading a granule should check EmptyGranule first. Swath data or grid data may be empty.

4.4 Array Dimension Order

In the definition of array dimensions, e.g. npixel x nscan, the first dimension (npixel) is the most rapidly varying index and the last dimension (nscan) is the least rapidly varying index. To implement the format in FORTRAN, declare an array with the dimensions as they appear in this document. To implement the format in C, declare an array with the dimensions reversed from their appearance in this document.

4.5 Array Index

The meaning of each array index is explained at the beginning of each algorithm section in the list called "Dimension Definitions." Some array indeces denote a type rather than a number. For example, PIAalt has dimensions method x nray x nscan and there are 6 methods. If an index is enumerated the index value will start with 1 (rather than 0) unless otherwise indicated.

4.6 Granule definition

For orbital products, the beginning and ending time are defined as the time the sub-satellite track reaches its southernmost latitude. A scan is included in a granule when its ScanTime is greater than or equal to the Granule start time and less than the Granule end time.

For time-averaged products, the beginning time is the first millisecond of the period and the ending time is the last millisecond.

5 Standard GPM Products

5.1 TMIBASE - TMI Antenna Temperatures

The TMI BASE Product, TMIBASE, "TMI Antenna Temperatures," is written as one Swath. It is similar to TRMM 1B11 but channels are not scaled and there is no overlap with the last and next granules. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nchan	9	Total number of channels.
nchUIA	1	Number of unique incidence angles.
npixel	208	Number of high frequency pixels in each scan.
npixlo	104	Number of low frequency pixels in each scan.

Figure 1 through Figure 7 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains metadata of general interest. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

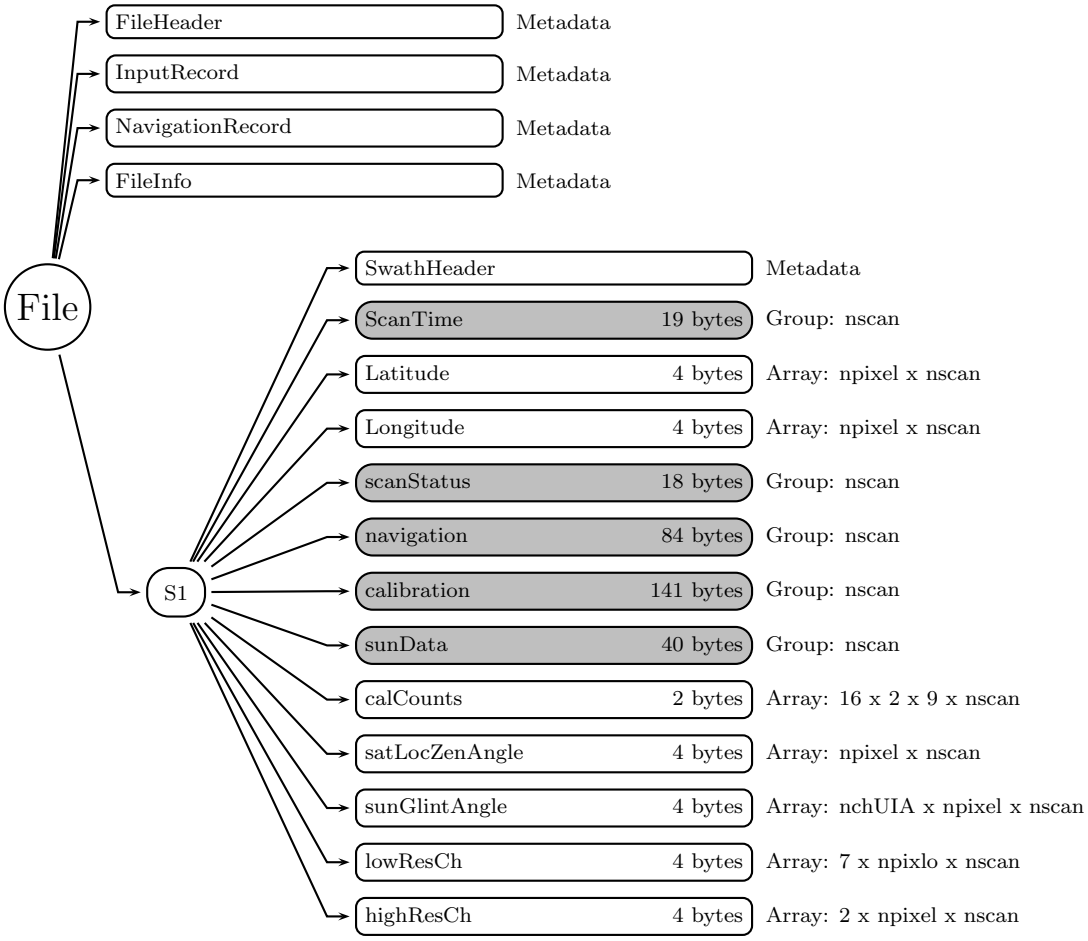


Figure 1: Data Format Structure for TMIBASE, TMI Antenna Temperatures

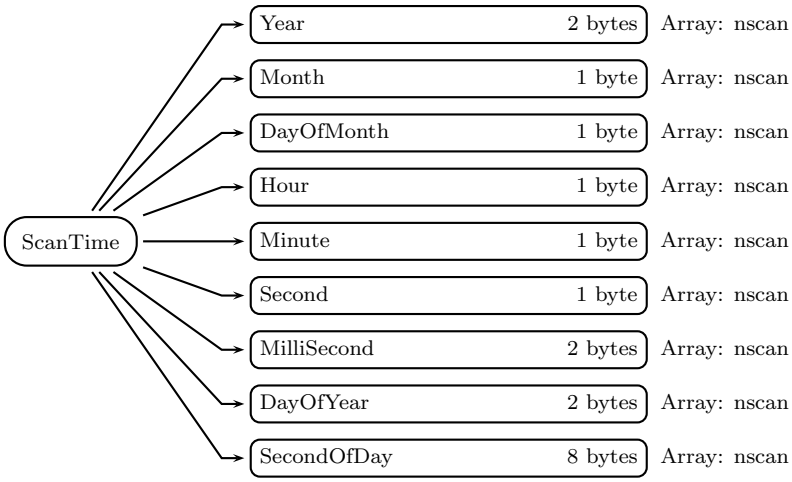


Figure 2: Data Format Structure for TMIBASE, ScanTime

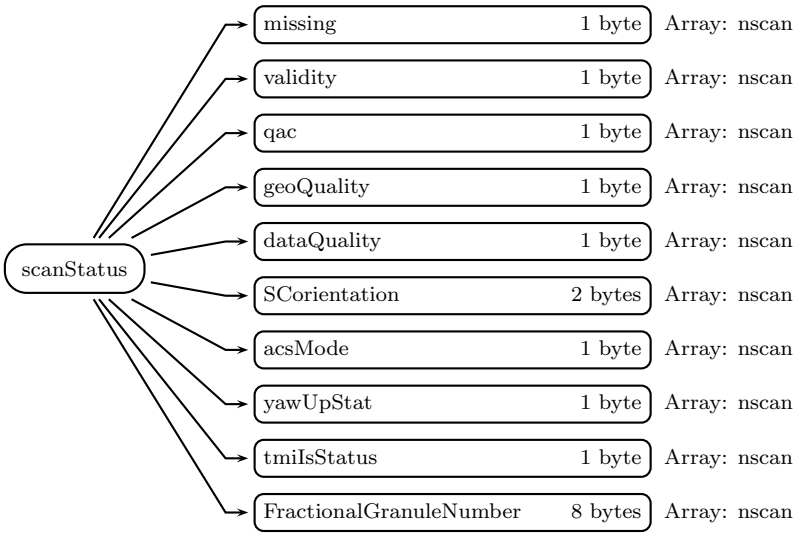


Figure 3: Data Format Structure for TMIBASE, scanStatus

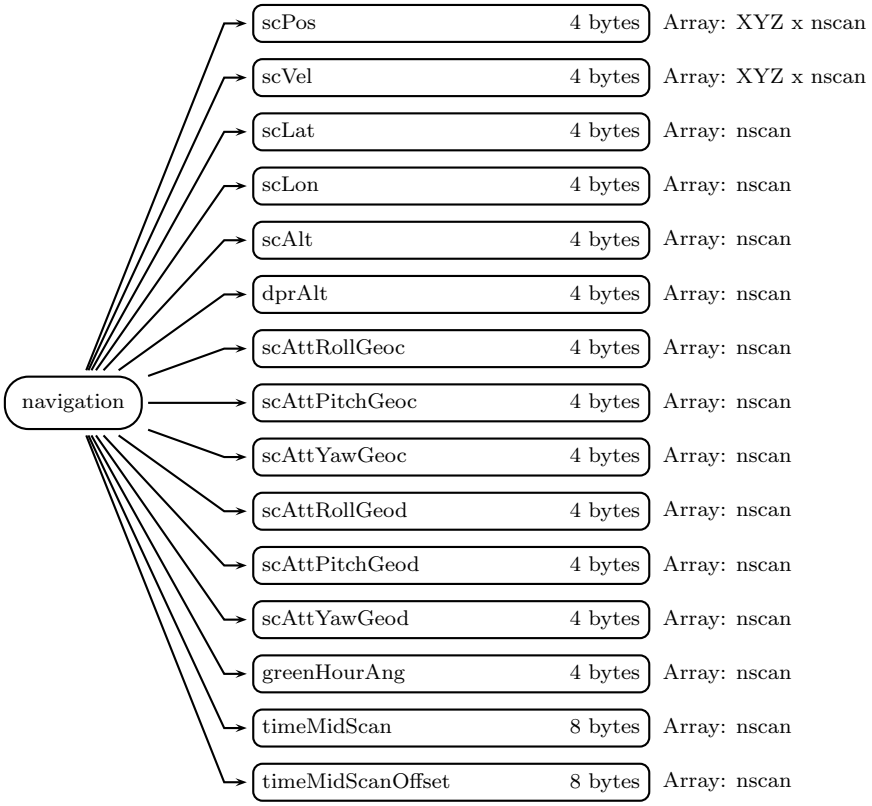


Figure 4: Data Format Structure for TMIBASE, navigation

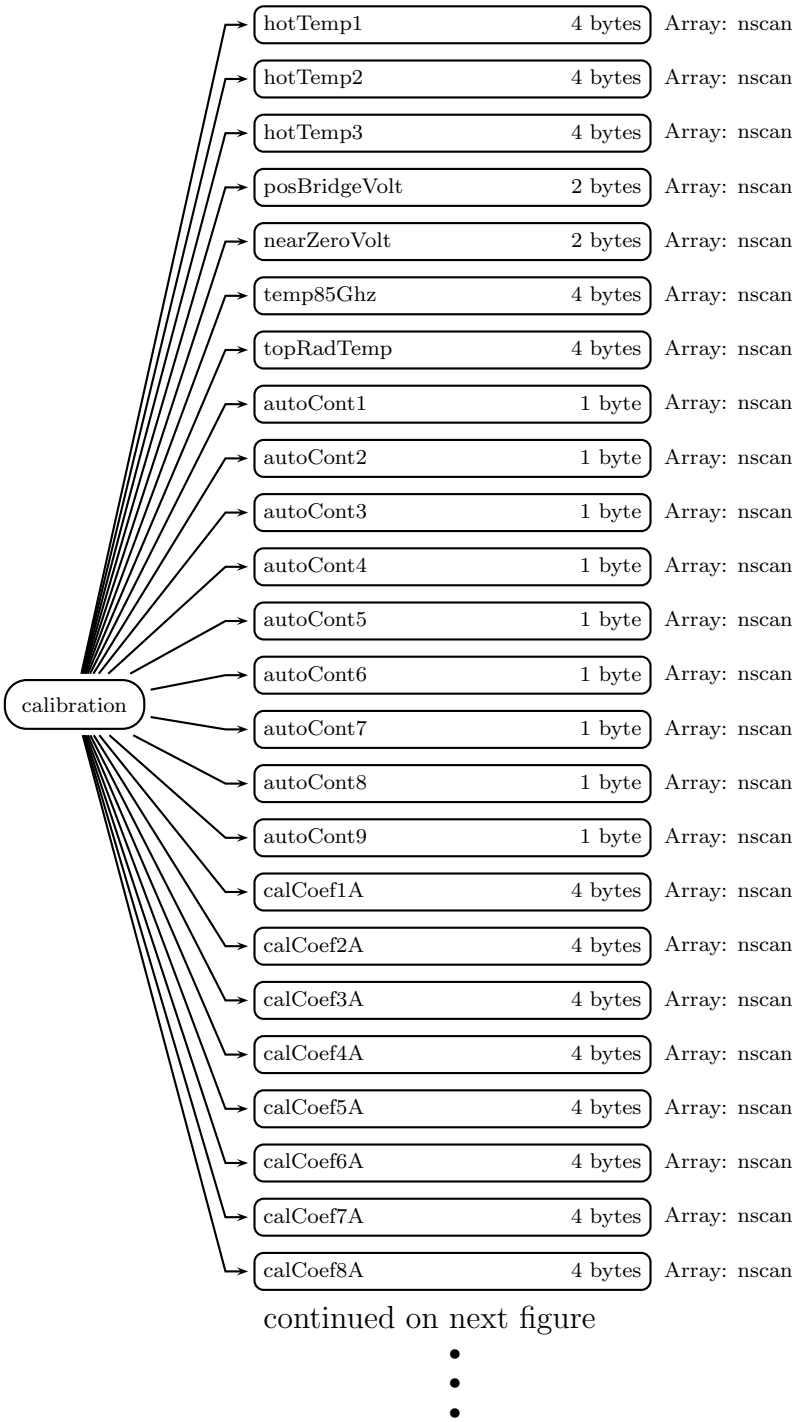


Figure 5: Data Format Structure for TMIBASE, calibration

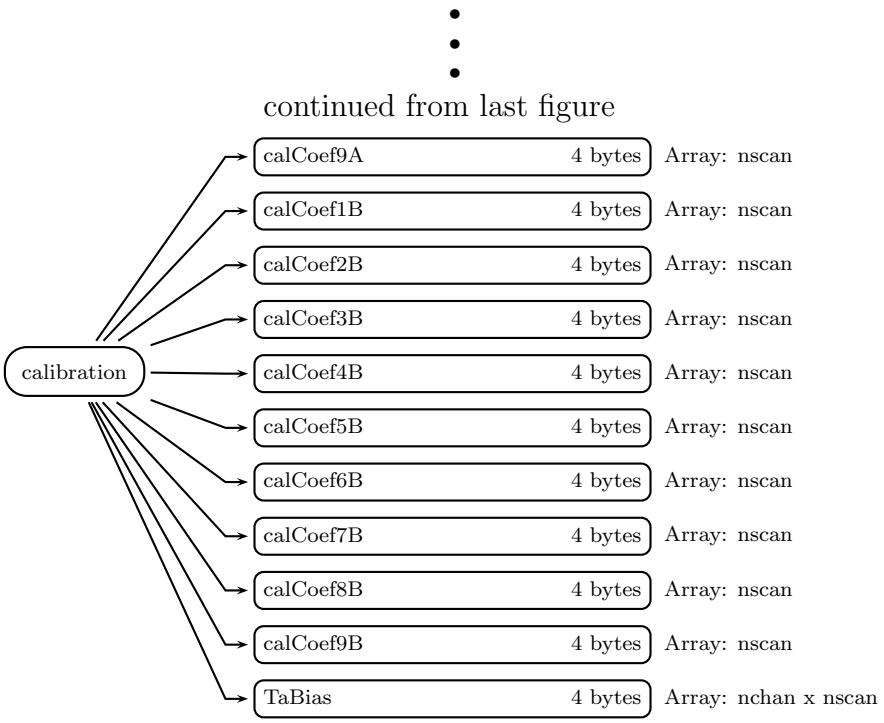


Figure 6: Data Format Structure for TMIBASE, calibration

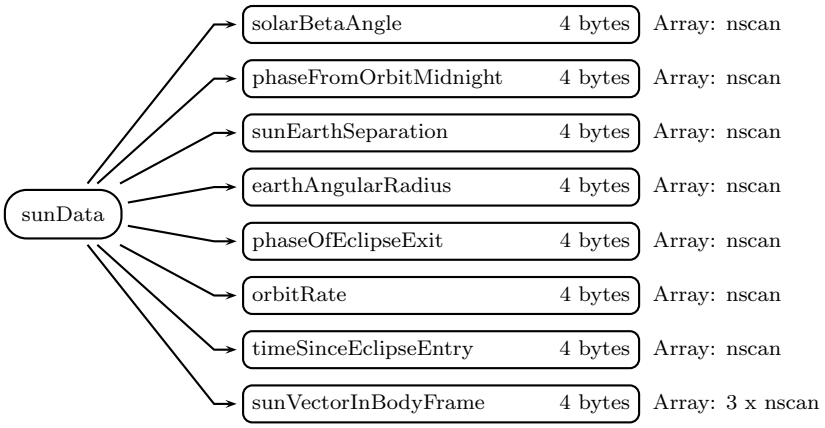


Figure 7: Data Format Structure for TMIBASE, sunData

ScanTime (Group)
A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value

-180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group)

missing (1-byte integer, array size: nscan):
Missing indicates whether information is contained in the scan data. The values are:

```
0 Scan data elements contain information
1 Scan was missing in the telemetry data
```

validity (1-byte integer, array size: nscan):
Validity is a summary of status modes. If all status modes are routine, all bits in Validity = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. Validity does not assess data or geolocation quality. Validity is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   Non-routine spacecraft orientation (2 or 3)
2   Non-routine ACS mode (other than 4)
3   Non-routine yaw update status (0 or 1)
4   Non-routine instrument status (Bit 0 = 0 or bit 1 = 0)
5   Non-routine QAC (non-zero)

6   21 GHz Cold Count Flag (1 if Flag set)
7   Spare (always 0)
```

qac (1-byte integer, array size: nscan):
The Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.

geoQuality (1-byte integer, array size: nscan):
geoQuality is broken into 8 one-bit flags. Some flags represent problems but other flags are informational. Bits 0, 5, and 6 represent problems: 0 = 'good' quality and 1 = 'bad' quality. It is recommended not to use scans when any problem flag is 1. The informational flags have: 0 = routine conditions and 1 = non-routine conditions. Bit 0 is the most significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**(7-i). Note that good scans may have non-zero geoQuality. Each flag is listed below.

```
Bit Meaning if bit = 1
0   Grossly bad geolocation results:
    Spacecraft position vector magnitude outside range 6715 to 6790 km.
    Z component of midpoint of scan outside range -4100 to 4100 km.
    Distance from S/C to midpoint of scan outside range 500 to 750 km.
1   Unexpectedly large scan to scan jumps in geolocated positions in along and
    cross track directions for first, middle, and last pixels in each scan.
    Allowed deviation from nominal jump in along track motion = 3.0 km (first
    pixel), 3.0 km (middle pixel), and 3.0 km (last pixel).
    Allowed deviation from nominal jump in cross track motion = 3.0 km (first
    pixel), 3.0 km (middle pixel), and 3.0 km (last pixel).
    Bit set in normal mode only.
2   Scan to scan jumps in yaw, pitch, and roll exceed maximum values.  Values
    are :  yaw = 0.005 radians; pitch = 0.005 radians; roll = 0.005 radians.
    Bit set in normal control mode only.
3   In normal mode, yaw outside range (-0.005, 0.005) radians; pitch outside
    range (-0.005, 0.005) radians; roll outside range (-0.005, 0.005) radians.
4   Satellite undergoing maneuvers during which geolocation will be less
    accurate.
5   Summary QA flag for dataQuality:  Set to 1 if bit 0 is 1 or bit 6 is 1,
    i.e. Grossly bad or failed geolocation calculations.
    Science data use not recommended.
6   Geolocation calculations failed (fill values inserted in the per pixel
    geolocation products, but not in metadata).
7   Missing attitude data.  ACS data gap larger than 1.0 seconds.
      Pitch, roll, and yaw are interpolated or extrapolated from nearby data.
```

dataQuality (1-byte integer, array size: nscan):
dataQuality is a flag for overall scan quality. Unless this is 0, the scan data is meaningless to higher science processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit  Meaning if bit = 1
0    missing
5    geoQuality indicates bad or missing values

6    validity bits 0-5 not all normal
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the TMI scan. If +X is forward, SCorientation is 0. If -X is forward, SCorientation is 180. If -Y is forward, SCorientation is 90. Values range

from 0 to 360 degrees. Special values are defined as:
-8003 Inertial
-8004 Unknown
-9999 Missing value

acsMode (1-byte integer, array size: nscan):

```
Value Meaning
0     Standby
1     Sun Acquire
2     Earth Acquire
3     Yaw Acquire
4     Nominal
5     Yaw Maneuver
6     Delta-H (Thruster)
7     Delta-V (Thruster)
8     CERES Calibration
```

yawUpStat (1-byte integer, array size: nscan):

```
Value Meaning
0     Inaccurate
1     Indeterminate
2     Accurate
```

tmiIsStatus (1-byte integer, array size: nscan):
Bit 0 is the most significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**(8-i) - 1).

```
Bit Meaning
00  Receiver Status (1=ON, 0=OFF)
01  Spin-up Status (1=ON, 0=OFF)
02  Spare Command 1 Status
03  Spare Command 2 Status
04  1 Hz Clock Select (1=A, 0=B)

05  Spare
06  Spare Command 4 Status
07  Spare Command 5 Status
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the

spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group)

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity

direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range

from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

calibration (Group)

hotTemp1 (4-byte float, array size: nscan):
The physical temperatures, in degrees Kelvin, for the 3 temperature sensors attached to the hot load. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

hotTemp2 (4-byte float, array size: nscan):
The physical temperatures, in degrees Kelvin, for the 3 temperature sensors attached to the hot load. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

hotTemp3 (4-byte float, array size: nscan):
The physical temperatures, in degrees Kelvin, for the 3 temperature sensors attached to the hot load. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

posBridgeVolt (2-byte integer, array size: nscan):
The positive bridge voltage of the hot load bridge reference. Values range from 0 to 4095 volts. Special values are defined as:
-9999 Missing value

nearZeroVolt (2-byte integer, array size: nscan):
The near zero voltage of the hot load bridge reference. Values range from 0 to 4095 volts. Special values are defined as:
-9999 Missing value

temp85Ghz (4-byte float, array size: nscan):
The receiver shelf temperature of the 85.5 GHz channel. Values range from -273.15 to 126.85 Celsius. Special values are defined as:
-9999.9 Missing value

topRadTemp (4-byte float, array size: nscan):
The temperature of the top of the radiator channel. Values range from -273.15 to 126.85 Celsius. Special values are defined as:
-9999.9 Missing value

autoCont1 (1-byte integer, array size: nscan):
Automatic gain control for the 9 channels in counts. Values range from 0 to 15. Special

values are defined as:
-99 Missing value

autoCont2 (1-byte integer, array size: nscan):
Automatic gain control for the 9 channels in counts. Values range from 0 to 15. Special values are defined as:
-99 Missing value

autoCont3 (1-byte integer, array size: nscan):
Automatic gain control for the 9 channels in counts. Values range from 0 to 15. Special values are defined as:
-99 Missing value

autoCont4 (1-byte integer, array size: nscan):
Automatic gain control for the 9 channels in counts. Values range from 0 to 15. Special values are defined as:
-99 Missing value

autoCont5 (1-byte integer, array size: nscan):
Automatic gain control for the 9 channels in counts. Values range from 0 to 15. Special values are defined as:
-99 Missing value

autoCont6 (1-byte integer, array size: nscan):
Automatic gain control for the 9 channels in counts. Values range from 0 to 15. Special values are defined as:
-99 Missing value

autoCont7 (1-byte integer, array size: nscan):
Automatic gain control for the 9 channels in counts. Values range from 0 to 15. Special values are defined as:
-99 Missing value

autoCont8 (1-byte integer, array size: nscan):
Automatic gain control for the 9 channels in counts. Values range from 0 to 15. Special values are defined as:
-99 Missing value

autoCont9 (1-byte integer, array size: nscan):
Automatic gain control for the 9 channels in counts. Values range from 0 to 15. Special values are defined as:
-99 Missing value

calCoef1A (4-byte float, array size: nscan):
Calibration coefficient A (degrees Kelvin / counts) for the 9 channels. Coefficient A for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef2A (4-byte float, array size: nscan):
Calibration coefficient A (degrees Kelvin / counts) for the 9 channels. Coefficient A for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef3A (4-byte float, array size: nscan):
Calibration coefficient A (degrees Kelvin / counts) for the 9 channels. Coefficient A for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef4A (4-byte float, array size: nscan):
Calibration coefficient A (degrees Kelvin / counts) for the 9 channels. Coefficient A for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef5A (4-byte float, array size: nscan):
Calibration coefficient A (degrees Kelvin / counts) for the 9 channels. Coefficient A for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef6A (4-byte float, array size: nscan):
Calibration coefficient A (degrees Kelvin / counts) for the 9 channels. Coefficient A for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef7A (4-byte float, array size: nscan):
Calibration coefficient A (degrees Kelvin / counts) for the 9 channels. Coefficient A for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef8A (4-byte float, array size: nscan):
Calibration coefficient A (degrees Kelvin / counts) for the 9 channels. Coefficient A for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef9A (4-byte float, array size: nscan):
Calibration coefficient A (degrees Kelvin / counts) for the 9 channels. Coefficient A for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef1B (4-byte float, array size: nscan):
Calibration coefficient B (degrees Kelvin / counts) for the 9 channels. Coefficient B for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef2B (4-byte float, array size: nscan):
Calibration coefficient B (degrees Kelvin / counts) for the 9 channels. Coefficient B for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef3B (4-byte float, array size: nscan):
Calibration coefficient B (degrees Kelvin / counts) for the 9 channels. Coefficient B for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef4B (4-byte float, array size: nscan):
Calibration coefficient B (degrees Kelvin / counts) for the 9 channels. Coefficient B for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef5B (4-byte float, array size: nscan):
Calibration coefficient B (degrees Kelvin / counts) for the 9 channels. Coefficient B for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef6B (4-byte float, array size: nscan):
Calibration coefficient B (degrees Kelvin / counts) for the 9 channels. Coefficient B for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef7B (4-byte float, array size: nscan):
Calibration coefficient B (degrees Kelvin / counts) for the 9 channels. Coefficient B for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef8B (4-byte float, array size: nscan):
Calibration coefficient B (degrees Kelvin / counts) for the 9 channels. Coefficient B for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef9B (4-byte float, array size: nscan):
Calibration coefficient B (degrees Kelvin / counts) for the 9 channels. Coefficient B for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

TaBias (4-byte float, array size: nchan x nscan):
Bias in the antenna temperatures which is estimated due to instrument temperature fluctuations as a function of timeSinceEclipseEntry and solarBetaAngle. This bias is applied to reach the antenna temperature in this product. Values range from -10.0 to 10.0 K. In other words,

```
V6 Ta - TbBias = V7 Ta
```

sunData (Group)

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -59.0 to 59.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from

45.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: 3 x nscan):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

calCounts (2-byte integer, array size: 16 x 2 x 9 x nscan):
Calibration measurements, in counts. The dimensions are: samples, load, channel, and scan. The sample dimension has a maximum of 16. The load dimension has first hot load and then cold sky. The low resolution channels (1-7) have 8 samples (the remaining 8 elements in the array are not used for each low resolution channel) and the high resolution channels (8 - 9) have 16 samples.

satLocZenAngle (4-byte float, array size: npixel x nscan):
The angle, in degrees, between the local pixel geodetic zenith and the direction to the satellite.

sunGlintAngle (4-byte float, array size: nchUIA x npixel x nscan):
Sun glint angle. Values range from 0 to 180 degrees. Sun below horizon value is -8888.8. Missing value is -9999.9.

lowResCh (4-byte float, array size: 7 x npixlo x nscan):
Antenna temperature (K). The dimensions are: channel, pixel, scan. The pixel dimension has Offset = 0 and Increment = -2. The following channels are included:

Channel	Frequency	Polarization	Minimum	Maximum
1	10 GHz	Vertical	33	320
2	10 GHz	Horizontal	66	320
3	19 GHz	Vertical	133	320
4	19 GHz	Horizontal	80	320
5	21 GHz	Vertical	133	320
6	37 GHz	Vertical	133	320
7	37 GHz	Horizontal	112	320

highResCh (4-byte float, array size: 2 x npixel x nscan):
Antenna temperature (K). The dimensions are: channel, pixel, scan. The following channels are included:

Channel	Frequency	Polarization	Minimum	Maximum
8	85 GHz	Vertical	70	320
9	85 GHz	Horizontal	70	320

C Structure Header file:

```
#ifndef _TK_TMIBASE_H_
#define _TK_TMIBASE_H_

#ifndef _LTMIBASE_SUNDATA_
#define _LTMIBASE_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} LTMIBASE_SUNDATA;

#endif

#ifndef _LTMIBASE_CALIBRATION_
#define _LTMIBASE_CALIBRATION_

typedef struct {
    float hotTemp1;
    float hotTemp2;
    float hotTemp3;
    short posBridgeVolt;
    short nearZeroVolt;
    float temp85Ghz;
    float topRadTemp;
    signed char autoCont1;
    signed char autoCont2;
    signed char autoCont3;
```

```
    signed char autoCont4;
    signed char autoCont5;
    signed char autoCont6;
    signed char autoCont7;
    signed char autoCont8;
    signed char autoCont9;
    float calCoef1A;
    float calCoef2A;
    float calCoef3A;
    float calCoef4A;
    float calCoef5A;
    float calCoef6A;
    float calCoef7A;
    float calCoef8A;
    float calCoef9A;
    float calCoef1B;
    float calCoef2B;
    float calCoef3B;
    float calCoef4B;
    float calCoef5B;
    float calCoef6B;
    float calCoef7B;
    float calCoef8B;
    float calCoef9B;
    float TaBias[9];
} LTMIBASE_CALIBRATION;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
```

```
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _LTMIBASE_SCANSTATUS_
#define _LTMIBASE_SCANSTATUS_

typedef struct {
    signed char missing;
    signed char validity;
    signed char qac;
    signed char geoQuality;
    signed char dataQuality;
    short SCorientation;
    signed char acsMode;
    signed char yawUpStat;
    signed char tmiIsStatus;
    double FractionalGranuleNumber;
} LTMIBASE_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif
```

```
#ifndef _LTMIBASE_S1_
#define _LTMIBASE_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[208];
    float Longitude[208];
    LTMIBASE_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    LTMIBASE_CALIBRATION calibration;
    LTMIBASE_SUNDATA sunData;
    short calCounts[9][2][16];
    float satLocZenAngle[208];
    float sunGlintAngle[208][1];
    float lowResCh[104][7];
    float highResCh[208][2];
} LTMIBASE_S1;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /LTMIBASE_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /LTMIBASE_CALIBRATION/
    REAL*4 hotTemp1
    REAL*4 hotTemp2
    REAL*4 hotTemp3
    INTEGER*2 posBridgeVolt
    INTEGER*2 nearZeroVolt
    REAL*4 temp85Ghz
```

```
    REAL*4 topRadTemp
    BYTE autoCont1
    BYTE autoCont2
    BYTE autoCont3
    BYTE autoCont4
    BYTE autoCont5
    BYTE autoCont6
    BYTE autoCont7
    BYTE autoCont8
    BYTE autoCont9
    REAL*4 calCoef1A
    REAL*4 calCoef2A
    REAL*4 calCoef3A
    REAL*4 calCoef4A
    REAL*4 calCoef5A
    REAL*4 calCoef6A
    REAL*4 calCoef7A
    REAL*4 calCoef8A
    REAL*4 calCoef9A
    REAL*4 calCoef1B
    REAL*4 calCoef2B
    REAL*4 calCoef3B
    REAL*4 calCoef4B
    REAL*4 calCoef5B
    REAL*4 calCoef6B
    REAL*4 calCoef7B
    REAL*4 calCoef8B
    REAL*4 calCoef9B
    REAL*4 TaBias(9)
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
```

```
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /LTMIBASE_SCANSTATUS/
    BYTE missing
    BYTE validity
    BYTE qac
    BYTE geoQuality
    BYTE dataQuality
    INTEGER*2 SCorientation
    BYTE acsMode
    BYTE yawUpStat
    BYTE tmiIsStatus
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /LTMIBASE_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(208)
    REAL*4 Longitude(208)
    RECORD /LTMIBASE_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /LTMIBASE_CALIBRATION/ calibration
    RECORD /LTMIBASE_SUNDATA/ sunData
    INTEGER*2 calCounts(16,2,9)
    REAL*4 satLocZenAngle(208)
    REAL*4 sunGlintAngle(1,208)
    REAL*4 lowResCh(7,104)
```

```
    REAL*4 highResCh(2,208)
END STRUCTURE
```

5.2 GMIBASE - GMI Antenna Temperatures

The GMI BASE Product, GMIBASE, "GMI Antenna Temperatures," is written as a multi-Swath Structure. Swath S1 has channels 1-9: 10V 10H 19V 19H 23V 37V 37H 89V 89H. Swath S2 has channels 10-13: 166V 166H 183+/-3V 183+/-8V. Swath S3 is like S1 but full scan. Swath S4 is like S2 but full scan. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nchan1	9	Number of channels in Swath 1.
nchan2	4	Number of channels in Swath 2.
nfreq1	5	Number of frequencies in Swath 1.
nfreq2	2	Number of frequencies in Swath 2.
npix1	221	Number of pixels in Swath 1.
npix2	221	Number of pixels in Swath 2.
npix3	500	Number of pixels in Swath 3.
npix4	500	Number of pixels in Swath 4.
ncolds1	85	Maximum number of cold samples in Swath 1.
ncolds2	85	Maximum number of cold samples in Swath 2.
nhots1	65	Maximum number of hot samples in Swath 1.
nhots2	65	Maximum number of hot samples in Swath 2.
ntherm	11	Number of hot load thermisters.
LNL	2	Linear and non-linear.
nsamt	4	Number of sample types. The types are: total science GSDR, earth-view, hot load, cold sky.
ntach	32	Number of tachometer readings.
GMIxyz	3	x, y, z components in GMI instrument coordinate system.
nndiode	6	Number of noise diodes.
n7	7	Number seven.

Figure 8 through Figure 38 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

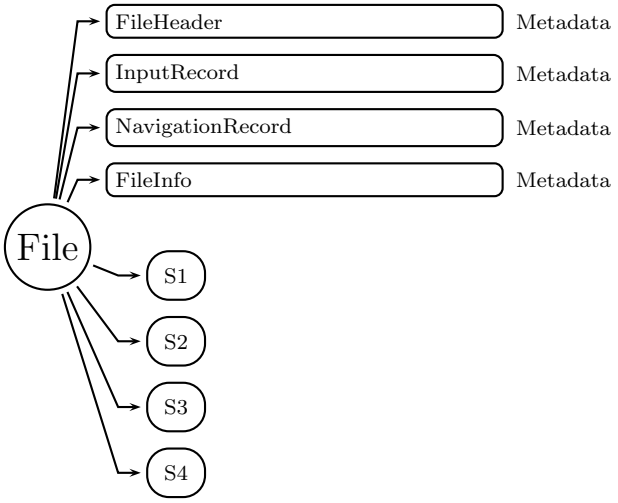


Figure 8: Data Format Structure for GMIBASE, GMI Antenna Temperatures

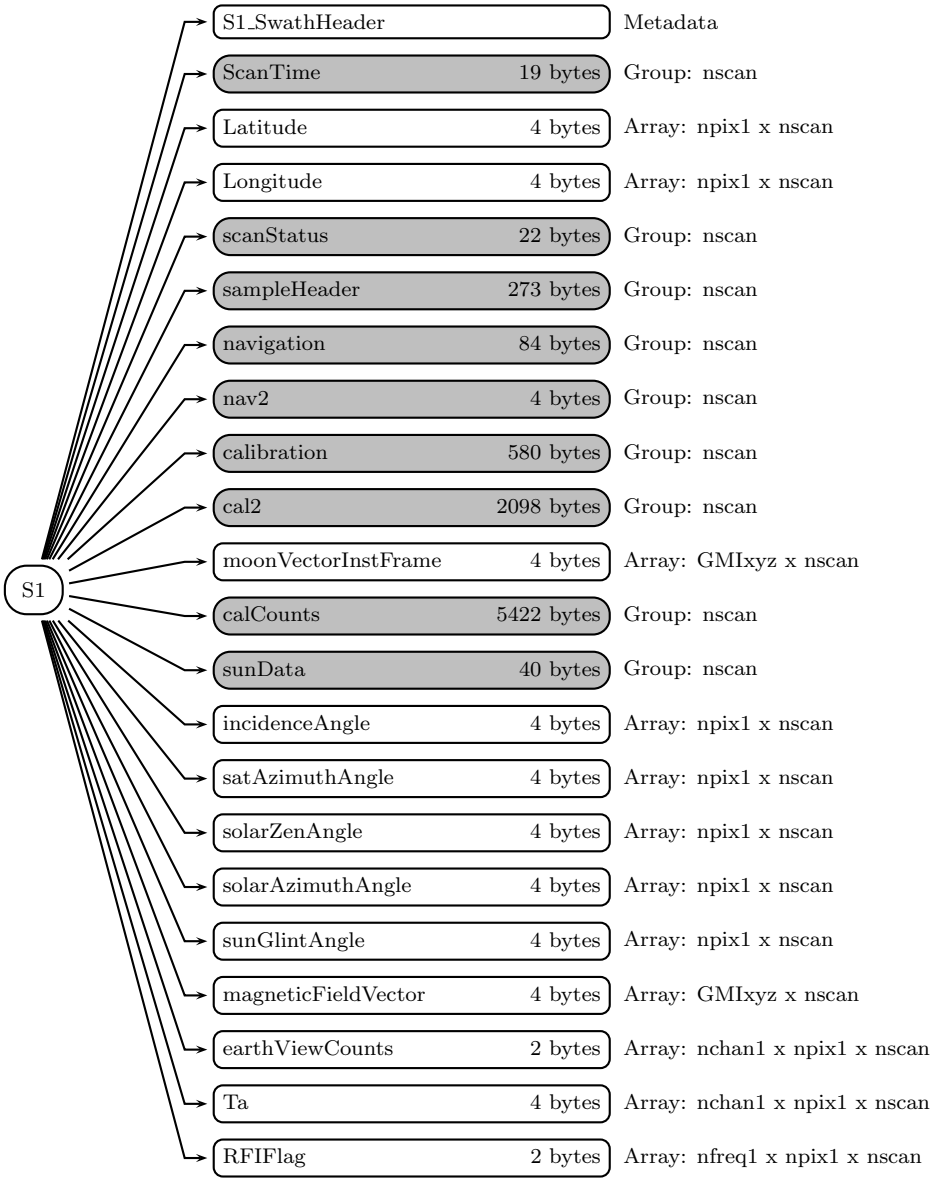


Figure 9: Data Format Structure for GMIBASE, S1

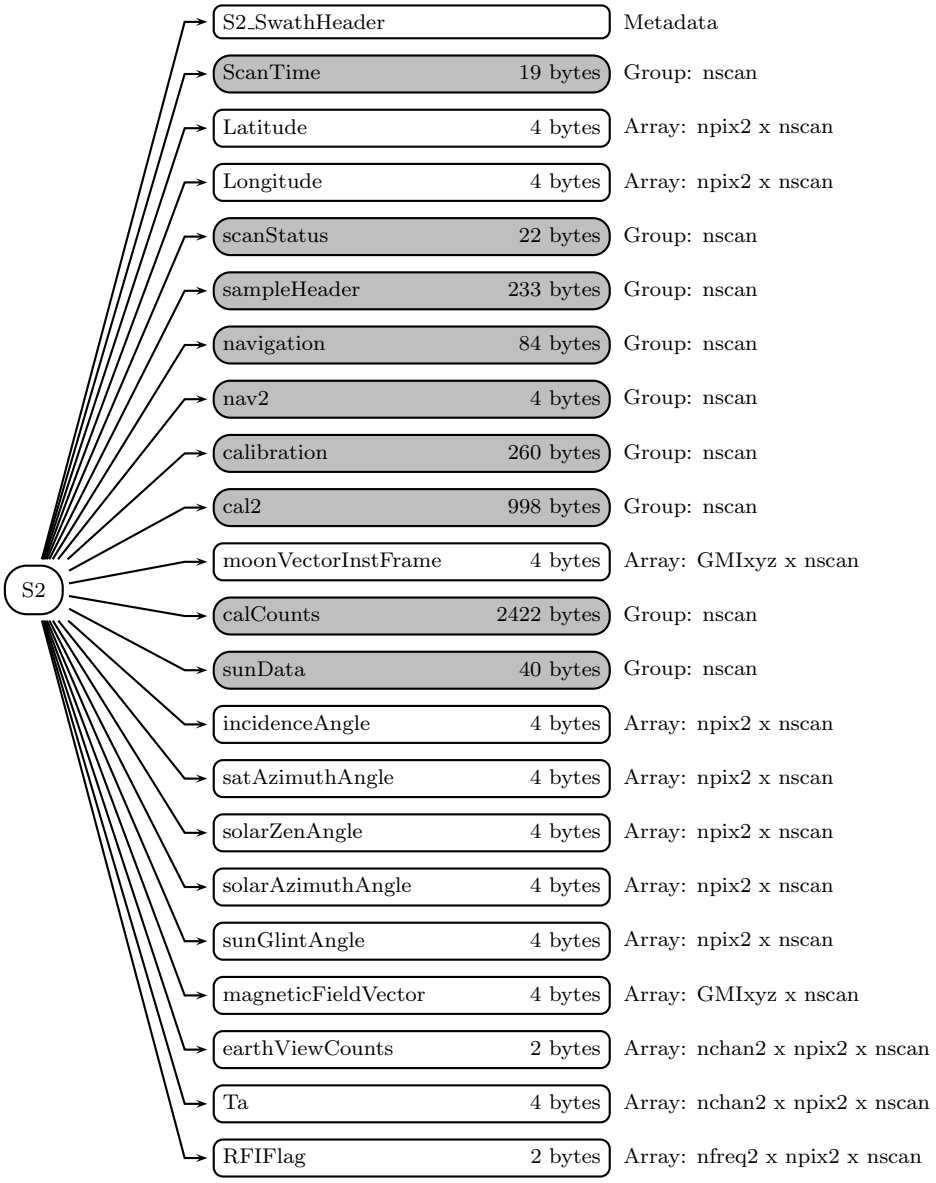


Figure 10: Data Format Structure for GMIBASE, S2

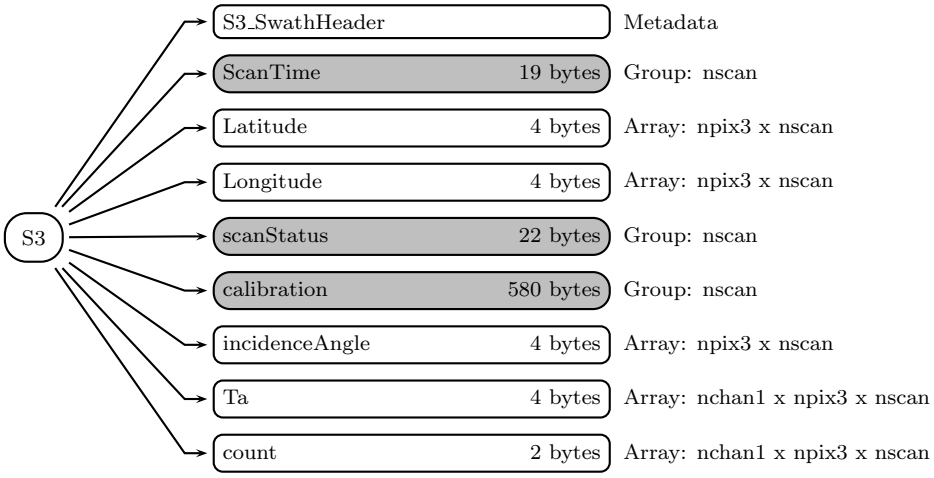


Figure 11: Data Format Structure for GMIBASE, S3

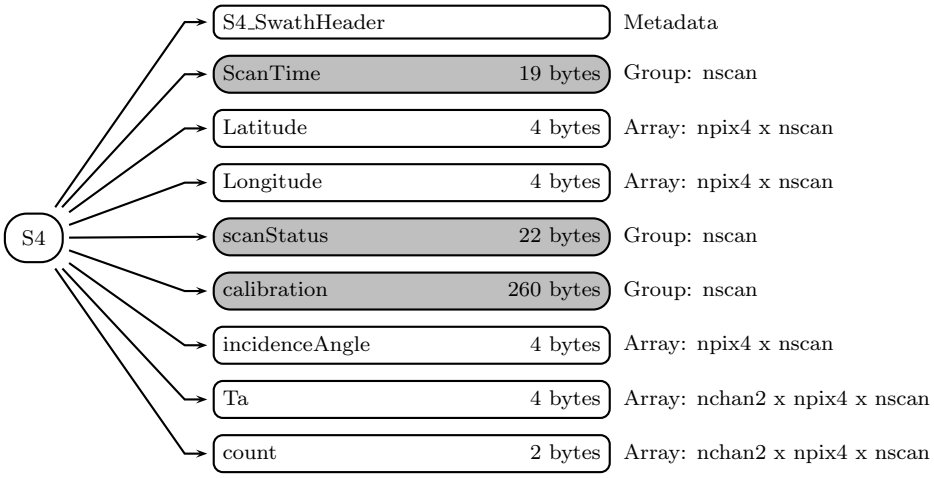


Figure 12: Data Format Structure for GMIBASE, S4

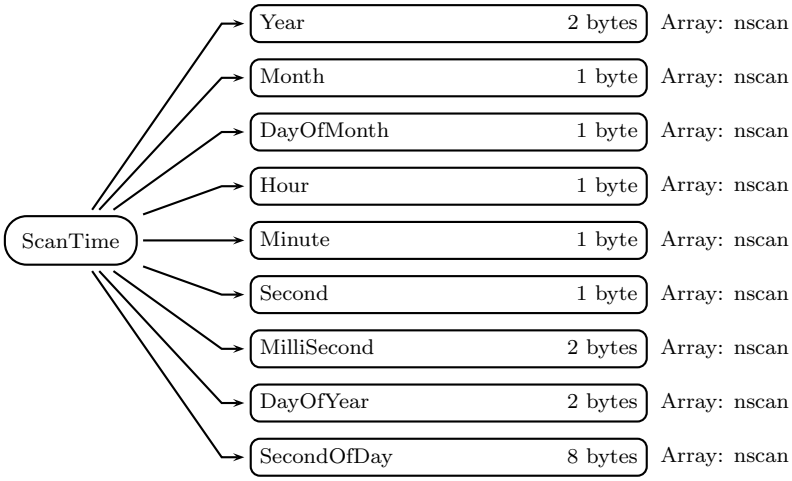


Figure 13: Data Format Structure for GMIBASE, S1, ScanTime

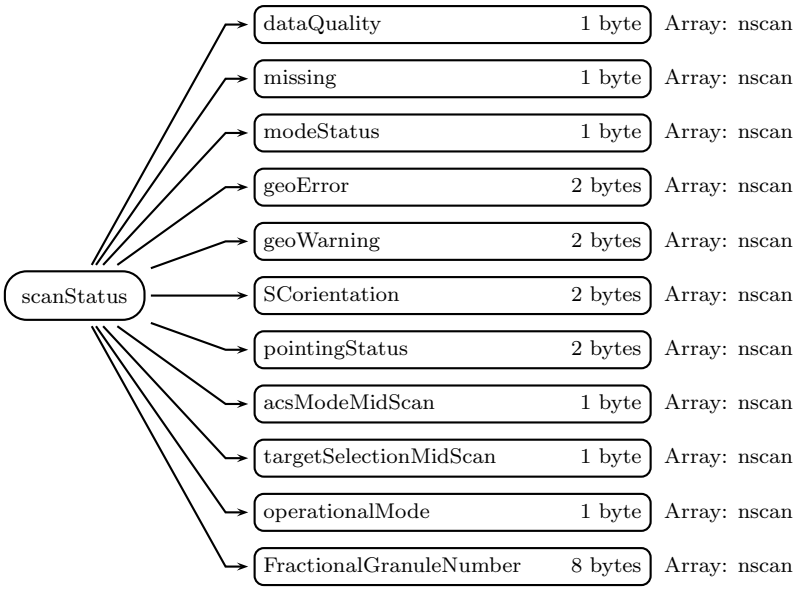


Figure 14: Data Format Structure for GMIBASE, S1, scanStatus

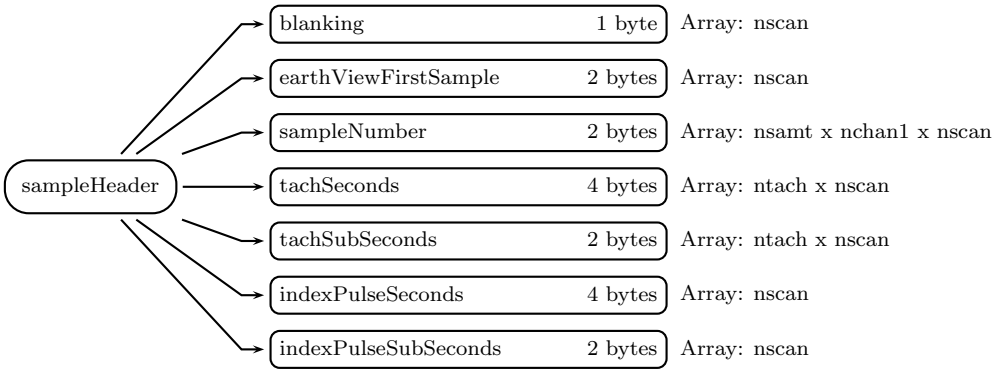


Figure 15: Data Format Structure for GMIBASE, S1, sampleHeader

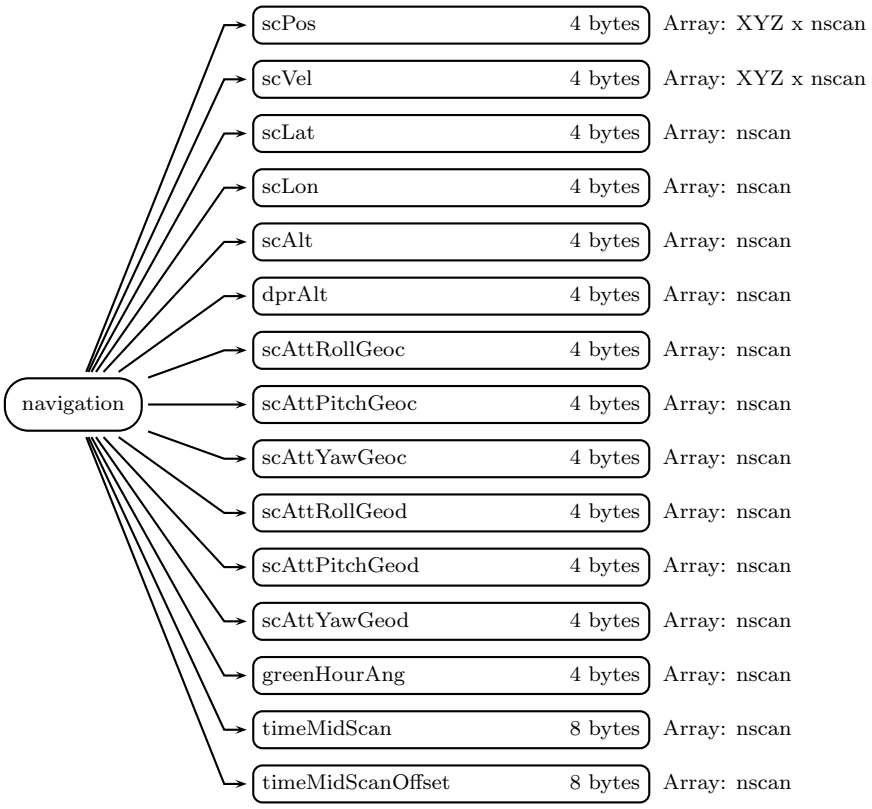


Figure 16: Data Format Structure for GMIBASE, S1, navigation

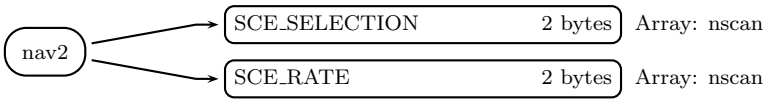


Figure 17: Data Format Structure for GMIBASE, S1, nav2

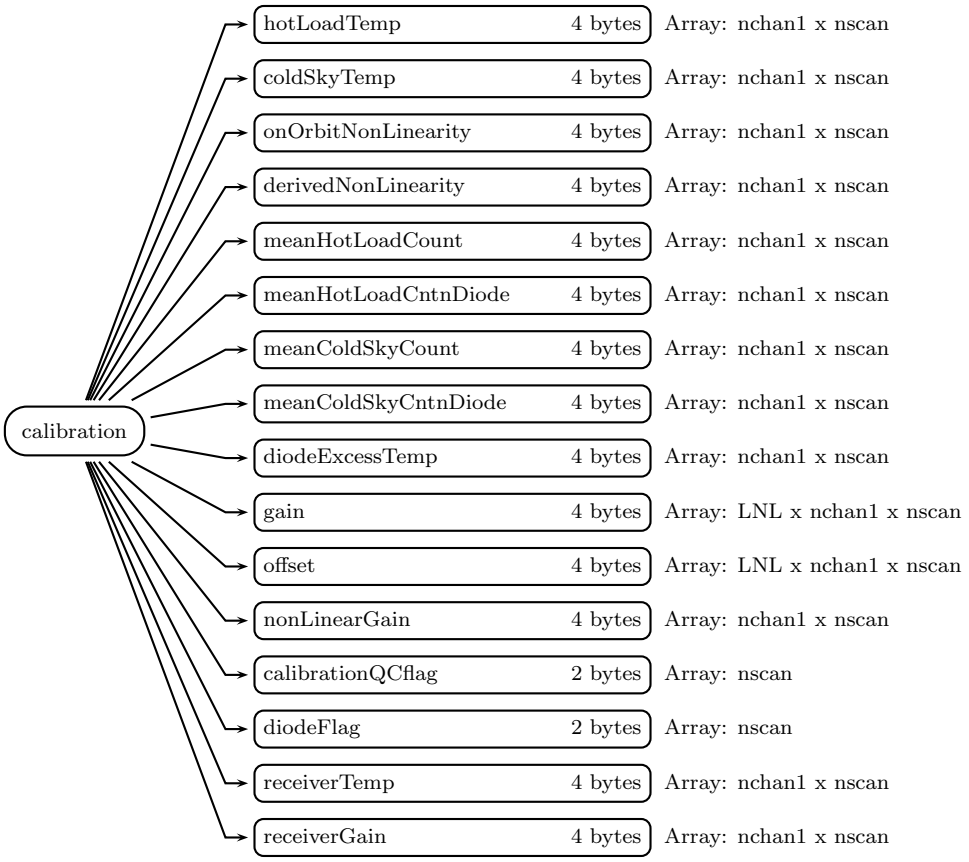
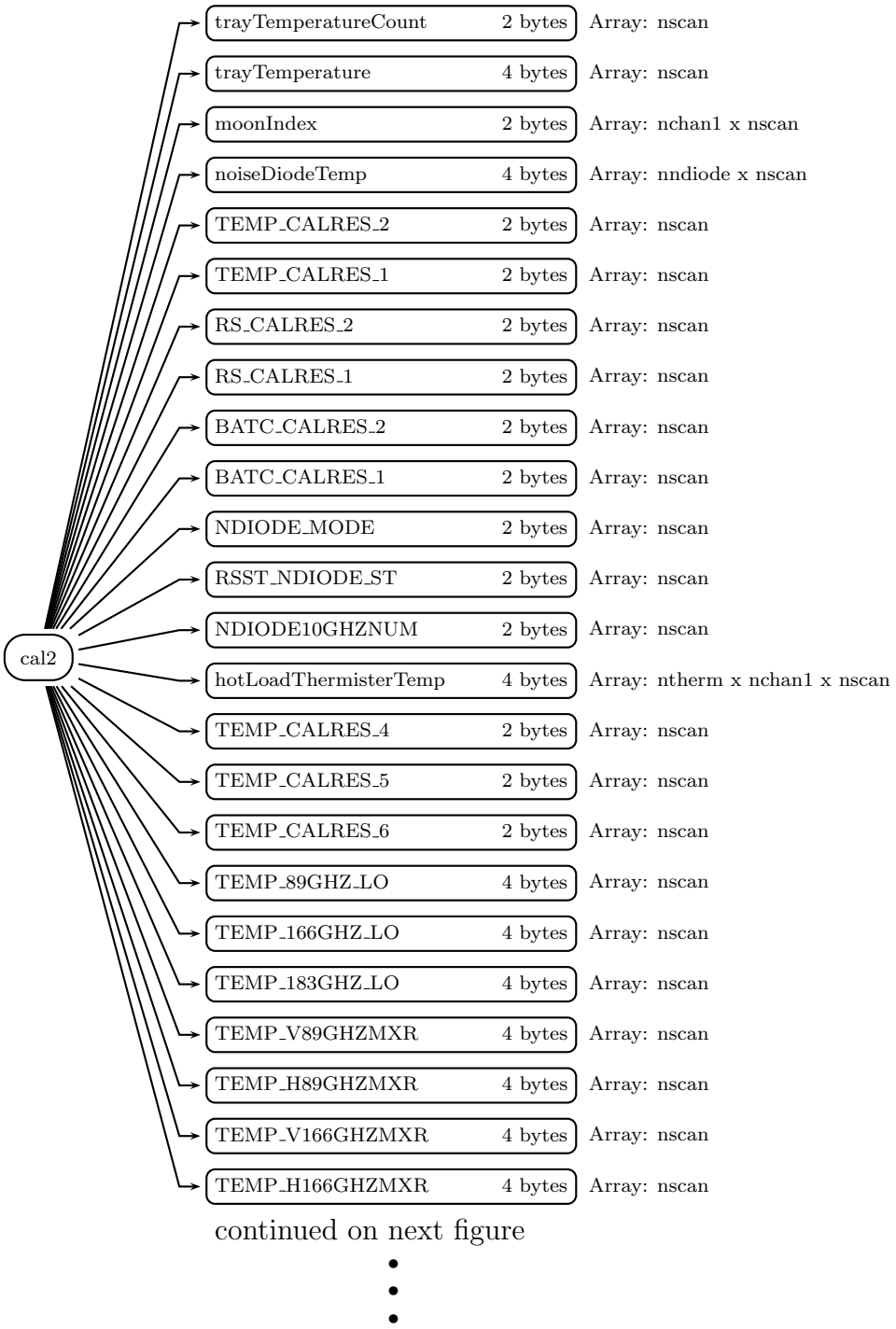


Figure 18: Data Format Structure for GMIBASE, S1, calibration



continued on next figure

Figure 19: Data Format Structure for GMIBASE, cal2

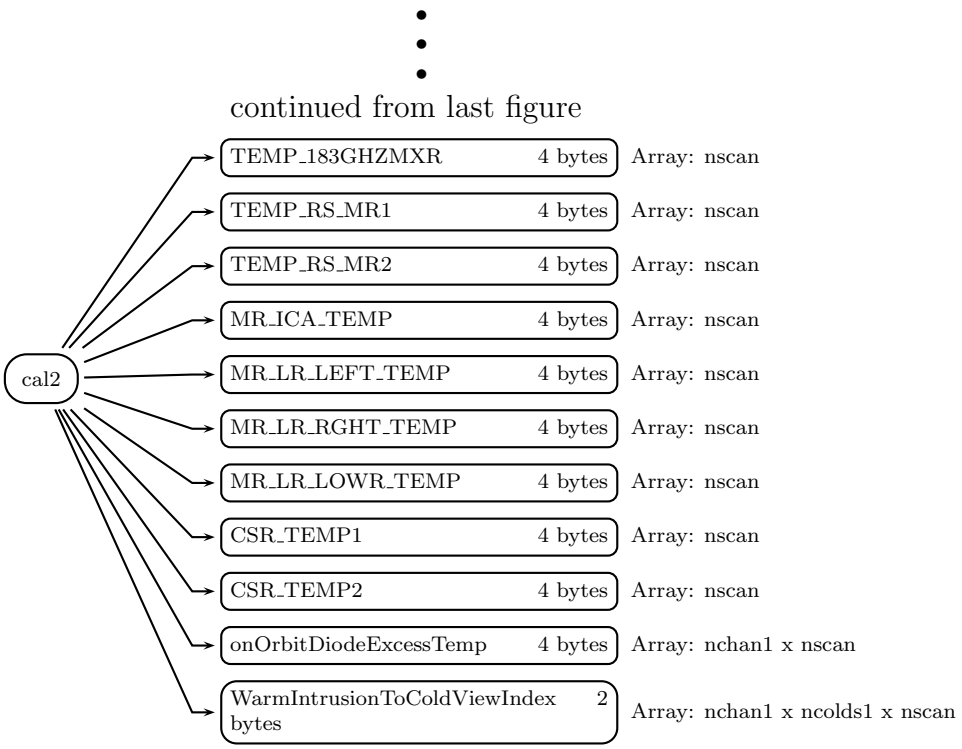


Figure 20: Data Format Structure for GMIBASE, S1, cal2

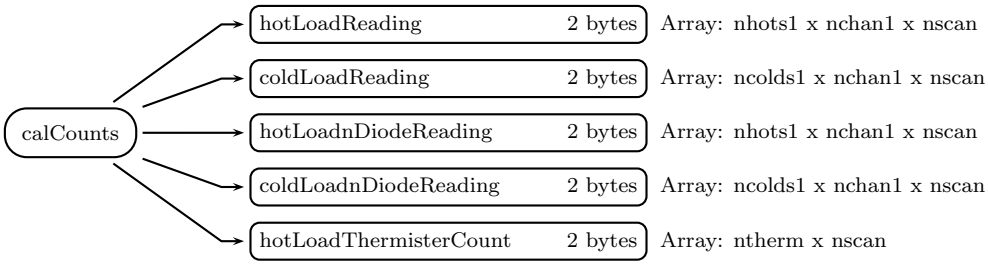


Figure 21: Data Format Structure for GMIBASE, S1, calCounts

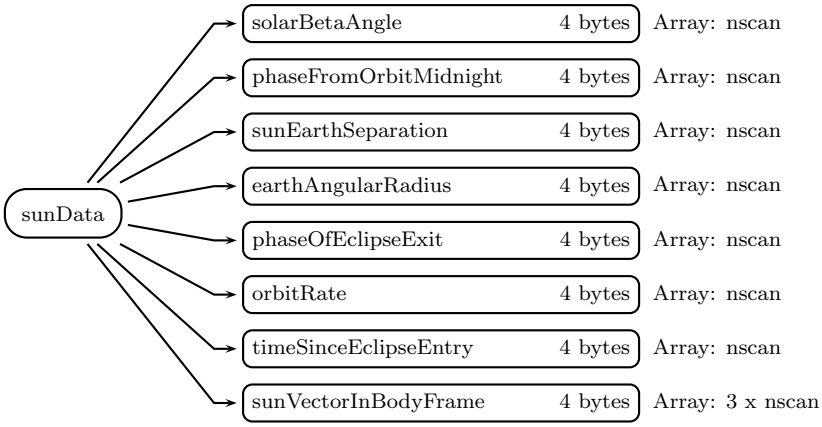


Figure 22: Data Format Structure for GMIBASE, S1, sunData

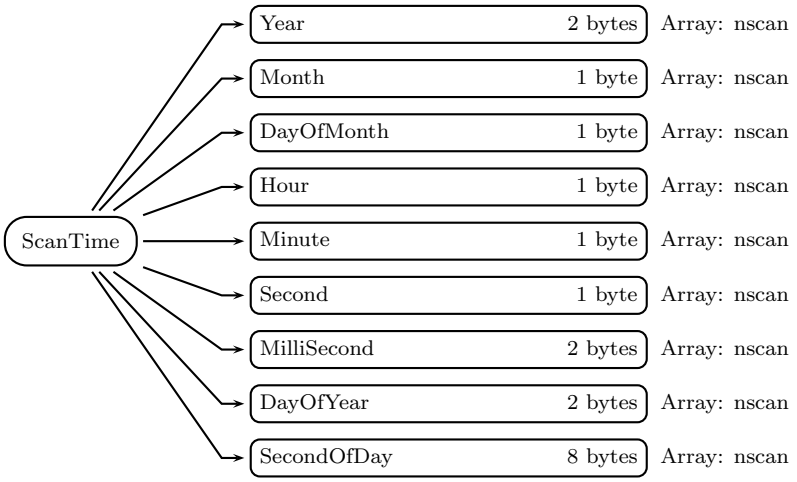


Figure 23: Data Format Structure for GMIBASE, S2, ScanTime

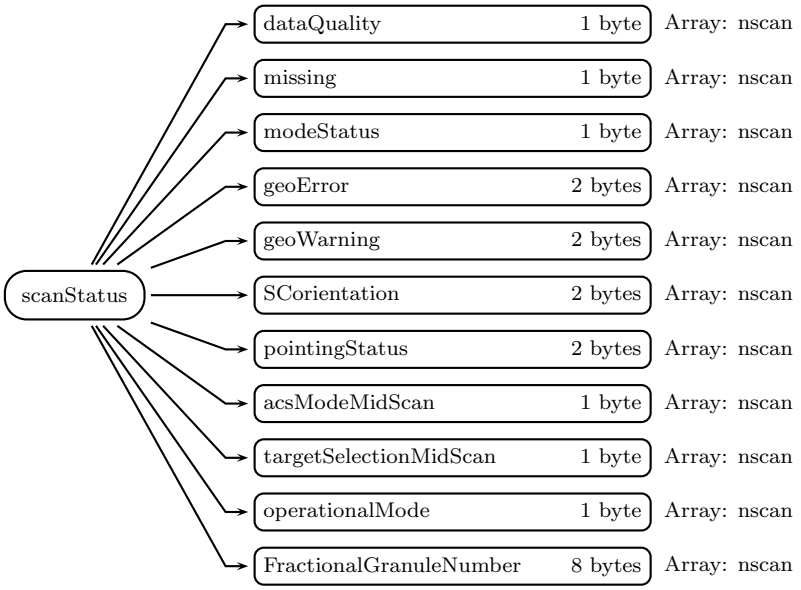


Figure 24: Data Format Structure for GMIBASE, S2, scanStatus

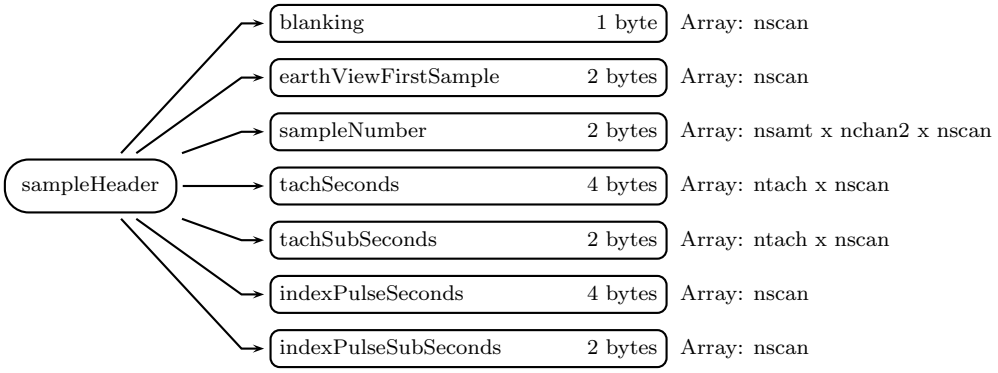


Figure 25: Data Format Structure for GMIBASE, S2, sampleHeader

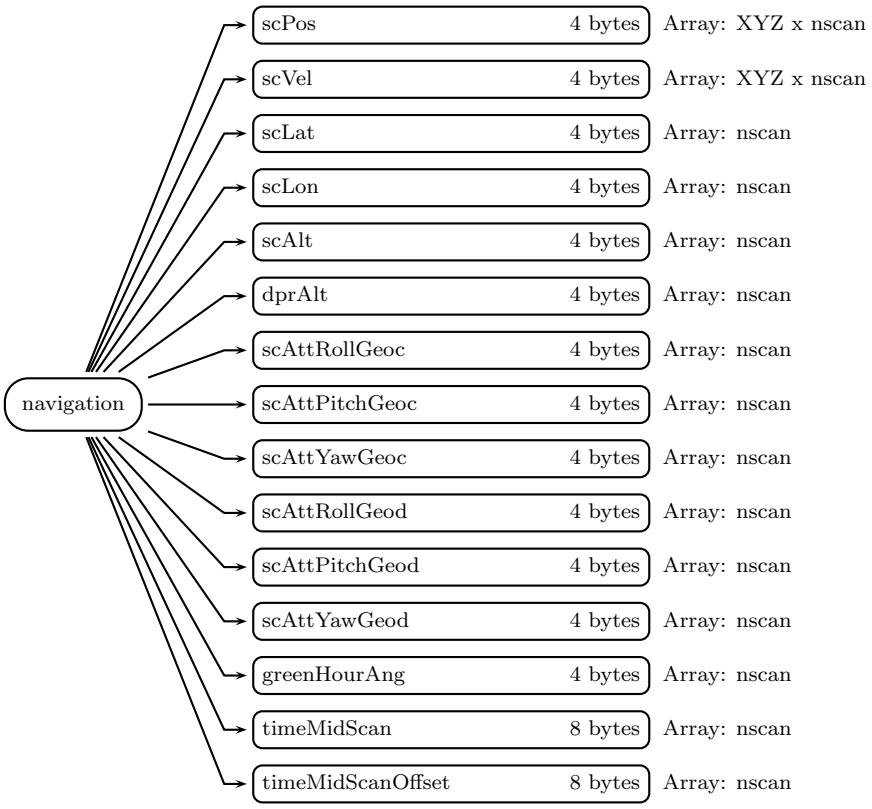


Figure 26: Data Format Structure for GMIBASE, S2, navigation

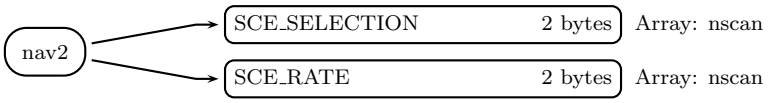


Figure 27: Data Format Structure for GMIBASE, S2, nav2

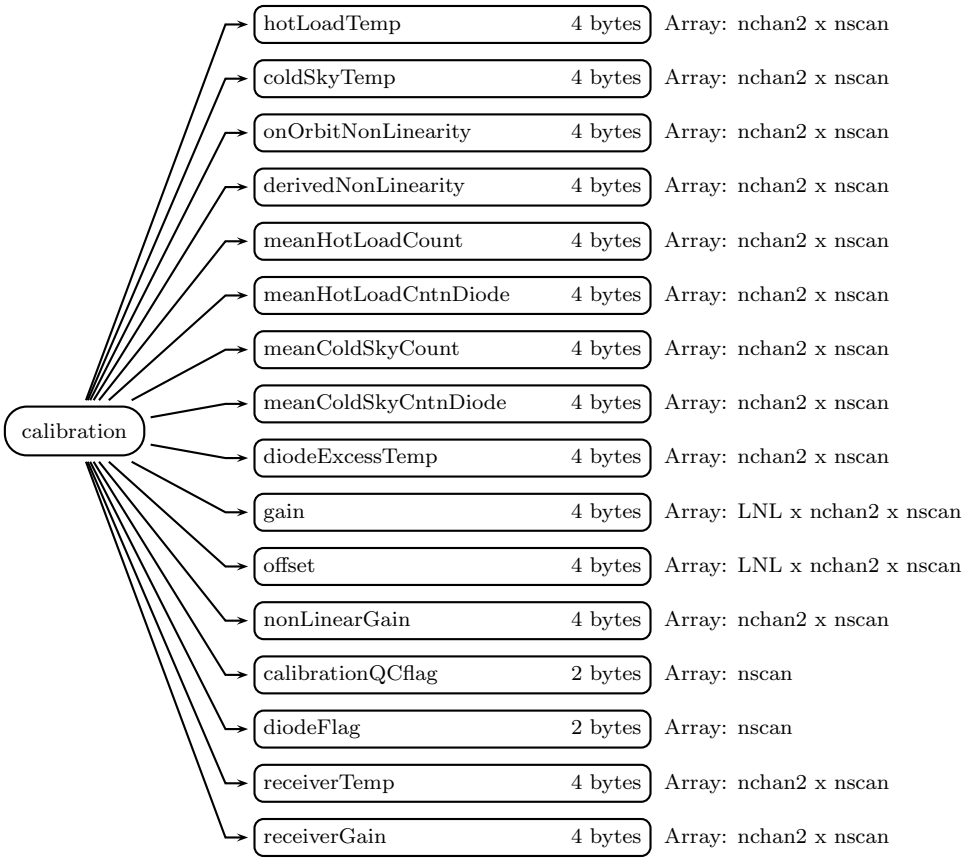


Figure 28: Data Format Structure for GMIBASE, S2, calibration

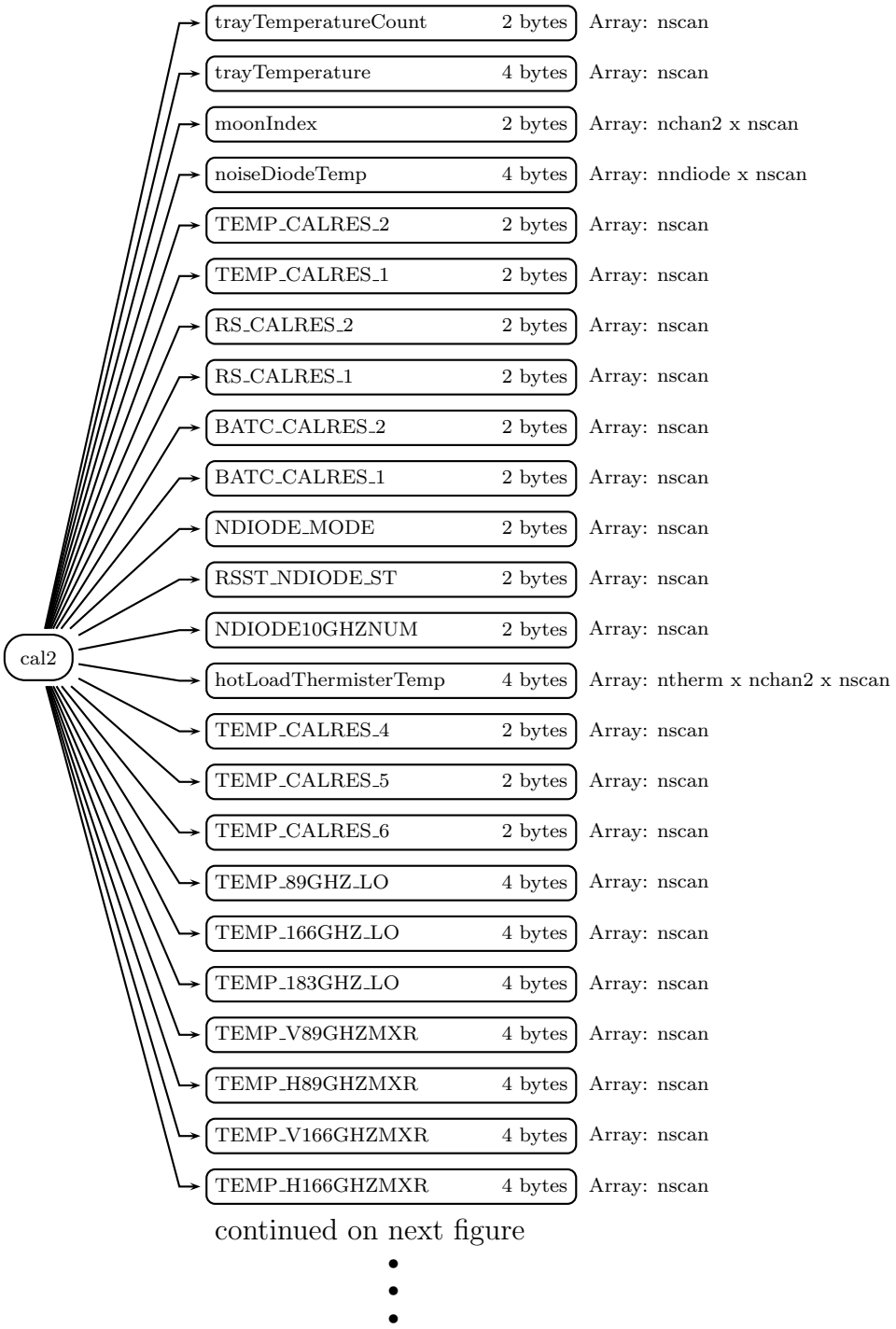


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Figure 29: Data Format Structure for GMIBASE, cal2

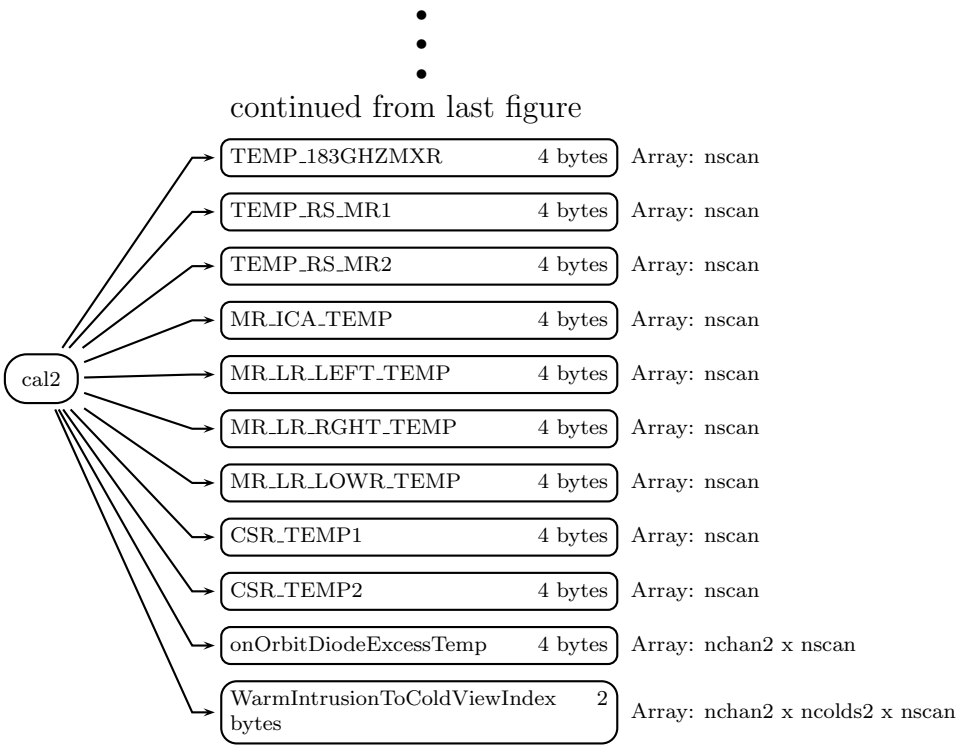


Figure 30: Data Format Structure for GMIBASE, S2, cal2

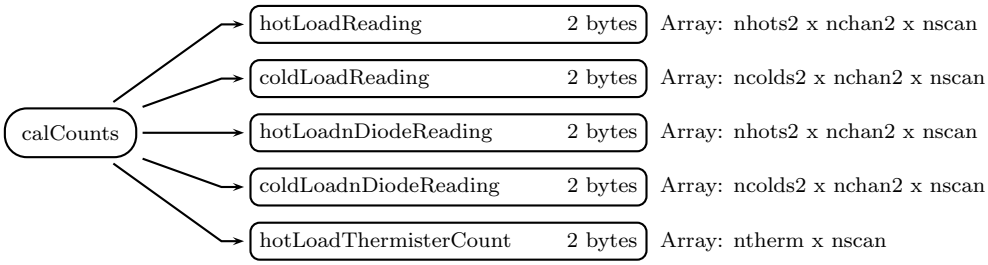


Figure 31: Data Format Structure for GMIBASE, S2, calCounts

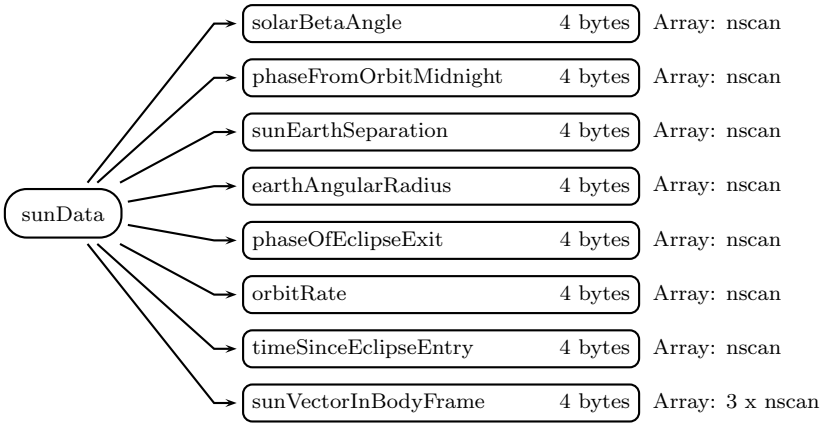


Figure 32: Data Format Structure for GMIBASE, S2, sunData

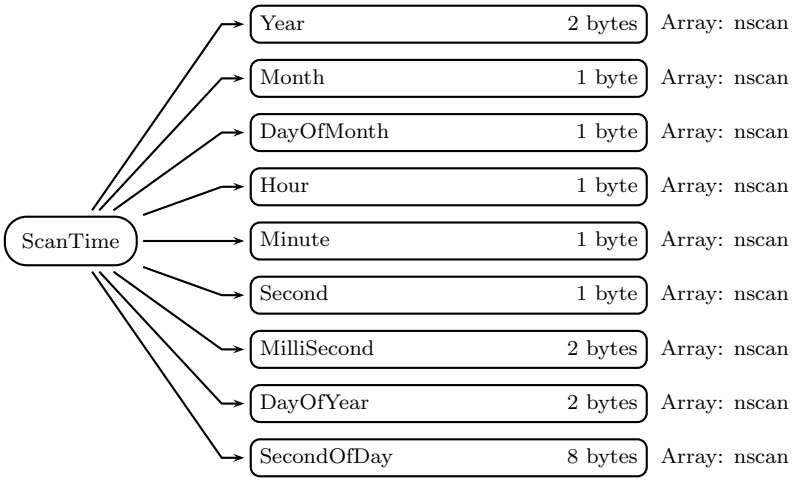


Figure 33: Data Format Structure for GMIBASE, S3, ScanTime

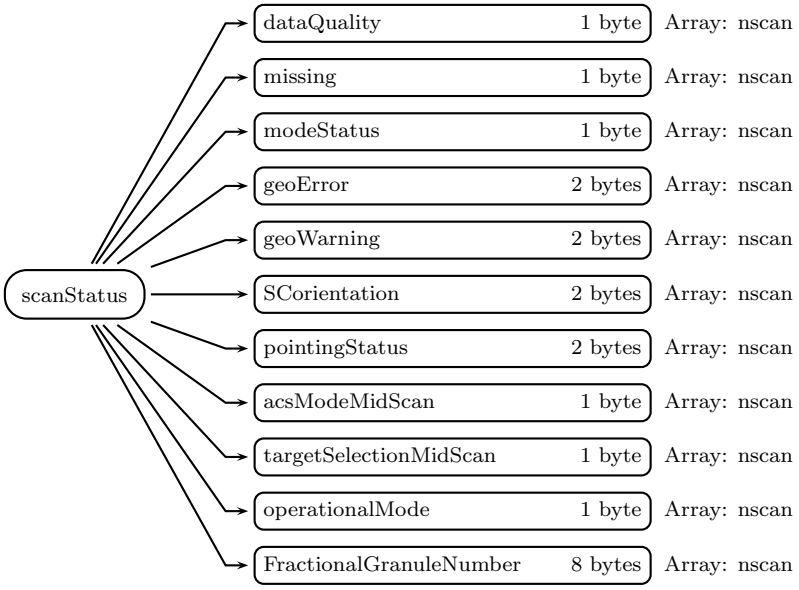


Figure 34: Data Format Structure for GMIBASE, S3, scanStatus

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

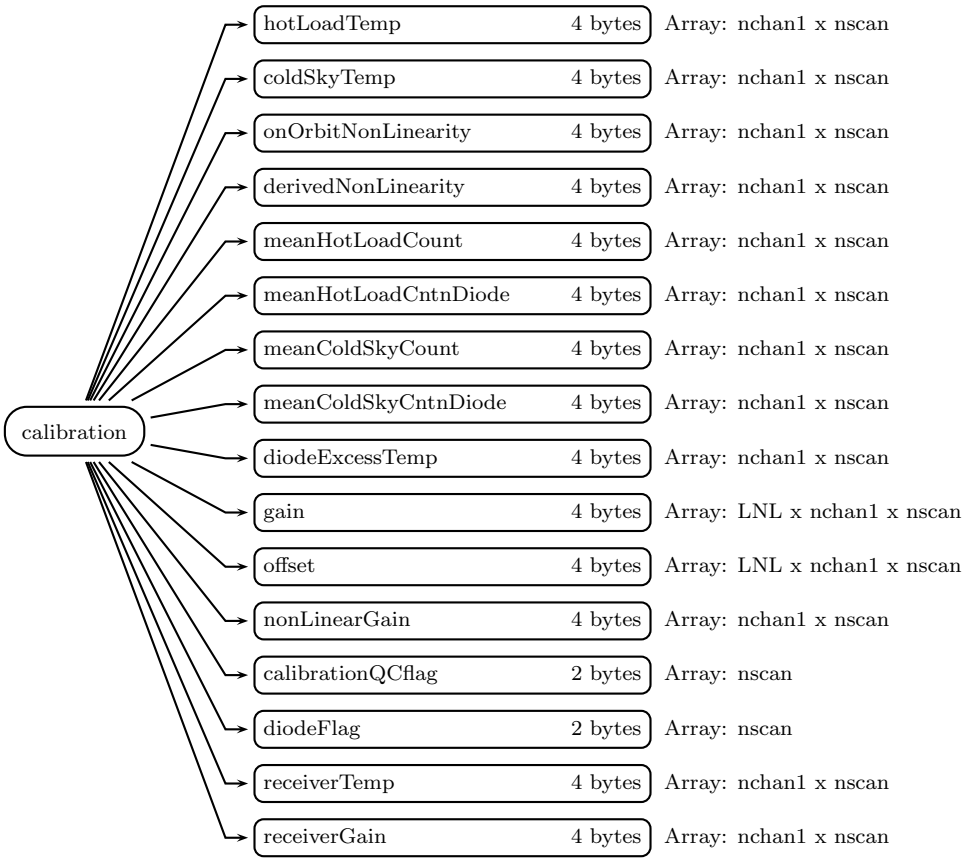


Figure 35: Data Format Structure for GMIBASE, S3, calibration

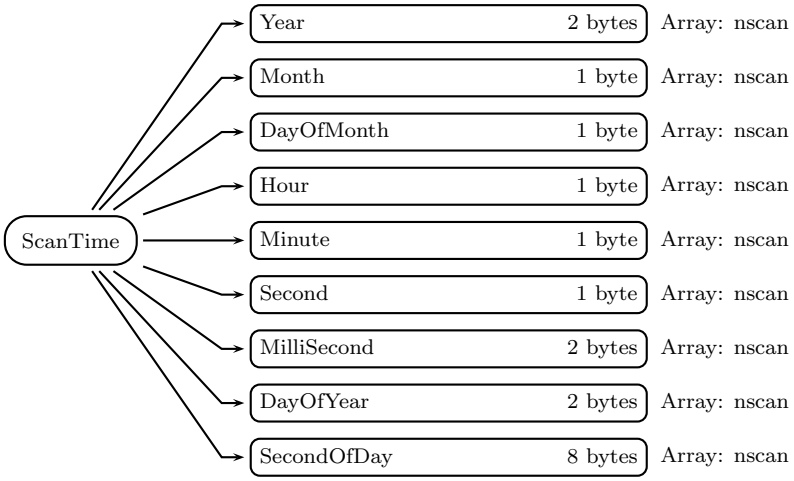


Figure 36: Data Format Structure for GMIBASE, S4, ScanTime

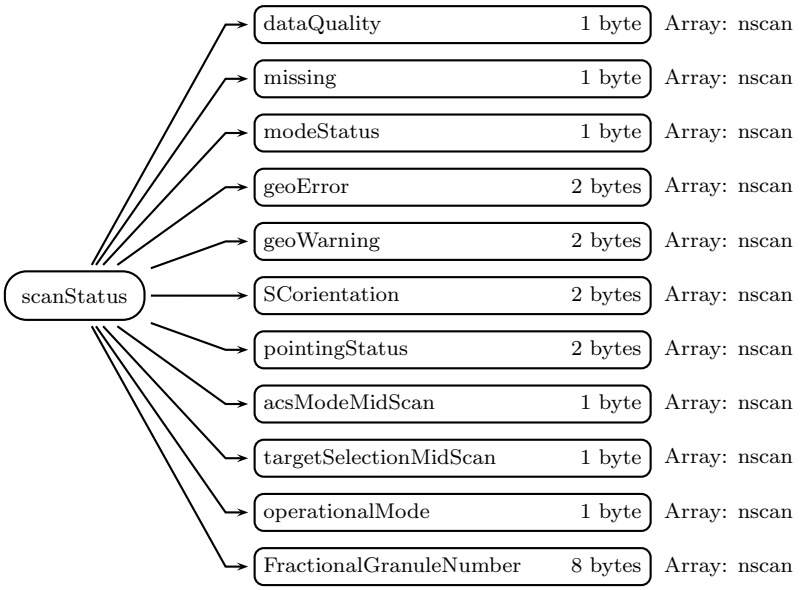


Figure 37: Data Format Structure for GMIBASE, S4, scanStatus

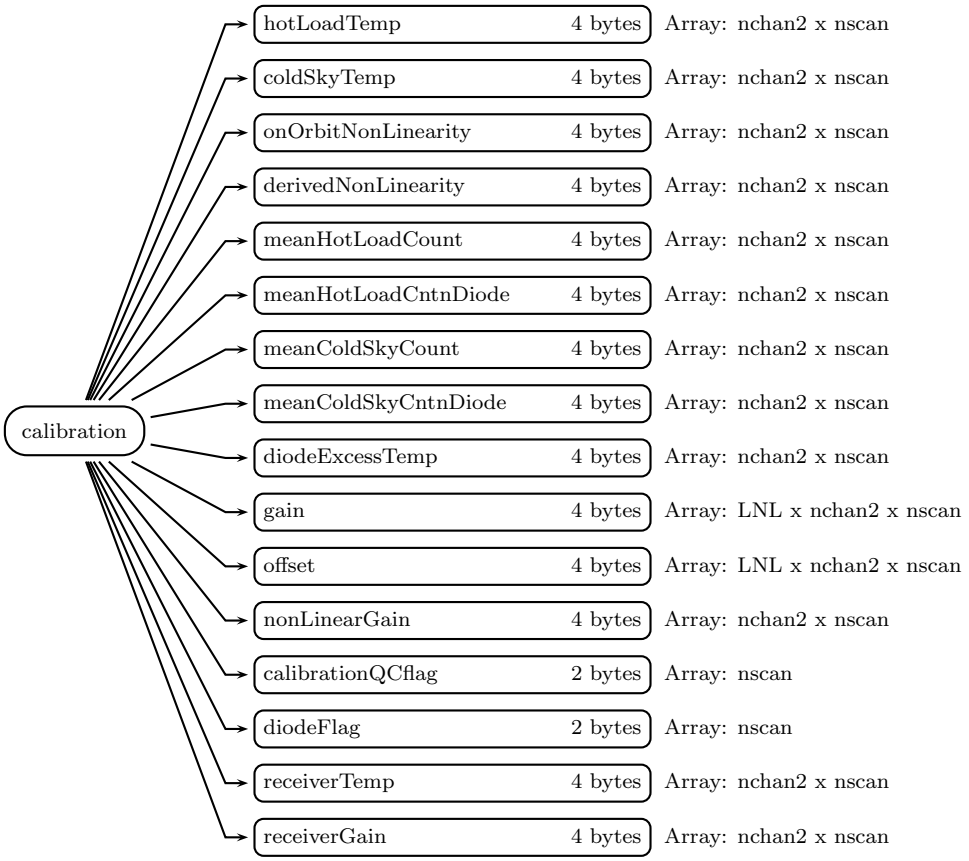


Figure 38: Data Format Structure for GMIBASE, S4, calibration

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix1 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix1 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value

-180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S1)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
```

```
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
```

```
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

sampleHeader (Group in S1)

blanking (1-byte integer, array size: nscan):

```
Value of 0 = Blanking off
Value of 1 = Blanking on
```

earthViewFirstSample (2-byte integer, array size: nscan):
Sample number of the first earth view. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

sampleNumber (2-byte integer, array size: nsamt x nchan1 x nscan):
Number of valid samples in scan. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

tachSeconds (4-byte unsigned integer, array size: ntach x nscan):
Tachometer seconds. Values are in second. Special values are defined as:
0 Missing value

tachSubSeconds (2-byte unsigned integer, array size: ntach x nscan):
Tachometer sub_seconds. Values range from 0 to 62499 in units of 16 microseconds. The missing value is 65535.

indexPulseSeconds (4-byte unsigned integer, array size: nscan):
Index Pulse seconds. Values are in second. Special values are defined as:
0 Missing value

indexPulseSubSeconds (2-byte unsigned integer, array size: nscan):
Index Pulse subseconds. Values range from 0 to 62499 in units of 16 microseconds. The missing value is 65535.

navigation (Group in S1)

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the

Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

nav2 (Group in S1)

SCE_SELECTION (2-byte unsigned integer, array size: nscan):
The current SCE selection setting. Special values are defined as:
0 Missing value

SCE_RATE (2-byte unsigned integer, array size: nscan):
The SMA rotational rate reported by the SCE. To obtain the spin rate in RPM, multiply SCE_RATE by 0.002999106 Values range from 1 to 65535 count. Special values are defined as:
0 Missing value

calibration (Group in S1)

hotLoadTemp (4-byte float, array size: nchan1 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load. For 10, 166, 183 GHZ channles, they are averages of PRT 1,7,8,9,10. For 18, 23, 36, 89 GHZ channels, they are averages of PRT 2,11,12,13,14. The values are corrected by tray temperature and averaged over closest 5 scans Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan1 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan1 x nscan):
The on Orbit Non-Linearity Tnl computed from ground calibrated u look-up table . Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan1 x nscan):
Non-Linearity Tnl derived from 4-point calibration. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (4-byte float, array size: nchan1 x nscan):
The mean Hot Load Count. Averaged over all Hot samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanHotLoadCntnDiode (4-byte float, array size: nchan1 x nscan):
The mean coupled Hot Load Plus Noise Diode counts Averaged over all samples and closest 5 scans. Values range from 0 to 65535. Special values are defined as:
-9999.9 Missing value

meanColdSkyCount (4-byte float, array size: nchan1 x nscan):
The mean Cold Sky Count.Averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanColdSkyCntnDiode (4-byte float, array size: nchan1 x nscan):
The mean coupled Cold Sky Plus Noise Diode counts, averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

diodeExcessTemp (4-byte float, array size: nchan1 x nscan):
The Noise Diode Excess Temperature. Cold and diode Coupled Temperature=diodeExcessTemp

+ coldSkyTemp. Hot and diode Coupled Temperature=diodeExcessTemp + hotLoadTemp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan1 x nscan):
gain[0] determine the total Ta gain. Ta=offset[0]+gain[0]*earthCount+ nonLinearGaian*earthCount*earthCount. Nonlinearity=offset[1]+gain[1]*earthCount+ nonLinearGaian*earthCount*earthCount. Values range from 0 to 1 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan1 x nscan):
Offset[0] determine the total Ta offset. min=-999 K (from -1 K), max=999 K (from 1 K). Missing value is -9999.9.

nonLinearGain (4-byte float, array size: nchan1 x nscan):
The nonlinear gain. Values range from -1 to 1 K. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. value 0 indicates good calibration. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

```
Diode flag.
0, Noise Diode on
2, Noise Diode off
5, Noise Diode status unknown
```

receiverTemp (4-byte float, array size: nchan1 x nscan):
The receiver temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan1 x nscan):
The receiver gain. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

cal2 (Group in S1)

trayTemperatureCount (2-byte unsigned integer, array size: nscan):
Counts to derive hot load tray temperature. Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

trayTemperature (4-byte float, array size: nscan):
Derive hot load tray temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

moonIndex (2-byte unsigned integer, array size: nchan1 x nscan):
Index determined by the angle between moon vector and cold sample vectors. 0 means angles between moon vector and all cold view vectors are greater than 5 degrees. Non-zero value means the number of cold samples that may be contaminated by moon. Values range from 0 to 100. Special values are defined as:
0 Missing value

noiseDiodeTemp (4-byte float, array size: nndiode x nscan):
Physical temperature of noise diode. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

TEMP_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for PRT temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for PRT temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

RS_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for tray temperature and receiver temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

RS_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for tray temperature and receiver temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

BATC_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for noise diode temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

BATC_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for noise diode temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

NDIODE_MODE (2-byte unsigned integer, array size: nscan):
RS configuration of Noise Diode Mode. 0 = On every scan, 1 = On every other scan, 2

= Off. Values range from 0 to 2 count. Special values are defined as:
65535 Missing value

RSST_NDIODE_ST (2-byte unsigned integer, array size: nscan):
Noise diode state during the scan. 0 = Noise diodes OFF for the scan, 1 = Noise diodes ON for the scan. Values range from 0 to 1 count. Special values are defined as:
65535 Missing value

NDIODE10GHZNUM (2-byte unsigned integer, array size: nscan):
RS configuration of Noise Diode Start Sample Number, i.e., the sample number where noise diodes are turned on. Values range from 0 to 500 count. Special values are defined as:
65535 Missing value

hotLoadThermisterTemp (4-byte float, array size: ntherm x nchan1 x nscan):
Hot Load Thermister Temperature of 11 PRTs. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

TEMP_CALRES_4 (2-byte unsigned integer, array size: nscan):
Low calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_5 (2-byte unsigned integer, array size: nscan):
High calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_6 (2-byte unsigned integer, array size: nscan):
High calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_89GHZ_LO (4-byte float, array size: nscan):
89 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_166GHZ_LO (4-byte float, array size: nscan):
166 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_183GHZ_LO (4-byte float, array size: nscan):
183 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_V89GHZMXR (4-byte float, array size: nscan):
89 GHZ V channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_H89GHZMXR (4-byte float, array size: nscan):
89 GHZ H channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_V166GHZMXR (4-byte float, array size: nscan):
166 GHZ V channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_H166GHZMXR (4-byte float, array size: nscan):
166 GHZ H channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_183GHZMXR (4-byte float, array size: nscan):
183 GHZ Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_RS_MR1 (4-byte float, array size: nscan):
Main Reflector Temperature Read By RS 1 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_RS_MR2 (4-byte float, array size: nscan):
Main Reflector Temperature Read By RS 2 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_ICA_TEMP (4-byte float, array size: nscan):
Main Reflector Temperature Read By ICA Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_LEFT_TEMP (4-byte float, array size: nscan):
Main Reflector left Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_RGHT_TEMP (4-byte float, array size: nscan):
Main Reflector right Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_LOWR_TEMP (4-byte float, array size: nscan):
Main Reflector lower Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

CSR_TEMP1 (4-byte float, array size: nscan):
Cold Sky Reflector Temperature 1 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

CSR_TEMP2 (4-byte float, array size: nscan):
Cold Sky Reflector Temperature 2 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

onOrbitDiodeExcessTemp (4-byte float, array size: nchan1 x nscan):
Diode Excess Temperature derived from on orbit trended look-up tables as a function of noise diode temperature from telemetry. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

WarmIntrusionToColdViewIndex (2-byte unsigned integer, array size: nchan1 x ncolds1 x nscan):
Index flag to determine if a cold view sample is contaminated by certain warmer sources. If the value is 0, the sample is good and the count is used in calibration. If the value is non-zero, the sample is contaminated and excluded in calibration.

```
0:  Good sample
1:  Bad sample determined by limit check
2:  Bad sample determined by 2D medium filter
```

Values range from 0 to 2. Special values are defined as:
65535 Missing value

moonVectorInstFrame (4-byte float, array size: GMIxyz x nscan):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

calCounts (Group in S1)

hotLoadReading (2-byte unsigned integer, array size: nhots1 x nchan1 x nscan):
Hot Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

coldLoadReading (2-byte unsigned integer, array size: ncolds1 x nchan1 x nscan):
Cold Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadnDiodeReading (2-byte unsigned integer, array size: nhots1 x nchan1 x nscan):
Hot Load Plus Diode Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

coldLoadnDiodeReading (2-byte unsigned integer, array size: ncolds1 x nchan1 x nscan):
Cold Load Plus Diode Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadThermisterCount (2-byte unsigned integer, array size: ntherm x nscan):
Counts from 11 PRTs in the hot load Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

sunData (Group in S1)

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius.

Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: 3 x nscan):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix1 x nscan):
The angle at the center of the IFOV between the antenna boresight vector and the zenith vector normal to the Earth Ellipsiod. Also known as Satellite Zenith Angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npix1 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npix1 x nscan):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npix1 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npix1 x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location

on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

magneticFieldVector (4-byte float, array size: GMIxyz x nscan):
Magnetometer volt reading in TAM (x, y, z) coordinate system. Used to perform along-scan correction of earth view counts. (The TAM (x,y,z) coordinate system is similar to GPM S/C coordinate system but y and z axis are rotated by 180 degrees.) Values range from -500 to 500 V. Special values are defined as:
-9999.9 Missing value

earthViewCounts (2-byte unsigned integer, array size: nchan1 x npix1 x nscan):
Earth view counts. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

Ta (4-byte float, array size: nchan1 x npix1 x nscan):
Earth view antenna temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

RFIFlag (2-byte integer, array size: nfreq1 x npix1 x nscan):

```
Radio Frequency Interference (RFI) Flag.  The flag is set
to non-zero if the pixel is contaminated by RFI according
to certain filters.  Current values are:

0:     Not affected by RFI.
1:     Affected by RFI with X-cal filter.
2:     Affected by RFI with RSS filter.
3-7:   Spare
-9999: Missing
```

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S2)
A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix2 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix2 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value

-180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S2)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
```

```
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
```

```
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

sampleHeader (Group in S2)

blanking (1-byte integer, array size: nscan):

```
Value of 0 = Blanking off
Value of 1 = Blanking on
```

earthViewFirstSample (2-byte integer, array size: nscan):
Sample number of the first earth view. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

sampleNumber (2-byte integer, array size: nsamt x nchan2 x nscan):
Number of valid samples in scan. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

tachSeconds (4-byte unsigned integer, array size: ntach x nscan):
Tachometer seconds. Values are in second. Special values are defined as:
0 Missing value

tachSubSeconds (2-byte unsigned integer, array size: ntach x nscan):
Tachometer sub_seconds. Values range from 0 to 62499 in units of 16 microseconds. The missing value is 65535.

indexPulseSeconds (4-byte unsigned integer, array size: nscan):
Index Pulse seconds. Values are in second. Special values are defined as:
0 Missing value

indexPulseSubSeconds (2-byte unsigned integer, array size: nscan):
Index Pulse subseconds. Values range from 0 to 62499 in units of 16 microseconds. The missing value is 65535.

navigation (Group in S2)

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the

Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

nav2 (Group in S2)

SCE_SELECTION (2-byte unsigned integer, array size: nscan):
The current SCE selection setting. Special values are defined as:
0 Missing value

SCE_RATE (2-byte unsigned integer, array size: nscan):
The SMA rotational rate reported by the SCE. To obtain the spin rate in RPM, multiply SCE_RATE by 0.002999106 Values range from 1 to 65535 count. Special values are defined as:
0 Missing value

calibration (Group in S2)

hotLoadTemp (4-byte float, array size: nchan2 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load. For 10, 166, 183 GHZ channles, they are averages of PRT 1,7,8,9,10. For 18, 23, 36, 89 GHZ channels, they are averages of PRT 2,11,12,13,14. The values are corrected by tray temperature and averaged over closest 5 scans Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan2 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan2 x nscan):
The on Orbit Non-Linearity Tnl computed from ground calibrated u look-up table . Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan2 x nscan):
Non-Linearity Tnl derived from 4-point calibration. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (4-byte float, array size: nchan2 x nscan):
The mean Hot Load Count. Averaged over all Hot samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanHotLoadCntnDiode (4-byte float, array size: nchan2 x nscan):
The mean coupled Hot Load Plus Noise Diode counts Averaged over all samples and closest 5 scans. Values range from 0 to 65535. Special values are defined as:
-9999.9 Missing value

meanColdSkyCount (4-byte float, array size: nchan2 x nscan):
The mean Cold Sky Count.Averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanColdSkyCntnDiode (4-byte float, array size: nchan2 x nscan):
The mean coupled Cold Sky Plus Noise Diode counts, averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

diodeExcessTemp (4-byte float, array size: nchan2 x nscan):
The Noise Diode Excess Temperature. Cold and diode Coupled Temperature=diodeExcessTemp

+ coldSkyTemp. Hot and diode Coupled Temperature=diodeExcessTemp + hotLoadTemp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan2 x nscan):
gain[0] determine the total Ta gain. Ta=offset[0]+gain[0]*earthCount+ nonLinearGaian*earthCount*earthCount. Nonlinearity=offset[1]+gain[1]*earthCount+ nonLinearGaian*earthCount*earthCount. Values range from 0 to 1 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan2 x nscan):
Offset[0] determine the total Ta offset. min=-999 K (from -1 K), max=999 K (from 1 K). Missing value is -9999.9.

nonLinearGain (4-byte float, array size: nchan2 x nscan):
The nonlinear gain. Values range from -1 to 1 K. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. value 0 indicates good calibration. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

```
Diode flag.
0, Noise Diode on
2, Noise Diode off
5, Noise Diode status unknown
```

receiverTemp (4-byte float, array size: nchan2 x nscan):
The receiver temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan2 x nscan):
The receiver gain. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

cal2 (Group in S2)

trayTemperatureCount (2-byte unsigned integer, array size: nscan):
Counts to derive hot load tray temperature. Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

trayTemperature (4-byte float, array size: nscan):
Derive hot load tray temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

moonIndex (2-byte unsigned integer, array size: nchan2 x nscan):
Index determined by the angle between moon vector and cold sample vectors. 0 means angles between moon vector and all cold view vectors are greater than 5 degrees. Non-zero value means the number of cold samples that may be contaminated by moon. Values range from 0 to 100. Special values are defined as:
0 Missing value

noiseDiodeTemp (4-byte float, array size: nndiode x nscan):
Physical temperature of noise diode. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

TEMP_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for PRT temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for PRT temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

RS_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for tray temperature and receiver temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

RS_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for tray temperature and receiver temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

BATC_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for noise diode temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

BATC_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for noise diode temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

NDIODE_MODE (2-byte unsigned integer, array size: nscan):
RS configuration of Noise Diode Mode. 0 = On every scan, 1 = On every other scan, 2

= Off. Values range from 0 to 2 count. Special values are defined as:
65535 Missing value

RSST_NDIODE_ST (2-byte unsigned integer, array size: nscan):
Noise diode state during the scan. 0 = Noise diodes OFF for the scan, 1 = Noise diodes ON for the scan. Values range from 0 to 1 count. Special values are defined as:
65535 Missing value

NDIODE10GHZNUM (2-byte unsigned integer, array size: nscan):
RS configuration of Noise Diode Start Sample Number, i.e., the sample number where noise diodes are turned on. Values range from 0 to 500 count. Special values are defined as:
65535 Missing value

hotLoadThermisterTemp (4-byte float, array size: ntherm x nchan2 x nscan):
Hot Load Thermister Temperature of 11 PRTs. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

TEMP_CALRES_4 (2-byte unsigned integer, array size: nscan):
Low calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_5 (2-byte unsigned integer, array size: nscan):
High calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_6 (2-byte unsigned integer, array size: nscan):
High calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_89GHZ_LO (4-byte float, array size: nscan):
89 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_166GHZ_LO (4-byte float, array size: nscan):
166 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_183GHZ_LO (4-byte float, array size: nscan):
183 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_V89GHZMXR (4-byte float, array size: nscan):
89 GHZ V channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_H89GHZMXR (4-byte float, array size: nscan):
89 GHZ H channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_V166GHZMXR (4-byte float, array size: nscan):
166 GHZ V channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_H166GHZMXR (4-byte float, array size: nscan):
166 GHZ H channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_183GHZMXR (4-byte float, array size: nscan):
183 GHZ Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_RS_MR1 (4-byte float, array size: nscan):
Main Reflector Temperature Read By RS 1 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_RS_MR2 (4-byte float, array size: nscan):
Main Reflector Temperature Read By RS 2 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_ICA_TEMP (4-byte float, array size: nscan):
Main Reflector Temperature Read By ICA Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_LEFT_TEMP (4-byte float, array size: nscan):
Main Reflector left Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_RGHT_TEMP (4-byte float, array size: nscan):
Main Reflector right Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_LOWR_TEMP (4-byte float, array size: nscan):
Main Reflector lower Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

CSR_TEMP1 (4-byte float, array size: nscan):
Cold Sky Reflector Temperature 1 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

CSR_TEMP2 (4-byte float, array size: nscan):
Cold Sky Reflector Temperature 2 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

onOrbitDiodeExcessTemp (4-byte float, array size: nchan2 x nscan):
Diode Excess Temperature derived from on orbit trended look-up tables as a function of noise diode temperature from telemetry. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

WarmIntrusionToColdViewIndex (2-byte unsigned integer, array size: nchan2 x ncolds2 x nscan):
Index flag to determine if a cold view sample is contaminated by certain warmer sources. If the value is 0, the sample is good and the count is used in calibration. If the value is non-zero, the sample is contaminated and excluded in calibration.

```
0:  Good sample
1:  Bad sample determined by limit check
2:  Bad sample determined by 2D medium filter
```

Values range from 0 to 2. Special values are defined as:
65535 Missing value

moonVectorInstFrame (4-byte float, array size: GMIxyz x nscan):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

calCounts (Group in S2)

hotLoadReading (2-byte unsigned integer, array size: nhots2 x nchan2 x nscan):
Hot Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

coldLoadReading (2-byte unsigned integer, array size: ncolds2 x nchan2 x nscan):
Cold Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadnDiodeReading (2-byte unsigned integer, array size: nhots2 x nchan2 x nscan):
Hot Load Plus Diode Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

coldLoadnDiodeReading (2-byte unsigned integer, array size: ncolds2 x nchan2 x nscan):
Cold Load Plus Diode Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadThermisterCount (2-byte unsigned integer, array size: ntherm x nscan):
Counts from 11 PRTs in the hot load Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

sunData (Group in S2)

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius.

Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: 3 x nscan):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix2 x nscan):
The angle at the center of the IFOV between the antenna boresight vector and the zenith vector normal to the Earth Ellipsiod. Also known as Satellite Zenith Angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npix2 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npix2 x nscan):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npix2 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npix2 x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location

on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

magneticFieldVector (4-byte float, array size: GMIxyz x nscan):
Magnetometer volt reading in TAM (x, y, z) coordinate system. Used to perform along-scan correction of earth view counts. (The TAM (x,y,z) coordinate system is similar to GPM S/C coordinate system but y and z axis are rotated by 180 degrees.) Values range from -500 to 500 V. Special values are defined as:
-9999.9 Missing value

earthViewCounts (2-byte unsigned integer, array size: nchan2 x npix2 x nscan):
Earth view counts. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

Ta (4-byte float, array size: nchan2 x npix2 x nscan):
Earth view antenna temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

RFIFlag (2-byte integer, array size: nfreq2 x npix2 x nscan):

```
Radio Frequency Interference (RFI) Flag.  The flag is set
to non-zero if the pixel is contaminated by RFI according
to certain filters.  Current values are:

0:     Not affected by RFI.
1:     Affected by RFI with X-cal filter.
2:     Affected by RFI with RSS filter.
3-7:   Spare
-9999: Missing
```

S3 (Swath)

S3_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S3)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix3 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix3 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value

-180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S3)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
```

```
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
```

```
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

calibration (Group in S3)

hotLoadTemp (4-byte float, array size: nchan1 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load.

For 10, 166, 183 GHZ channles, they are averages of PRT 1,7,8,9,10. For 18, 23, 36, 89 GHZ channels, they are averages of PRT 2,11,12,13,14. The values are corrected by tray temperature and averaged over closest 5 scans Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan1 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan1 x nscan):
The on Orbit Non-Linearity Tnl computed from ground calibrated u look-up table . Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan1 x nscan):
Non-Linearity Tnl derived from 4-point calibration. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (4-byte float, array size: nchan1 x nscan):
The mean Hot Load Count. Averaged over all Hot samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanHotLoadCntnDiode (4-byte float, array size: nchan1 x nscan):
The mean coupled Hot Load Plus Noise Diode counts Averaged over all samples and closest 5 scans. Values range from 0 to 65535. Special values are defined as:
-9999.9 Missing value

meanColdSkyCount (4-byte float, array size: nchan1 x nscan):
The mean Cold Sky Count.Averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanColdSkyCntnDiode (4-byte float, array size: nchan1 x nscan):
The mean coupled Cold Sky Plus Noise Diode counts, averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

diodeExcessTemp (4-byte float, array size: nchan1 x nscan):
The Noise Diode Excess Temperature. Cold and diode Coupled Temperature=diodeExcessTemp + coldSkyTemp. Hot and diode Coupled Temperature=diodeExcessTemp + hotLoadTemp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan1 x nscan):
gain[0] determine the total Ta gain. Ta=offset[0]+gain[0]*earthCount+ nonLinearGaian*earthCount*earthCount. Nonlinearity=offset[1]+gain[1]*earthCount+ nonLinearGa-

ian*earthCount*earthCount. Values range from 0 to 1 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan1 x nscan):
Offset[0] determine the total Ta offset. min=-999 K (from -1 K), max=999 K (from 1 K). Missing value is -9999.9.

nonLinearGain (4-byte float, array size: nchan1 x nscan):
The nonlinear gain. Values range from -1 to 1 K. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. value 0 indicates good calibration. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

```
Diode flag.
0, Noise Diode on
2, Noise Diode off
5, Noise Diode status unknown
```

receiverTemp (4-byte float, array size: nchan1 x nscan):
The receiver temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan1 x nscan):
The receiver gain. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix3 x nscan):
The angle at the center of the IFOV between the antenna boresight vector and the zenith vector normal to the Earth Ellipsiod. Also known as Satellite Zenith Angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Ta (4-byte float, array size: nchan1 x npix3 x nscan):
Earth view antenna temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

count (2-byte unsigned integer, array size: nchan1 x npix3 x nscan):
Full scan count. Values range from 0 to 65534. Special values are defined as:
65535 Missing value

S4 (Swath)

S4_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S4)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix4 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude

is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix4 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S4)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be

useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

calibration (Group in S4)

hotLoadTemp (4-byte float, array size: nchan2 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load. For 10, 166, 183 GHZ channles, they are averages of PRT 1,7,8,9,10. For 18, 23, 36, 89 GHZ channels, they are averages of PRT 2,11,12,13,14. The values are corrected by tray temperature and averaged over closest 5 scans Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan2 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan2 x nscan):
The on Orbit Non-Linearity Tnl computed from ground calibrated u look-up table . Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan2 x nscan):
Non-Linearity Tnl derived from 4-point calibration. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (4-byte float, array size: nchan2 x nscan):
The mean Hot Load Count. Averaged over all Hot samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanHotLoadCntnDiode (4-byte float, array size: nchan2 x nscan):
The mean coupled Hot Load Plus Noise Diode counts Averaged over all samples and closest 5 scans. Values range from 0 to 65535. Special values are defined as:
-9999.9 Missing value

meanColdSkyCount (4-byte float, array size: nchan2 x nscan):
The mean Cold Sky Count.Averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanColdSkyCntnDiode (4-byte float, array size: nchan2 x nscan):
The mean coupled Cold Sky Plus Noise Diode counts, averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

diodeExcessTemp (4-byte float, array size: nchan2 x nscan):
The Noise Diode Excess Temperature. Cold and diode Coupled Temperature=diodeExcessTemp

+ coldSkyTemp. Hot and diode Coupled Temperature=diodeExcessTemp + hotLoadTemp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan2 x nscan):
gain[0] determine the total Ta gain. Ta=offset[0]+gain[0]*earthCount+ nonLinearGain*earthCount*earthCount. Nonlinearity=offset[1]+gain[1]*earthCount+ nonLinearGain*earthCount*earthCount. Values range from 0 to 1 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan2 x nscan):
Offset[0] determine the total Ta offset. min=-999 K (from -1 K), max=999 K (from 1 K). Missing value is -9999.9.

nonLinearGain (4-byte float, array size: nchan2 x nscan):
The nonlinear gain. Values range from -1 to 1 K. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. value 0 indicates good calibration. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

```
Diode flag.
0, Noise Diode on
2, Noise Diode off
5, Noise Diode status unknown
```

receiverTemp (4-byte float, array size: nchan2 x nscan):
The receiver temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan2 x nscan):
The receiver gain. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix4 x nscan):
The angle at the center of the IFOV between the antenna boresight vector and the zenith vector normal to the Earth Ellipsiod. Also known as Satellite Zenith Angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Ta (4-byte float, array size: nchan2 x npix4 x nscan):
Earth view antenna temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

count (2-byte unsigned integer, array size: nchan2 x npix4 x nscan):
Full scan count. Values range from 0 to 65534. Special values are defined as:
65535 Missing value

C Structure Header file:

```
#ifndef _TK_GMIBASE_H_
#define _TK_GMIBASE_H_

#ifndef _LGMIBASE_S4_CALIBRATION_
#define _LGMIBASE_S4_CALIBRATION_

typedef struct {
    float hotLoadTemp[4];
    float coldSkyTemp[4];
    float onOrbitNonLinearity[4];
    float derivedNonLinearity[4];
    float meanHotLoadCount[4];
    float meanHotLoadCntnDiode[4];
    float meanColdSkyCount[4];
    float meanColdSkyCntnDiode[4];
    float diodeExcessTemp[4];
    float gain[4][2];
    float offset[4][2];
    float nonLinearGain[4];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[4];
    float receiverGain[4];
} LGMIBASE_S4_CALIBRATION;

#endif

#ifndef _LGMIBASE_S4_SCANSTATUS_
#define _LGMIBASE_S4_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
```

```
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} LGMIBASE_S4_SCANSTATUS;

#endif

#ifndef _LGMIBASE_S4_
#define _LGMIBASE_S4_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[500];
    float Longitude[500];
    LGMIBASE_S4_SCANSTATUS scanStatus;
    LGMIBASE_S4_CALIBRATION calibration;
    float incidenceAngle[500];
    float Ta[500][4];
    unsigned short count[500][4];
} LGMIBASE_S4;

#endif

#ifndef _LGMIBASE_S3_CALIBRATION_
#define _LGMIBASE_S3_CALIBRATION_

typedef struct {
    float hotLoadTemp[9];
    float coldSkyTemp[9];
    float onOrbitNonLinearity[9];
    float derivedNonLinearity[9];
    float meanHotLoadCount[9];
    float meanHotLoadCntnDiode[9];
    float meanColdSkyCount[9];
    float meanColdSkyCntnDiode[9];
    float diodeExcessTemp[9];
    float gain[9][2];
    float offset[9][2];
    float nonLinearGain[9];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[9];
```

```
    float receiverGain[9];
} LGMIBASE_S3_CALIBRATION;

#endif

#ifndef _LGMIBASE_S3_SCANSTATUS_
#define _LGMIBASE_S3_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} LGMIBASE_S3_SCANSTATUS;

#endif

#ifndef _LGMIBASE_S3_
#define _LGMIBASE_S3_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[500];
    float Longitude[500];
    LGMIBASE_S3_SCANSTATUS scanStatus;
    LGMIBASE_S3_CALIBRATION calibration;
    float incidenceAngle[500];
    float Ta[500][9];
    unsigned short count[500][9];
} LGMIBASE_S3;

#endif

#ifndef _LGMIBASE_S2_SUNDATA_
#define _LGMIBASE_S2_SUNDATA_
```

```
typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} LGMIBASE_S2_SUNDATA;

#endif

#ifndef _LGMIBASE_S2_CALCOUNTS_
#define _LGMIBASE_S2_CALCOUNTS_

typedef struct {
    unsigned short hotLoadReading[4][65];
    unsigned short coldLoadReading[4][85];
    unsigned short hotLoadnDiodeReading[4][65];
    unsigned short coldLoadnDiodeReading[4][85];
    unsigned short hotLoadThermisterCount[11];
} LGMIBASE_S2_CALCOUNTS;

#endif

#ifndef _LGMIBASE_S2_CAL2_
#define _LGMIBASE_S2_CAL2_

typedef struct {
    unsigned short trayTemperatureCount;
    float trayTemperature;
    unsigned short moonIndex[4];
    float noiseDiodeTemp[6];
    unsigned short TEMP_CALRES_2;
    unsigned short TEMP_CALRES_1;
    unsigned short RS_CALRES_2;
    unsigned short RS_CALRES_1;
    unsigned short BATC_CALRES_2;
    unsigned short BATC_CALRES_1;
    unsigned short NDIODE_MODE;
    unsigned short RSST_NDIODE_ST;
    unsigned short NDIODE10GHZNUM;
```

```
    float hotLoadThermisterTemp[4][11];
    unsigned short TEMP_CALRES_4;
    unsigned short TEMP_CALRES_5;
    unsigned short TEMP_CALRES_6;
    float TEMP_89GHZ_LO;
    float TEMP_166GHZ_LO;
    float TEMP_183GHZ_LO;
    float TEMP_V89GHZMXR;
    float TEMP_H89GHZMXR;
    float TEMP_V166GHZMXR;
    float TEMP_H166GHZMXR;
    float TEMP_183GHZMXR;
    float TEMP_RS_MR1;
    float TEMP_RS_MR2;
    float MR_ICA_TEMP;
    float MR_LR_LEFT_TEMP;
    float MR_LR_RGHT_TEMP;
    float MR_LR_LOWR_TEMP;
    float CSR_TEMP1;
    float CSR_TEMP2;
    float onOrbitDiodeExcessTemp[4];
    unsigned short WarmIntrusionToColdViewIndex[85][4];
} LGMIBASE_S2_CAL2;

#endif

#ifndef _LGMIBASE_S2_CALIBRATION_
#define _LGMIBASE_S2_CALIBRATION_

typedef struct {
    float hotLoadTemp[4];
    float coldSkyTemp[4];
    float onOrbitNonLinearity[4];
    float derivedNonLinearity[4];
    float meanHotLoadCount[4];
    float meanHotLoadCntnDiode[4];
    float meanColdSkyCount[4];
    float meanColdSkyCntnDiode[4];
    float diodeExcessTemp[4];
    float gain[4][2];
    float offset[4][2];
    float nonLinearGain[4];
    short calibrationQCflag;
```

```
    short diodeFlag;
    float receiverTemp[4];
    float receiverGain[4];
} LGMIBASE_S2_CALIBRATION;

#endif

#ifndef _LGMIBASE_S2_NAV2_
#define _LGMIBASE_S2_NAV2_

typedef struct {
    unsigned short SCE_SELECTION;
    unsigned short SCE_RATE;
} LGMIBASE_S2_NAV2;

#endif

#ifndef _LGMIBASE_S2_SAMPLEHEADER_
#define _LGMIBASE_S2_SAMPLEHEADER_

typedef struct {
    signed char blanking;
    short earthViewFirstSample;
    short sampleNumber[4][4];
    unsigned int tachSeconds[32];
    unsigned short tachSubSeconds[32];
    unsigned int indexPulseSeconds;
    unsigned short indexPulseSubSeconds;
} LGMIBASE_S2_SAMPLEHEADER;

#endif

#ifndef _LGMIBASE_S2_SCANSTATUS_
#define _LGMIBASE_S2_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
```

```
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} LGMIBASE_S2_SCANSTATUS;

#endif

#ifndef _LGMIBASE_S2_
#define _LGMIBASE_S2_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    LGMIBASE_S2_SCANSTATUS scanStatus;
    LGMIBASE_S2_SAMPLEHEADER sampleHeader;
    NAVIGATION navigation;
    LGMIBASE_S2_NAV2 nav2;
    LGMIBASE_S2_CALIBRATION calibration;
    LGMIBASE_S2_CAL2 cal2;
    float moonVectorInstFrame[3];
    LGMIBASE_S2_CALCOUNTS calCounts;
    LGMIBASE_S2_SUNDATA sunData;
    float incidenceAngle[221];
    float satAzimuthAngle[221];
    float solarZenAngle[221];
    float solarAzimuthAngle[221];
    float sunGlintAngle[221];
    float magneticFieldVector[3];
    unsigned short earthViewCounts[221][4];
    float Ta[221][4];
    short RFIFlag[221][2];
} LGMIBASE_S2;

#endif

#ifndef _LGMIBASE_S1_SUNDATA_
#define _LGMIBASE_S1_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
```

```
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} LGMIBASE_S1_SUNDATA;

#endif

#ifndef _LGMIBASE_S1_CALCOUNTS_
#define _LGMIBASE_S1_CALCOUNTS_

typedef struct {
    unsigned short hotLoadReading[9][65];
    unsigned short coldLoadReading[9][85];
    unsigned short hotLoadnDiodeReading[9][65];
    unsigned short coldLoadnDiodeReading[9][85];
    unsigned short hotLoadThermisterCount[11];
} LGMIBASE_S1_CALCOUNTS;

#endif

#ifndef _LGMIBASE_S1_CAL2_
#define _LGMIBASE_S1_CAL2_

typedef struct {
    unsigned short trayTemperatureCount;
    float trayTemperature;
    unsigned short moonIndex[9];
    float noiseDiodeTemp[6];
    unsigned short TEMP_CALRES_2;
    unsigned short TEMP_CALRES_1;
    unsigned short RS_CALRES_2;
    unsigned short RS_CALRES_1;
    unsigned short BATC_CALRES_2;
    unsigned short BATC_CALRES_1;
    unsigned short NDIODE_MODE;
    unsigned short RSST_NDIODE_ST;
    unsigned short NDIODE10GHZNUM;
    float hotLoadThermisterTemp[9][11];
    unsigned short TEMP_CALRES_4;
    unsigned short TEMP_CALRES_5;
```

```
    unsigned short TEMP_CALRES_6;
    float TEMP_89GHZ_LO;
    float TEMP_166GHZ_LO;
    float TEMP_183GHZ_LO;
    float TEMP_V89GHZMXR;
    float TEMP_H89GHZMXR;
    float TEMP_V166GHZMXR;
    float TEMP_H166GHZMXR;
    float TEMP_183GHZMXR;
    float TEMP_RS_MR1;
    float TEMP_RS_MR2;
    float MR_ICA_TEMP;
    float MR_LR_LEFT_TEMP;
    float MR_LR_RGHT_TEMP;
    float MR_LR_LOWR_TEMP;
    float CSR_TEMP1;
    float CSR_TEMP2;
    float onOrbitDiodeExcessTemp[9];
    unsigned short WarmIntrusionToColdViewIndex[85][9];
} LGMIBASE_S1_CAL2;

#endif

#ifndef _LGMIBASE_S1_CALIBRATION_
#define _LGMIBASE_S1_CALIBRATION_

typedef struct {
    float hotLoadTemp[9];
    float coldSkyTemp[9];
    float onOrbitNonLinearity[9];
    float derivedNonLinearity[9];
    float meanHotLoadCount[9];
    float meanHotLoadCntnDiode[9];
    float meanColdSkyCount[9];
    float meanColdSkyCntnDiode[9];
    float diodeExcessTemp[9];
    float gain[9][2];
    float offset[9][2];
    float nonLinearGain[9];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[9];
    float receiverGain[9];
```

```
} LGMIBASE_S1_CALIBRATION;

#endif

#ifndef _LGMIBASE_S1_NAV2_
#define _LGMIBASE_S1_NAV2_

typedef struct {
    unsigned short SCE_SELECTION;
    unsigned short SCE_RATE;
} LGMIBASE_S1_NAV2;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _LGMIBASE_S1_SAMPLEHEADER_
#define _LGMIBASE_S1_SAMPLEHEADER_

typedef struct {
    signed char blanking;
    short earthViewFirstSample;
```

```
    short sampleNumber[9][4];
    unsigned int tachSeconds[32];
    unsigned short tachSubSeconds[32];
    unsigned int indexPulseSeconds;
    unsigned short indexPulseSubSeconds;
} LGMIBASE_S1_SAMPLEHEADER;

#endif

#ifndef _LGMIBASE_S1_SCANSTATUS_
#define _LGMIBASE_S1_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} LGMIBASE_S1_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;
```

```
#endif

#ifndef _LGMIBASE_S1_
#define _LGMIBASE_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    LGMIBASE_S1_SCANSTATUS scanStatus;
    LGMIBASE_S1_SAMPLEHEADER sampleHeader;
    NAVIGATION navigation;
    LGMIBASE_S1_NAV2 nav2;
    LGMIBASE_S1_CALIBRATION calibration;
    LGMIBASE_S1_CAL2 cal2;
    float moonVectorInstFrame[3];
    LGMIBASE_S1_CALCOUNTS calCounts;
    LGMIBASE_S1_SUNDATA sunData;
    float incidenceAngle[221];
    float satAzimuthAngle[221];
    float solarZenAngle[221];
    float solarAzimuthAngle[221];
    float sunGlintAngle[221];
    float magneticFieldVector[3];
    unsigned short earthViewCounts[221][9];
    float Ta[221][9];
    short RFIFlag[221][5];
} LGMIBASE_S1;

#endif

#ifndef _LGMIBASE_SWATHS_
#define _LGMIBASE_SWATHS_

typedef struct {
    LGMIBASE_S1 S1;
    LGMIBASE_S2 S2;
    LGMIBASE_S3 S3;
    LGMIBASE_S4 S4;
} LGMIBASE_SWATHS;

#endif
```

```
#endif
```

Fortran Structure Header file:

```
STRUCTURE /LGMIBASE_S4_CALIBRATION/
    REAL*4 hotLoadTemp(4)
    REAL*4 coldSkyTemp(4)
    REAL*4 onOrbitNonLinearity(4)
    REAL*4 derivedNonLinearity(4)
    REAL*4 meanHotLoadCount(4)
    REAL*4 meanHotLoadCntnDiode(4)
    REAL*4 meanColdSkyCount(4)
    REAL*4 meanColdSkyCntnDiode(4)
    REAL*4 diodeExcessTemp(4)
    REAL*4 gain(2,4)
    REAL*4 offset(2,4)
    REAL*4 nonLinearGain(4)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(4)
    REAL*4 receiverGain(4)
END STRUCTURE

STRUCTURE /LGMIBASE_S4_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /LGMIBASE_S4/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(500)
    REAL*4 Longitude(500)
    RECORD /LGMIBASE_S4_SCANSTATUS/ scanStatus
    RECORD /LGMIBASE_S4_CALIBRATION/ calibration
```

```
    REAL*4 incidenceAngle(500)
    REAL*4 Ta(4,500)
    INTEGER*2 count(4,500)
END STRUCTURE

STRUCTURE /LGMIBASE_S3_CALIBRATION/
    REAL*4 hotLoadTemp(9)
    REAL*4 coldSkyTemp(9)
    REAL*4 onOrbitNonLinearity(9)
    REAL*4 derivedNonLinearity(9)
    REAL*4 meanHotLoadCount(9)
    REAL*4 meanHotLoadCntnDiode(9)
    REAL*4 meanColdSkyCount(9)
    REAL*4 meanColdSkyCntnDiode(9)
    REAL*4 diodeExcessTemp(9)
    REAL*4 gain(2,9)
    REAL*4 offset(2,9)
    REAL*4 nonLinearGain(9)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(9)
    REAL*4 receiverGain(9)
END STRUCTURE

STRUCTURE /LGMIBASE_S3_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /LGMIBASE_S3/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(500)
    REAL*4 Longitude(500)
    RECORD /LGMIBASE_S3_SCANSTATUS/ scanStatus
```

```
    RECORD /LGMIBASE_S3_CALIBRATION/ calibration
    REAL*4 incidenceAngle(500)
    REAL*4 Ta(9,500)
    INTEGER*2 count(9,500)
END STRUCTURE

STRUCTURE /LGMIBASE_S2_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /LGMIBASE_S2_CALCOUNTS/
    INTEGER*2 hotLoadReading(65,4)
    INTEGER*2 coldLoadReading(85,4)
    INTEGER*2 hotLoadnDiodeReading(65,4)
    INTEGER*2 coldLoadnDiodeReading(85,4)
    INTEGER*2 hotLoadThermisterCount(11)
END STRUCTURE

STRUCTURE /LGMIBASE_S2_CAL2/
    INTEGER*2 trayTemperatureCount
    REAL*4 trayTemperature
    INTEGER*2 moonIndex(4)
    REAL*4 noiseDiodeTemp(6)
    INTEGER*2 TEMP_CALRES_2
    INTEGER*2 TEMP_CALRES_1
    INTEGER*2 RS_CALRES_2
    INTEGER*2 RS_CALRES_1
    INTEGER*2 BATC_CALRES_2
    INTEGER*2 BATC_CALRES_1
    INTEGER*2 NDIODE_MODE
    INTEGER*2 RSST_NDIODE_ST
    INTEGER*2 NDIODE10GHZNUM
    REAL*4 hotLoadThermisterTemp(11,4)
    INTEGER*2 TEMP_CALRES_4
    INTEGER*2 TEMP_CALRES_5
    INTEGER*2 TEMP_CALRES_6
```

```
    REAL*4 TEMP_89GHZ_LO
    REAL*4 TEMP_166GHZ_LO
    REAL*4 TEMP_183GHZ_LO
    REAL*4 TEMP_V89GHZMXR
    REAL*4 TEMP_H89GHZMXR
    REAL*4 TEMP_V166GHZMXR
    REAL*4 TEMP_H166GHZMXR
    REAL*4 TEMP_183GHZMXR
    REAL*4 TEMP_RS_MR1
    REAL*4 TEMP_RS_MR2
    REAL*4 MR_ICA_TEMP
    REAL*4 MR_LR_LEFT_TEMP
    REAL*4 MR_LR_RGHT_TEMP
    REAL*4 MR_LR_LOWR_TEMP
    REAL*4 CSR_TEMP1
    REAL*4 CSR_TEMP2
    REAL*4 onOrbitDiodeExcessTemp(4)
    INTEGER*2 WarmIntrusionToColdViewIndex(4,85)
END STRUCTURE

STRUCTURE /LGMIBASE_S2_CALIBRATION/
    REAL*4 hotLoadTemp(4)
    REAL*4 coldSkyTemp(4)
    REAL*4 onOrbitNonLinearity(4)
    REAL*4 derivedNonLinearity(4)
    REAL*4 meanHotLoadCount(4)
    REAL*4 meanHotLoadCntnDiode(4)
    REAL*4 meanColdSkyCount(4)
    REAL*4 meanColdSkyCntnDiode(4)
    REAL*4 diodeExcessTemp(4)
    REAL*4 gain(2,4)
    REAL*4 offset(2,4)
    REAL*4 nonLinearGain(4)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(4)
    REAL*4 receiverGain(4)
END STRUCTURE

STRUCTURE /LGMIBASE_S2_NAV2/
    INTEGER*2 SCE_SELECTION
    INTEGER*2 SCE_RATE
END STRUCTURE
```

```
STRUCTURE /LGMIBASE_S2_SAMPLEHEADER/
    BYTE blanking
    INTEGER*2 earthViewFirstSample
    INTEGER*2 sampleNumber(4,4)
    INTEGER*4 tachSeconds(32)
    INTEGER*2 tachSubSeconds(32)
    INTEGER*4 indexPulseSeconds
    INTEGER*2 indexPulseSubSeconds
END STRUCTURE

STRUCTURE /LGMIBASE_S2_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /LGMIBASE_S2/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    RECORD /LGMIBASE_S2_SCANSTATUS/ scanStatus
    RECORD /LGMIBASE_S2_SAMPLEHEADER/ sampleHeader
    RECORD /NAVIGATION/ navigation
    RECORD /LGMIBASE_S2_NAV2/ nav2
    RECORD /LGMIBASE_S2_CALIBRATION/ calibration
    RECORD /LGMIBASE_S2_CAL2/ cal2
    REAL*4 moonVectorInstFrame(3)
    RECORD /LGMIBASE_S2_CALCOUNTS/ calCounts
    RECORD /LGMIBASE_S2_SUNDATA/ sunData
    REAL*4 incidenceAngle(221)
    REAL*4 satAzimuthAngle(221)
    REAL*4 solarZenAngle(221)
    REAL*4 solarAzimuthAngle(221)
    REAL*4 sunGlintAngle(221)
```

```
    REAL*4 magneticFieldVector(3)
    INTEGER*2 earthViewCounts(4,221)
    REAL*4 Ta(4,221)
    INTEGER*2 RFIFlag(2,221)
END STRUCTURE

STRUCTURE /LGMIBASE_S1_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /LGMIBASE_S1_CALCOUNTS/
    INTEGER*2 hotLoadReading(65,9)
    INTEGER*2 coldLoadReading(85,9)
    INTEGER*2 hotLoadnDiodeReading(65,9)
    INTEGER*2 coldLoadnDiodeReading(85,9)
    INTEGER*2 hotLoadThermisterCount(11)
END STRUCTURE

STRUCTURE /LGMIBASE_S1_CAL2/
    INTEGER*2 trayTemperatureCount
    REAL*4 trayTemperature
    INTEGER*2 moonIndex(9)
    REAL*4 noiseDiodeTemp(6)
    INTEGER*2 TEMP_CALRES_2
    INTEGER*2 TEMP_CALRES_1
    INTEGER*2 RS_CALRES_2
    INTEGER*2 RS_CALRES_1
    INTEGER*2 BATC_CALRES_2
    INTEGER*2 BATC_CALRES_1
    INTEGER*2 NDIODE_MODE
    INTEGER*2 RSST_NDIODE_ST
    INTEGER*2 NDIODE10GHZNUM
    REAL*4 hotLoadThermisterTemp(11,9)
    INTEGER*2 TEMP_CALRES_4
    INTEGER*2 TEMP_CALRES_5
    INTEGER*2 TEMP_CALRES_6
```

```
    REAL*4 TEMP_89GHZ_LO
    REAL*4 TEMP_166GHZ_LO
    REAL*4 TEMP_183GHZ_LO
    REAL*4 TEMP_V89GHZMXR
    REAL*4 TEMP_H89GHZMXR
    REAL*4 TEMP_V166GHZMXR
    REAL*4 TEMP_H166GHZMXR
    REAL*4 TEMP_183GHZMXR
    REAL*4 TEMP_RS_MR1
    REAL*4 TEMP_RS_MR2
    REAL*4 MR_ICA_TEMP
    REAL*4 MR_LR_LEFT_TEMP
    REAL*4 MR_LR_RGHT_TEMP
    REAL*4 MR_LR_LOWR_TEMP
    REAL*4 CSR_TEMP1
    REAL*4 CSR_TEMP2
    REAL*4 onOrbitDiodeExcessTemp(9)
    INTEGER*2 WarmIntrusionToColdViewIndex(9,85)
END STRUCTURE

STRUCTURE /LGMIBASE_S1_CALIBRATION/
    REAL*4 hotLoadTemp(9)
    REAL*4 coldSkyTemp(9)
    REAL*4 onOrbitNonLinearity(9)
    REAL*4 derivedNonLinearity(9)
    REAL*4 meanHotLoadCount(9)
    REAL*4 meanHotLoadCntnDiode(9)
    REAL*4 meanColdSkyCount(9)
    REAL*4 meanColdSkyCntnDiode(9)
    REAL*4 diodeExcessTemp(9)
    REAL*4 gain(2,9)
    REAL*4 offset(2,9)
    REAL*4 nonLinearGain(9)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(9)
    REAL*4 receiverGain(9)
END STRUCTURE

STRUCTURE /LGMIBASE_S1_NAV2/
    INTEGER*2 SCE_SELECTION
    INTEGER*2 SCE_RATE
END STRUCTURE
```

```
STRUCTURE /NAVIGATION/
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /LGMIBASE_S1_SAMPLEHEADER/
    BYTE blanking
    INTEGER*2 earthViewFirstSample
    INTEGER*2 sampleNumber(4,9)
    INTEGER*4 tachSeconds(32)
    INTEGER*2 tachSubSeconds(32)
    INTEGER*4 indexPulseSeconds
    INTEGER*2 indexPulseSubSeconds
END STRUCTURE

STRUCTURE /LGMIBASE_S1_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE
```

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /LGMIBASE_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    RECORD /LGMIBASE_S1_SCANSTATUS/ scanStatus
    RECORD /LGMIBASE_S1_SAMPLEHEADER/ sampleHeader
    RECORD /NAVIGATION/ navigation
    RECORD /LGMIBASE_S1_NAV2/ nav2
    RECORD /LGMIBASE_S1_CALIBRATION/ calibration
    RECORD /LGMIBASE_S1_CAL2/ cal2
    REAL*4 moonVectorInstFrame(3)
    RECORD /LGMIBASE_S1_CALCOUNTS/ calCounts
    RECORD /LGMIBASE_S1_SUNDATA/ sunData
    REAL*4 incidenceAngle(221)
    REAL*4 satAzimuthAngle(221)
    REAL*4 solarZenAngle(221)
    REAL*4 solarAzimuthAngle(221)
    REAL*4 sunGlintAngle(221)
    REAL*4 magneticFieldVector(3)
    INTEGER*2 earthViewCounts(9,221)
    REAL*4 Ta(9,221)
    INTEGER*2 RFIFlag(5,221)
END STRUCTURE

STRUCTURE /LGMIBASE_SWATHS/
    RECORD /LGMIBASE_S1/ S1
    RECORD /LGMIBASE_S2/ S2
    RECORD /LGMIBASE_S3/ S3
    RECORD /LGMIBASE_S4/ S4
END STRUCTURE
```

5.3 GMIBASERSS - GMI Antenna Temperatures

The GMI BASE Product, GMIBASERSS, "GMI Antenna Temperatures," is written as a multi-Swath Structure. Swath S1 has channels 1-9: 10V 10H 19V 19H 23V 37V 37H 89V 89H. Swath S2 has channels 10-13: 166V 166H 183+/-3V 183+/-8V. GMIBASERSS is like GMIBASE but has overlap of 200 scans on each end. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nchan1	9	Number of channels in Swath 1.
nchan2	4	Number of channels in Swath 2.
nfreq1	5	Number of frequencies in Swath 1.
nfreq2	2	Number of frequencies in Swath 2.
npix1	221	Number of pixels in Swath 1.
npix2	221	Number of pixels in Swath 2.
npix3	500	Number of pixels in Swath 3.
npix4	500	Number of pixels in Swath 4.
ncolds1	85	Maximum number of cold samples in Swath 1.
ncolds2	85	Maximum number of cold samples in Swath 2.
nhots1	65	Maximum number of hot samples in Swath 1.
nhots2	65	Maximum number of hot samples in Swath 2.
ntherm	11	Number of hot load thermisters.
LNL	2	Linear and non-linear.
nsamt	4	Number of sample types. The types are: total science GSDR, earth-view, hot load, cold sky.
ntach	32	Number of tachometer readings.
GMIxyz	3	x, y, z components in GMI instrument coordinate system.
nndiode	6	Number of noise diodes.
n7	7	Number seven.

Figure 39 through Figure 69 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

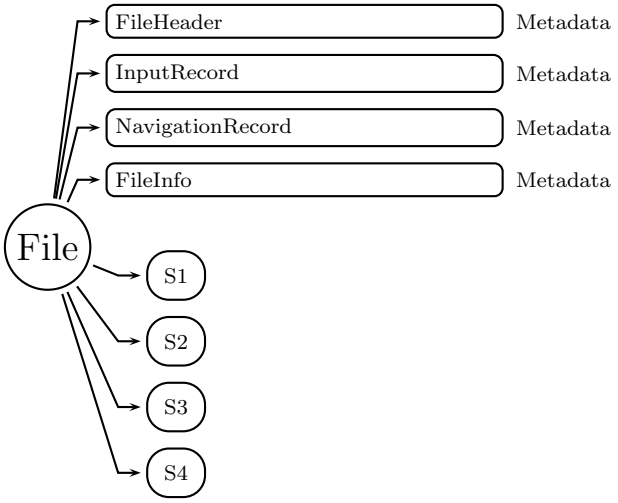


Figure 39: Data Format Structure for GMIBASERSS, GMI Antenna Temperatures

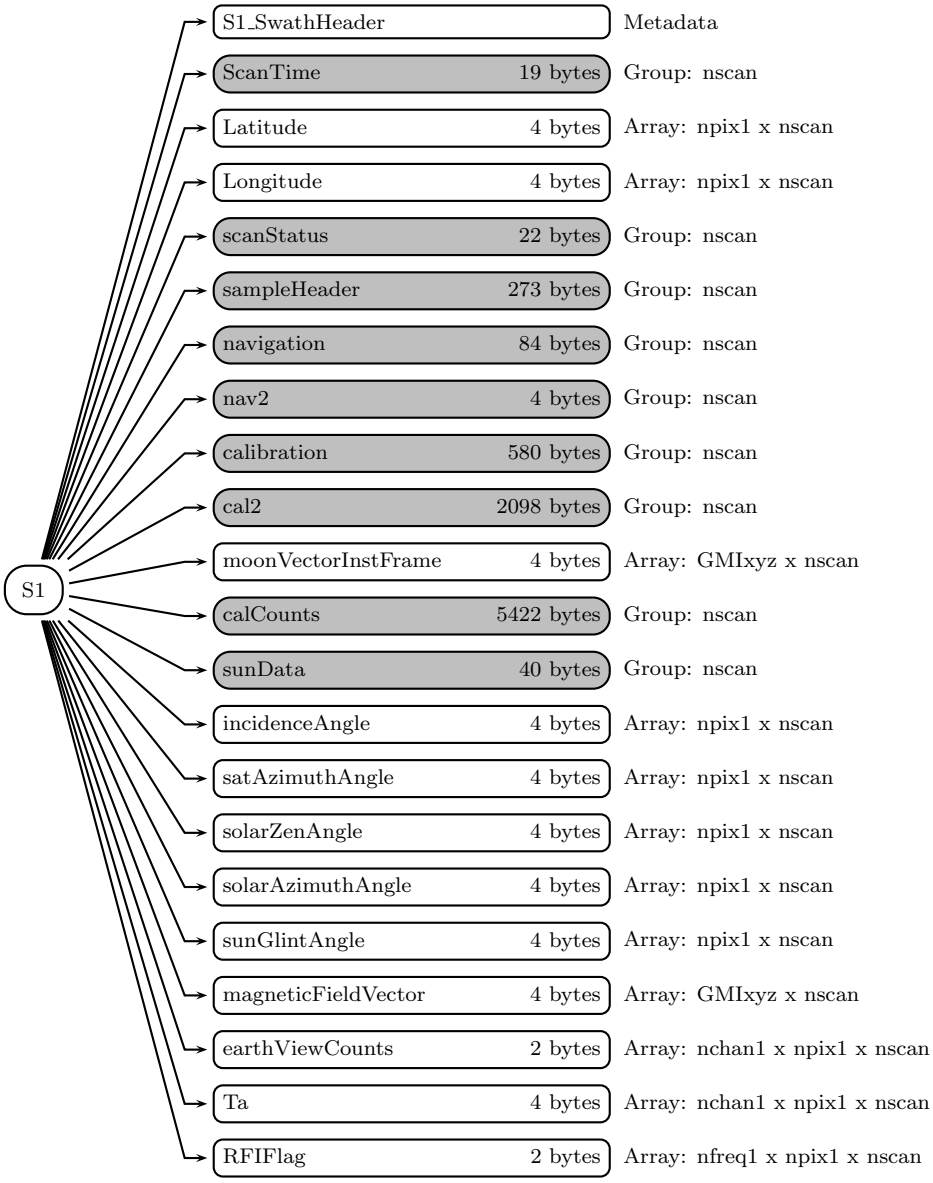


Figure 40: Data Format Structure for GMIBASERSS, S1

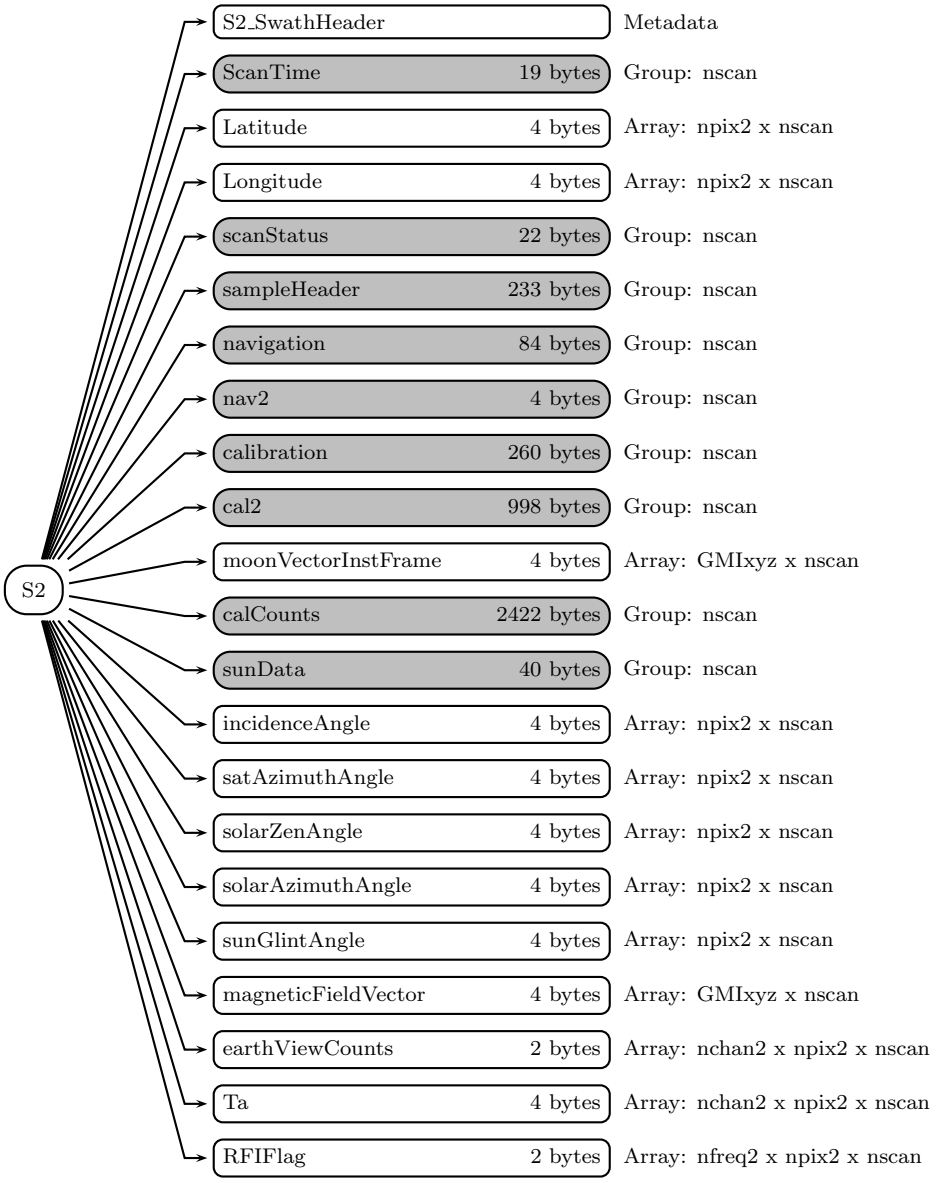


Figure 41: Data Format Structure for GMIBASERSS, S2

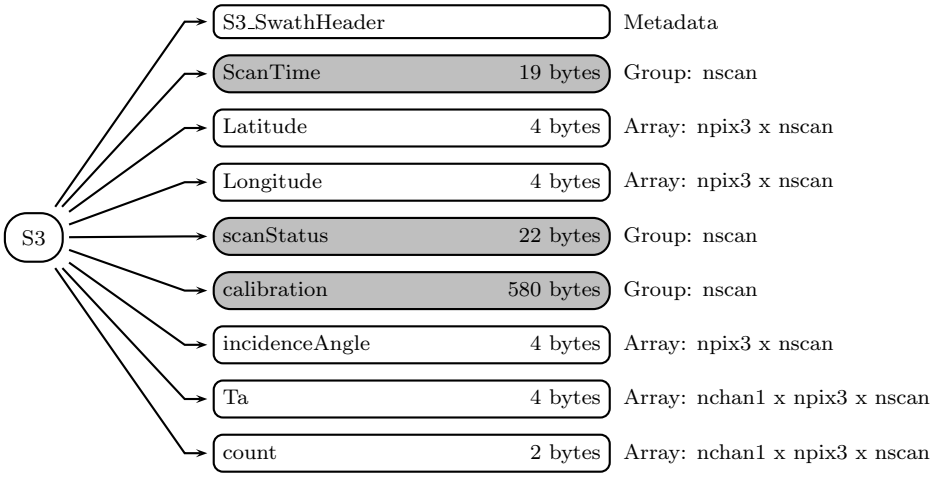


Figure 42: Data Format Structure for GMIBASERSS, S3

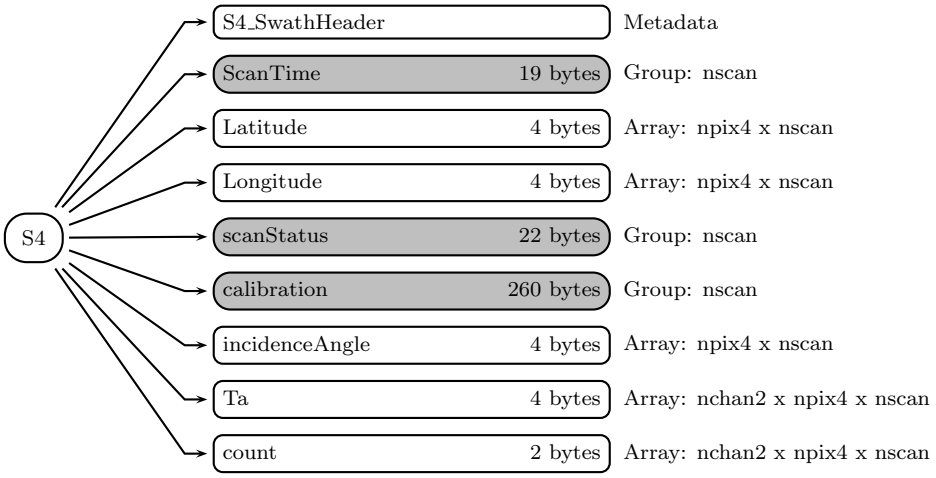


Figure 43: Data Format Structure for GMIBASERSS, S4

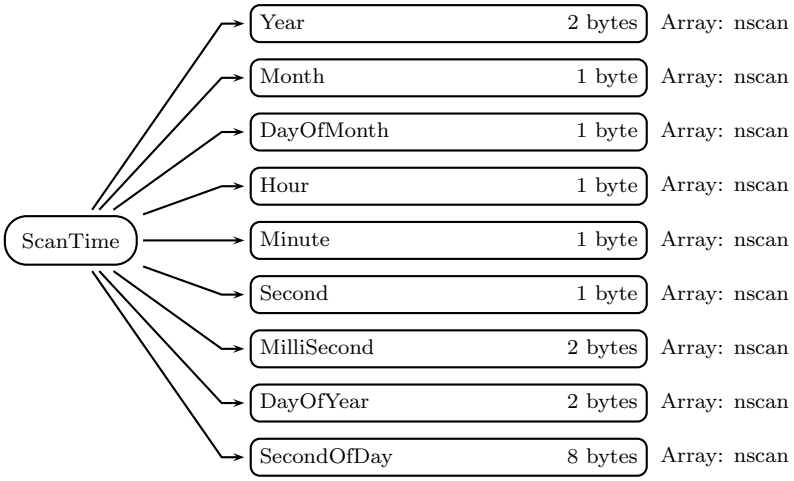


Figure 44: Data Format Structure for GMIBASERSS, S1, ScanTime

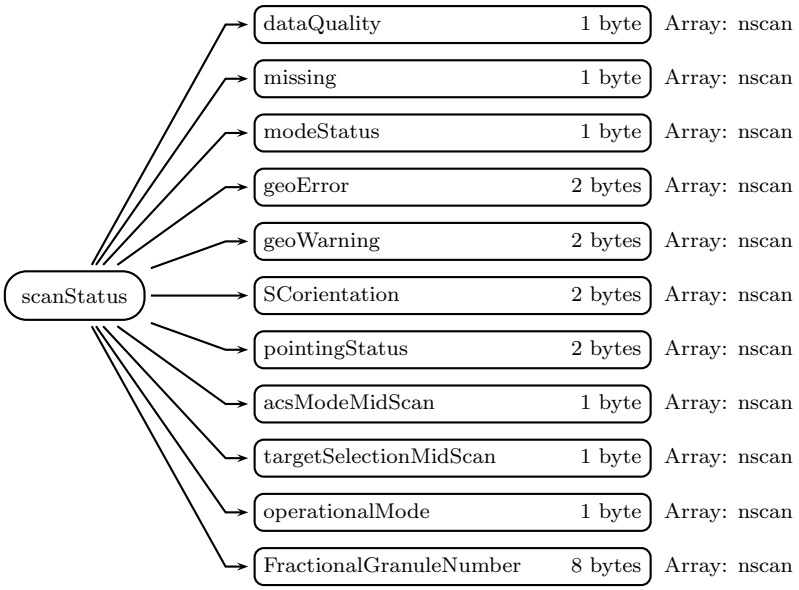


Figure 45: Data Format Structure for GMIBASERSS, S1, scanStatus

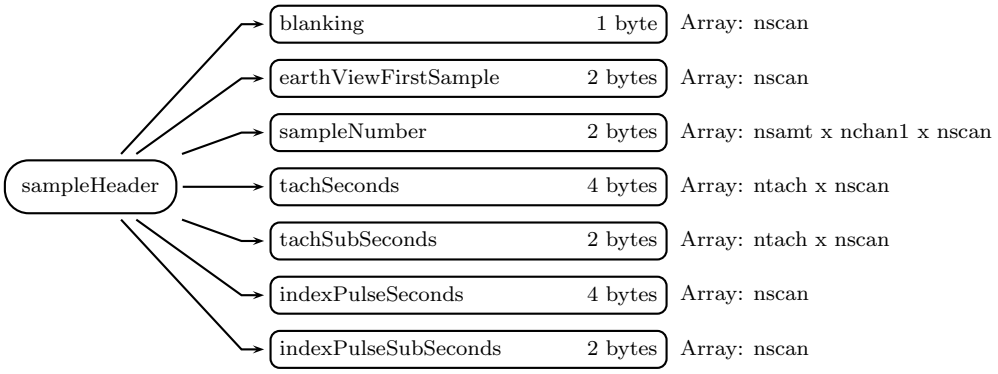


Figure 46: Data Format Structure for GMIBASERSS, S1, sampleHeader

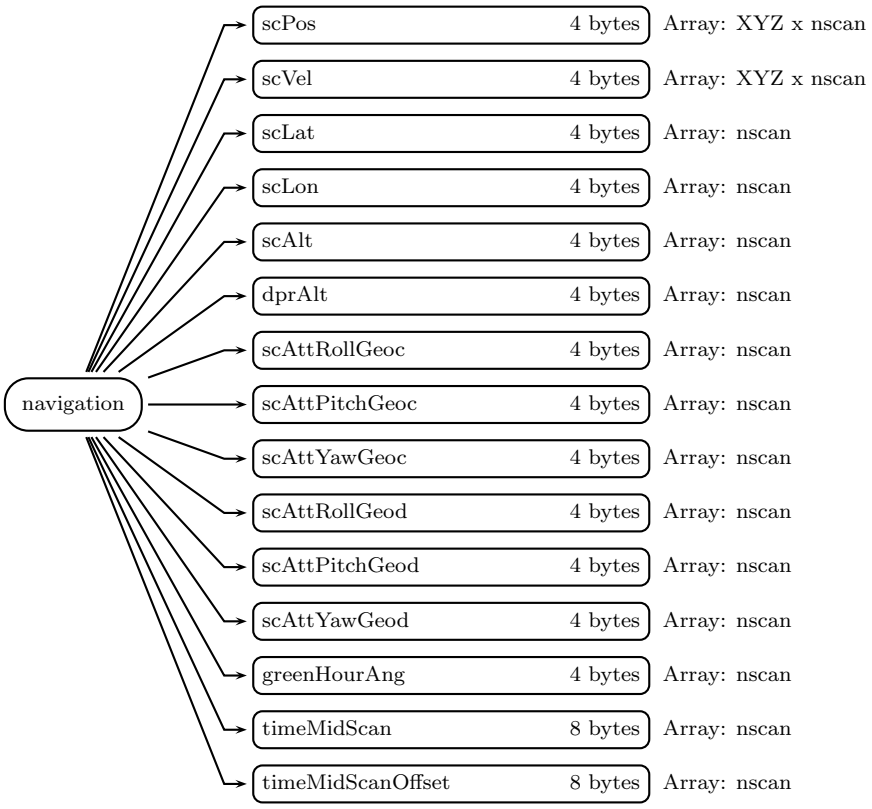


Figure 47: Data Format Structure for GMIBASERSS, S1, navigation

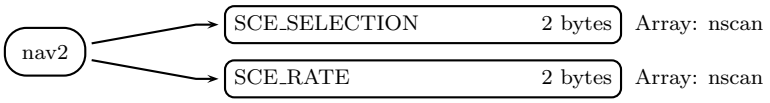


Figure 48: Data Format Structure for GMIBASERSS, S1, nav2

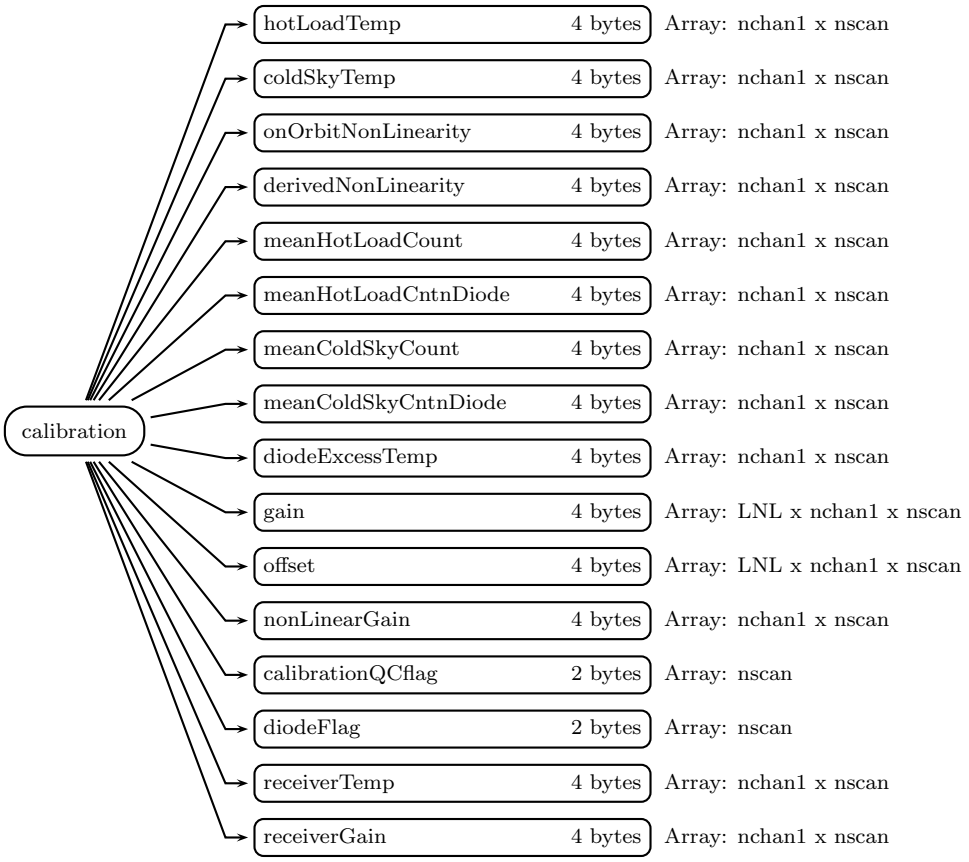
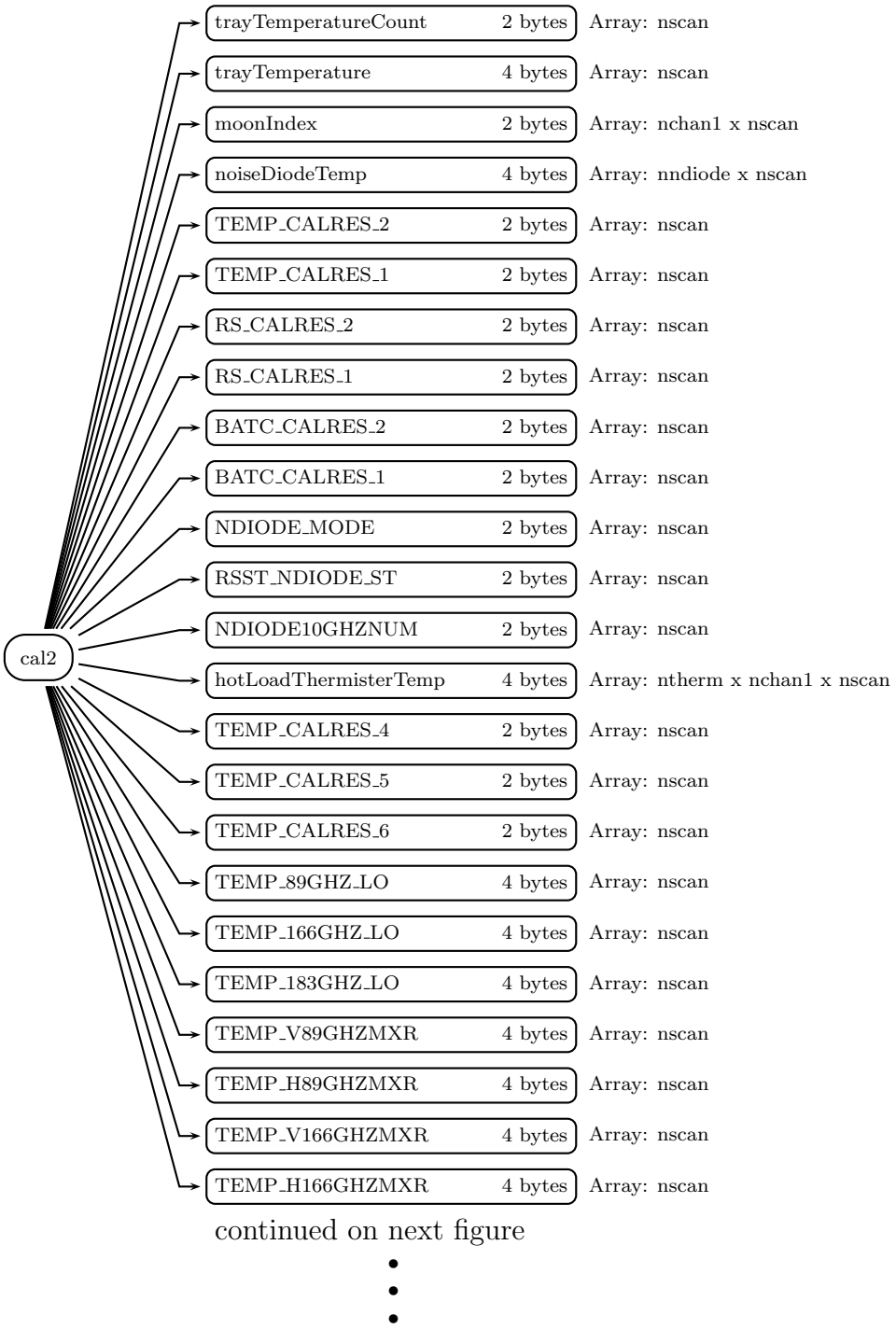


Figure 49: Data Format Structure for GMIBASERSS, S1, calibration



continued on next figure

Figure 50: Data Format Structure for GMIBASERSS, cal2

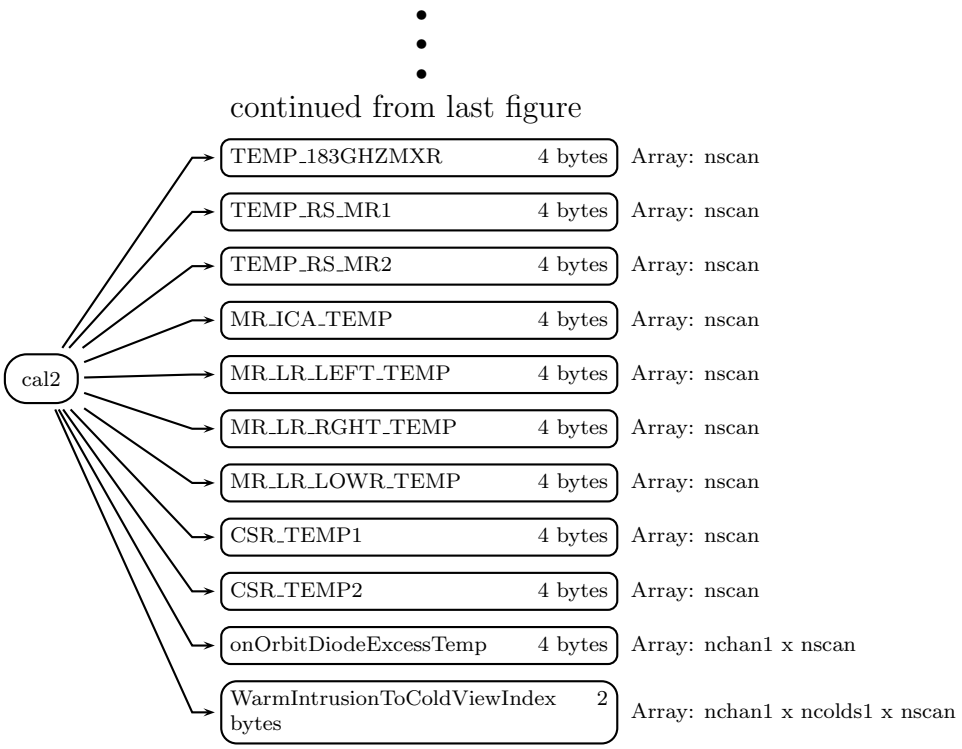


Figure 51: Data Format Structure for GMIBASERSS, S1, cal2

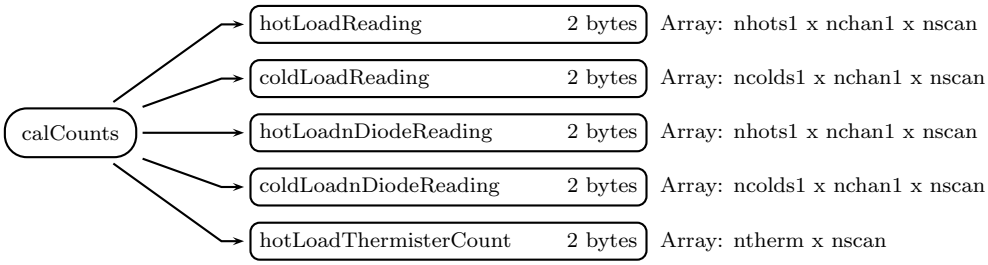


Figure 52: Data Format Structure for GMIBASERSS, S1, calCounts

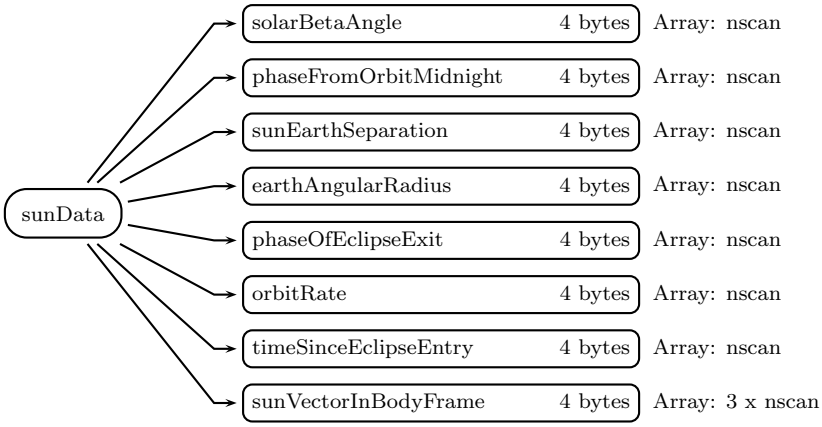


Figure 53: Data Format Structure for GMIBASERSS, S1, sunData

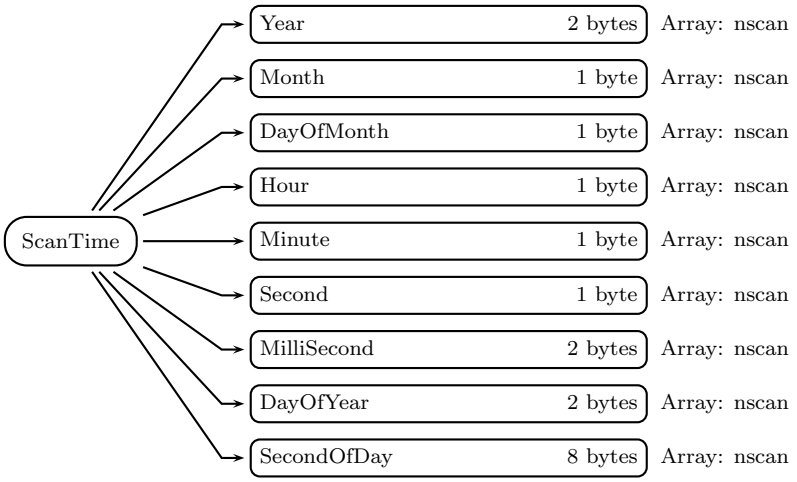


Figure 54: Data Format Structure for GMIBASERSS, S2, ScanTime

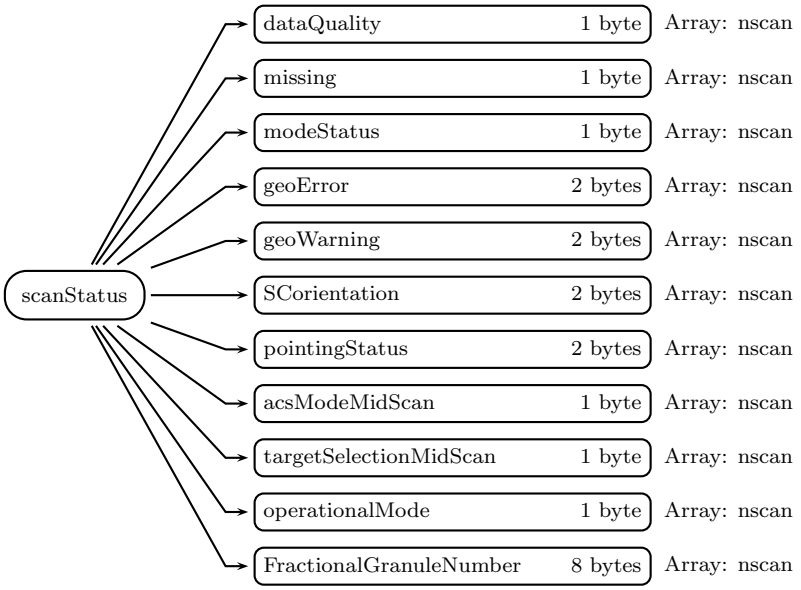


Figure 55: Data Format Structure for GMIBASERSS, S2, scanStatus

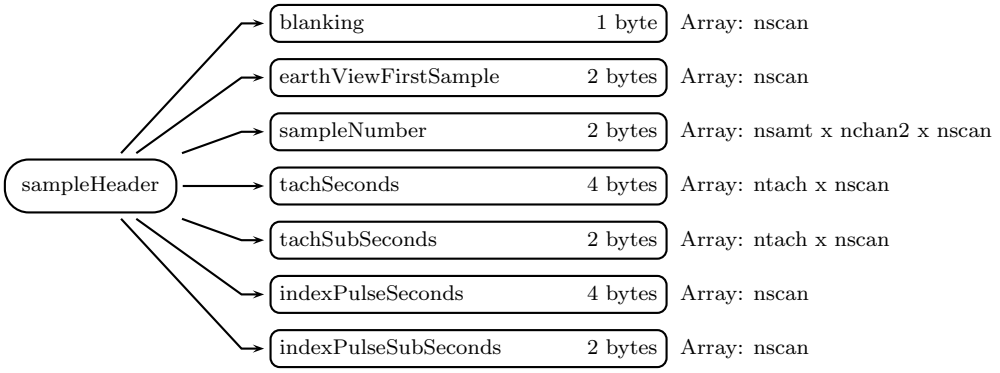


Figure 56: Data Format Structure for GMIBASERSS, S2, sampleHeader

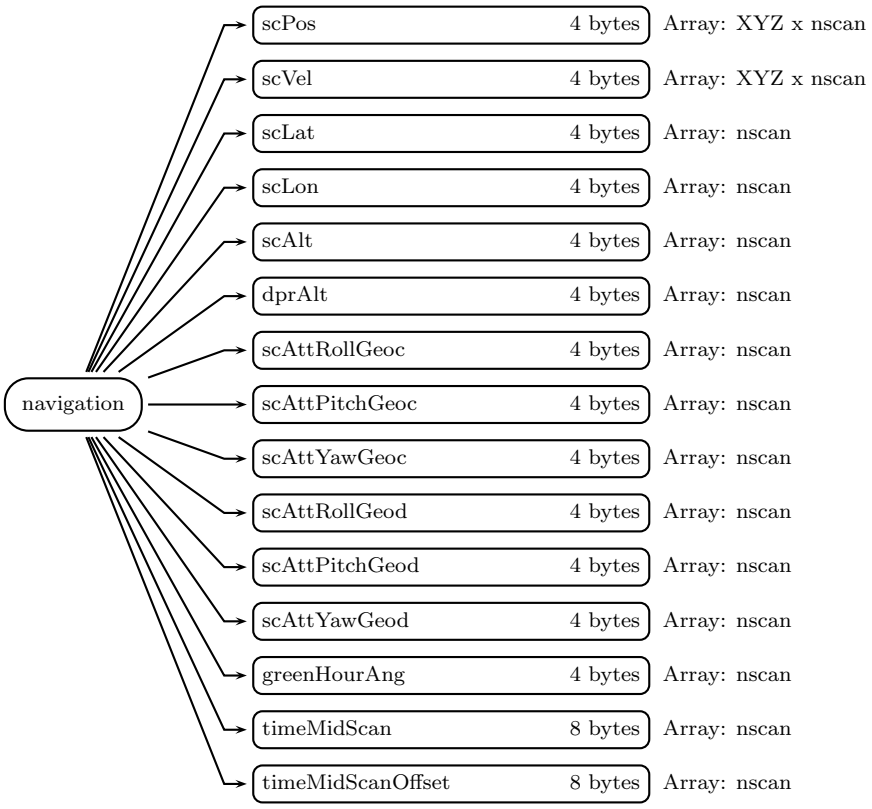


Figure 57: Data Format Structure for GMIBASERSS, S2, navigation

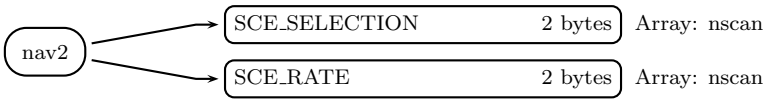


Figure 58: Data Format Structure for GMIBASERSS, S2, nav2

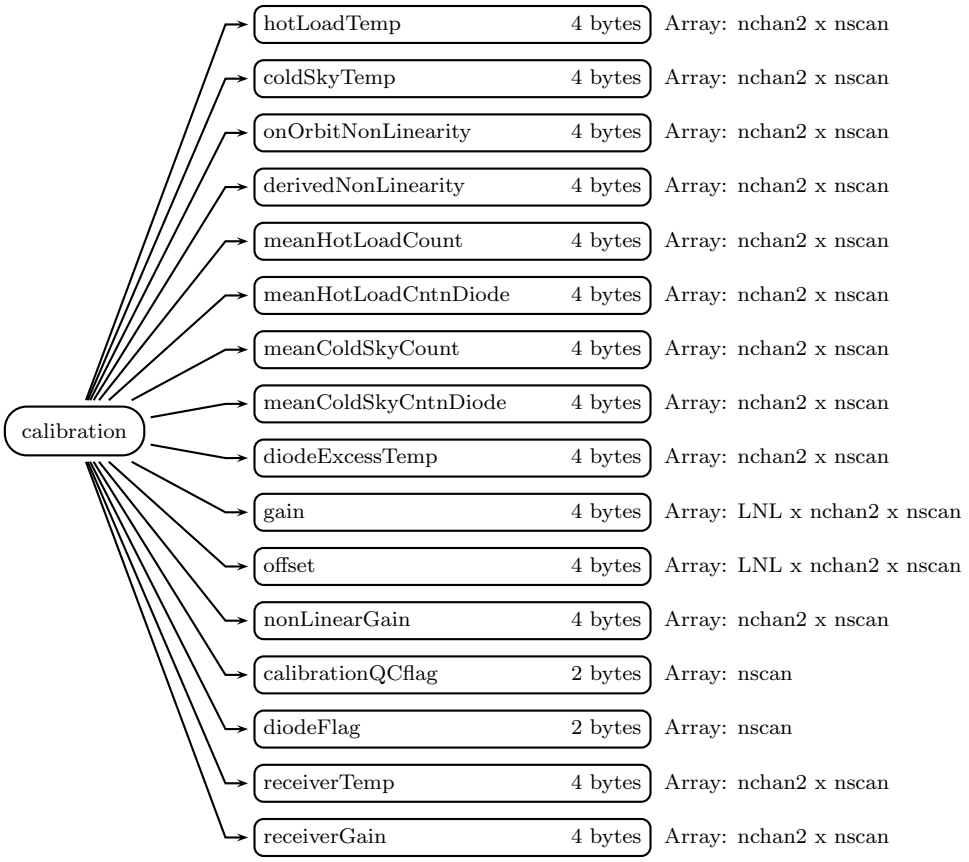


Figure 59: Data Format Structure for GMIBASERSS, S2, calibration

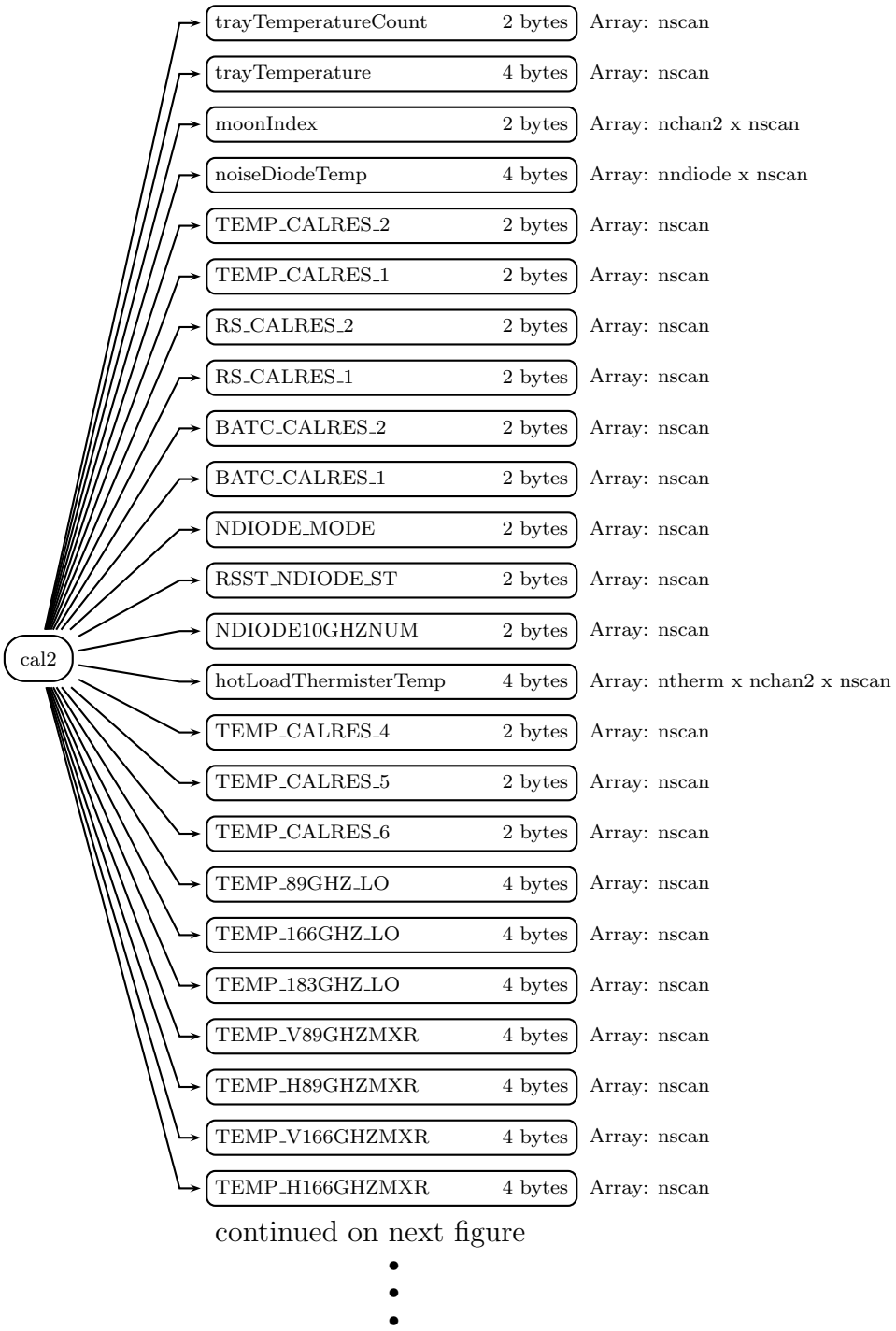


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Figure 60: Data Format Structure for GMIBASERSS, cal2

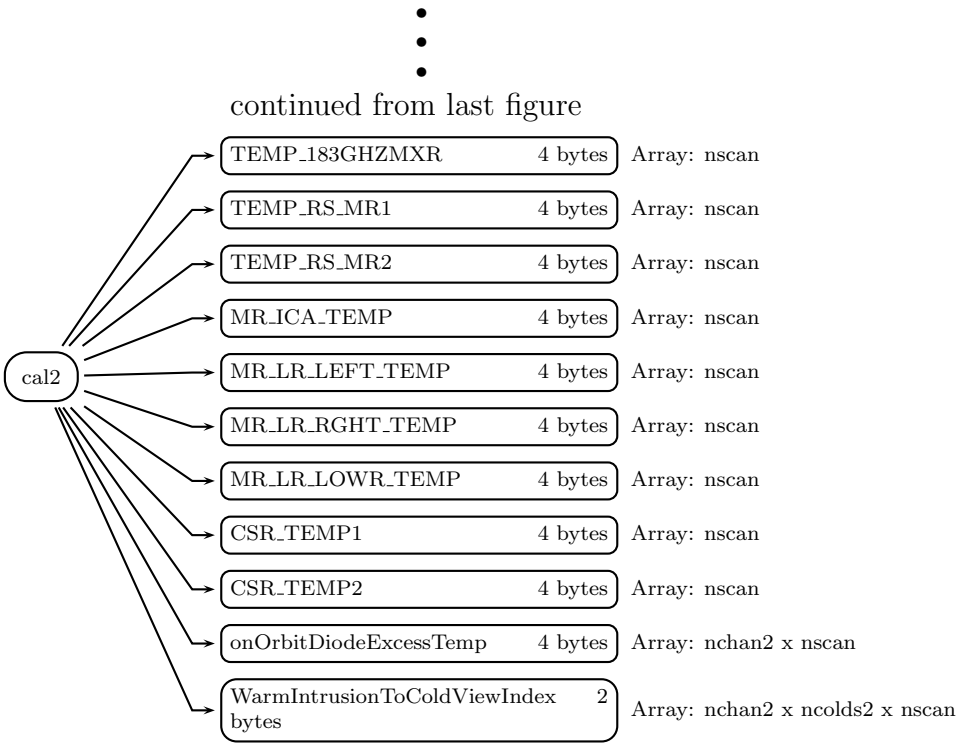


Figure 61: Data Format Structure for GMIBASERSS, S2, cal2

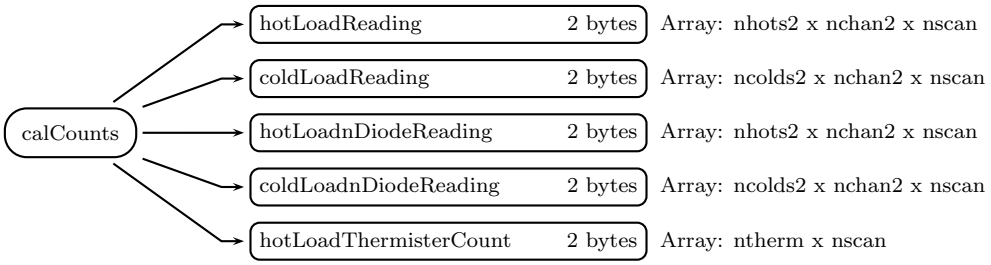


Figure 62: Data Format Structure for GMIBASERSS, S2, calCounts

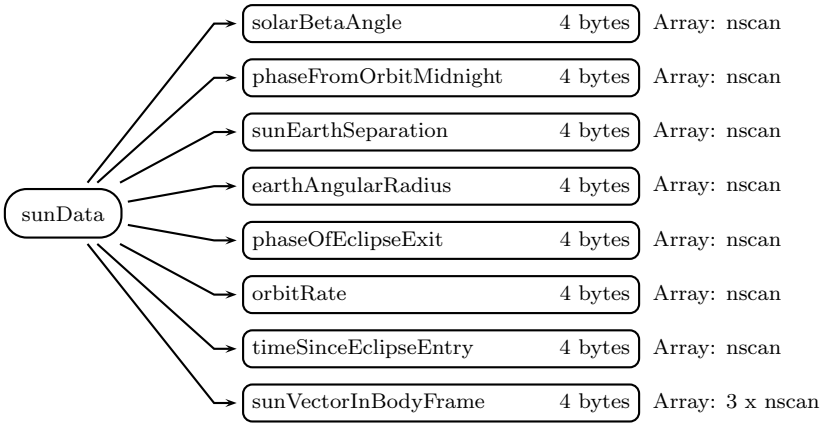


Figure 63: Data Format Structure for GMIBASERSS, S2, sunData

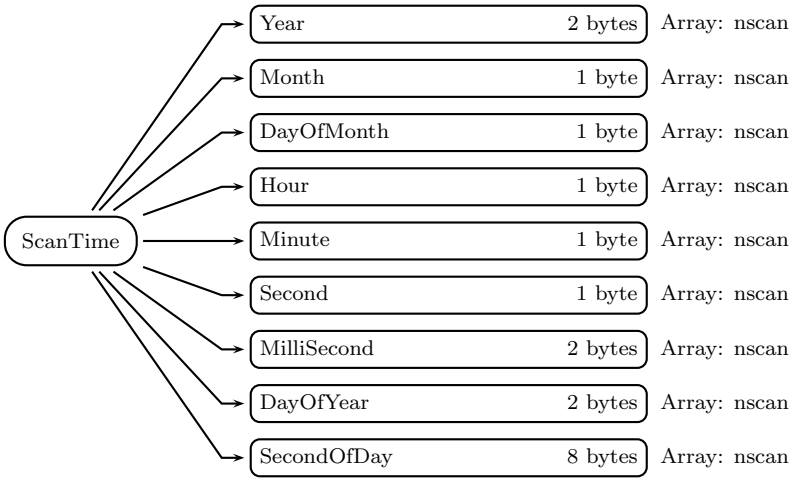


Figure 64: Data Format Structure for GMIBASERSS, S3, ScanTime

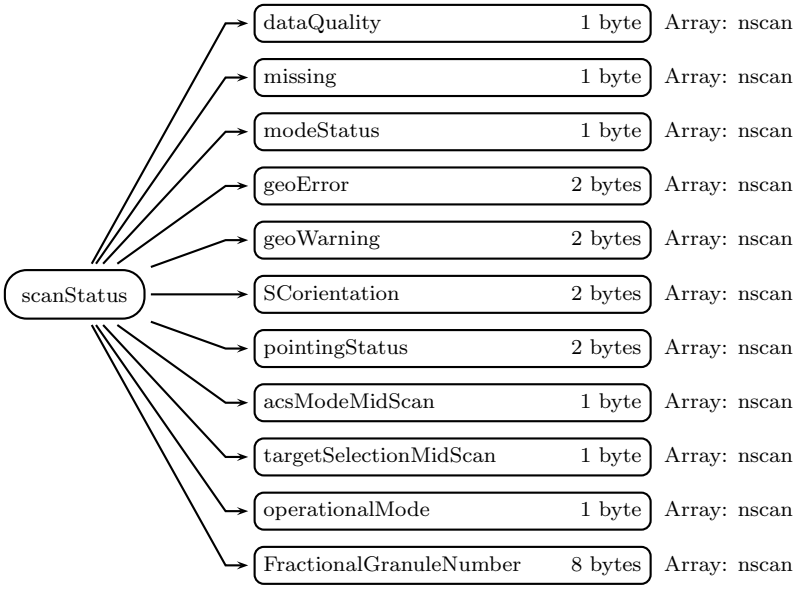


Figure 65: Data Format Structure for GMIBASERSS, S3, scanStatus

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

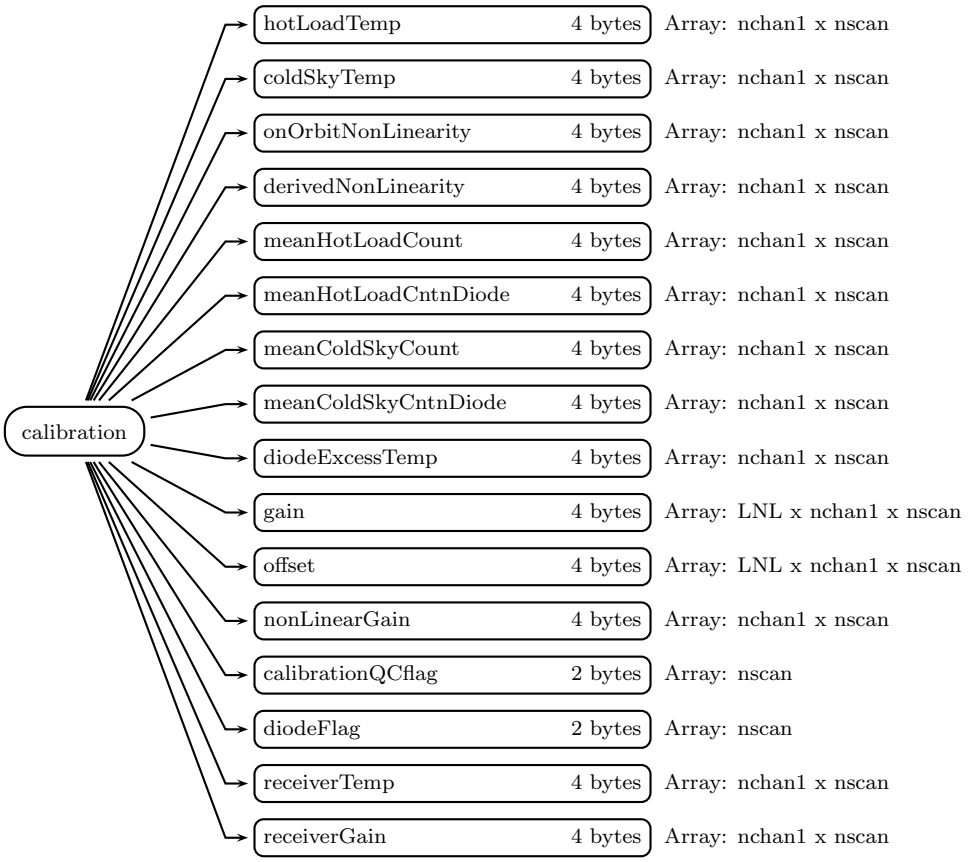


Figure 66: Data Format Structure for GMIBASERSS, S3, calibration

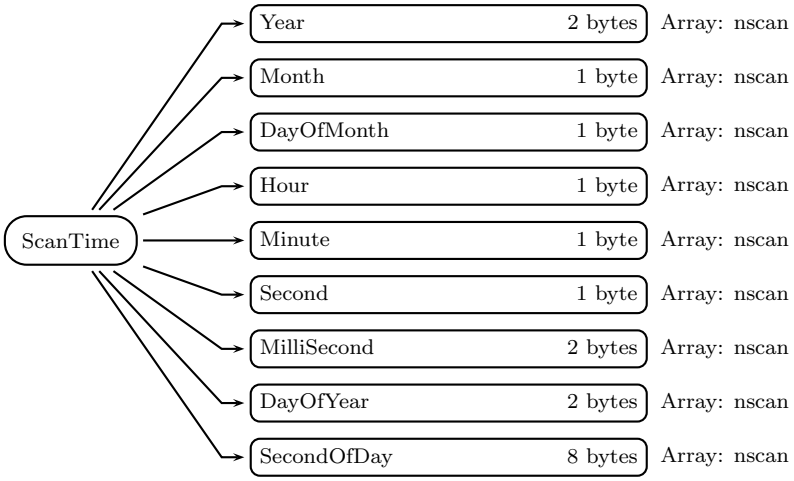


Figure 67: Data Format Structure for GMIBASERSS, S4, ScanTime

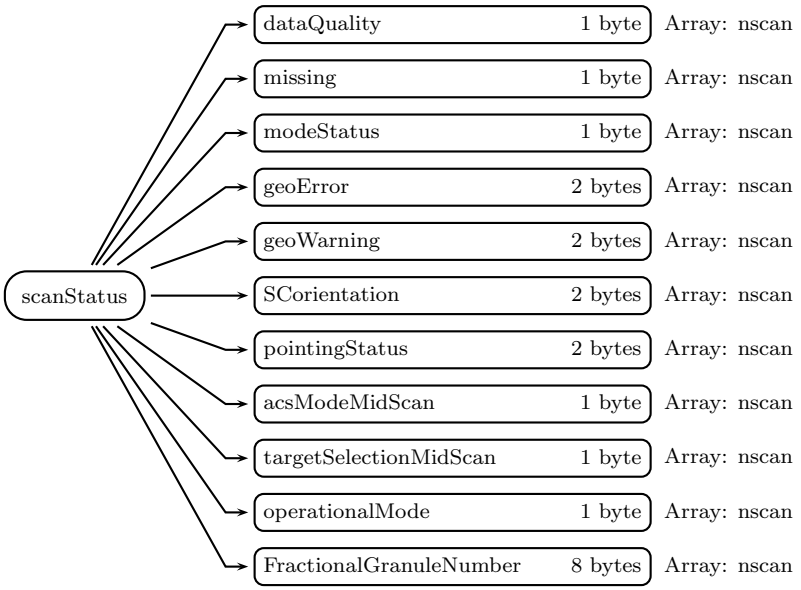


Figure 68: Data Format Structure for GMIBASERSS, S4, scanStatus

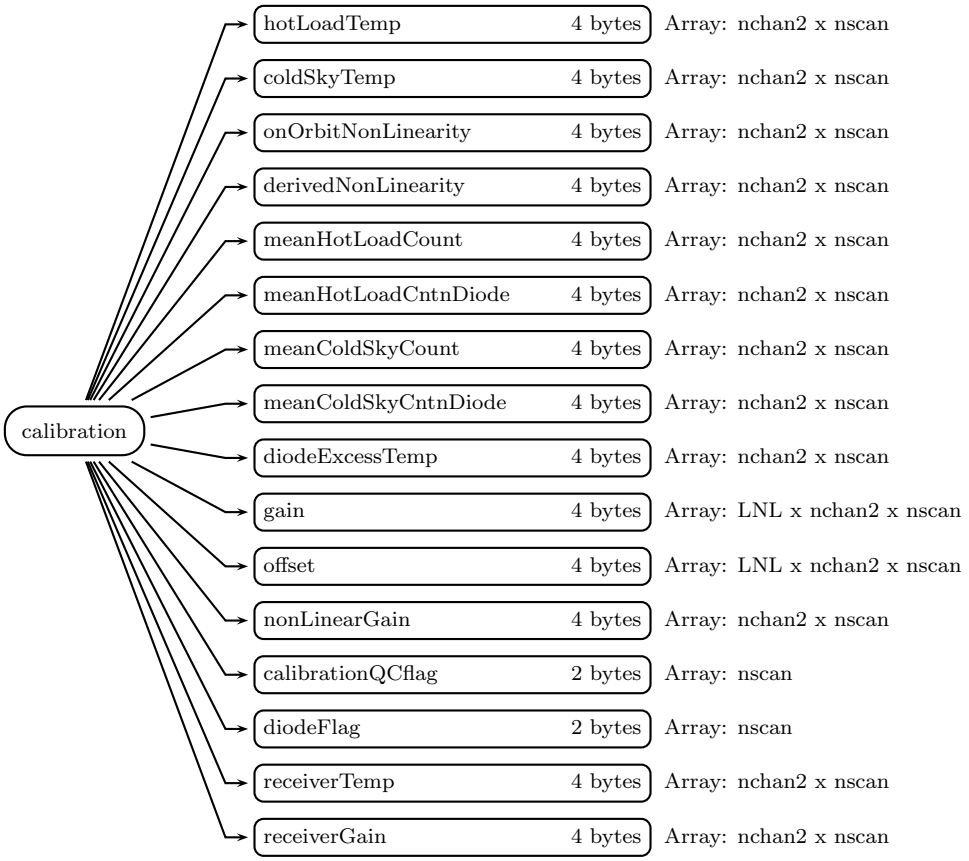


Figure 69: Data Format Structure for GMIBASERSS, S4, calibration

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix1 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix1 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value

-180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S1)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
```

```
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
```

```
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

sampleHeader (Group in S1)

blanking (1-byte integer, array size: nscan):

```
Value of 0 = Blanking off
Value of 1 = Blanking on
```

earthViewFirstSample (2-byte integer, array size: nscan):
Sample number of the first earth view. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

sampleNumber (2-byte integer, array size: nsamt x nchan1 x nscan):
Number of valid samples in scan. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

tachSeconds (4-byte unsigned integer, array size: ntach x nscan):
Tachometer seconds. Values are in second. Special values are defined as:
0 Missing value

tachSubSeconds (2-byte unsigned integer, array size: ntach x nscan):
Tachometer sub_seconds. Values range from 0 to 62499 in units of 16 microseconds. The missing value is 65535.

indexPulseSeconds (4-byte unsigned integer, array size: nscan):
Index Pulse seconds. Values are in second. Special values are defined as:
0 Missing value

indexPulseSubSeconds (2-byte unsigned integer, array size: nscan):
Index Pulse subseconds. Values range from 0 to 62499 in units of 16 microseconds. The missing value is 65535.

navigation (Group in S1)

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the

Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

nav2 (Group in S1)

SCE_SELECTION (2-byte unsigned integer, array size: nscan):
The current SCE selection setting. Special values are defined as:
0 Missing value

SCE_RATE (2-byte unsigned integer, array size: nscan):
The SMA rotational rate reported by the SCE. To obtain the spin rate in RPM, multiply SCE_RATE by 0.002999106 Values range from 1 to 65535 count. Special values are defined as:
0 Missing value

calibration (Group in S1)

hotLoadTemp (4-byte float, array size: nchan1 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load. For 10, 166, 183 GHZ channles, they are averages of PRT 1,7,8,9,10. For 18, 23, 36, 89 GHZ channels, they are averages of PRT 2,11,12,13,14. The values are corrected by tray temperature and averaged over closest 5 scans Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan1 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan1 x nscan):
The on Orbit Non-Linearity Tnl computed from ground calibrated u look-up table . Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan1 x nscan):
Non-Linearity Tnl derived from 4-point calibration. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (4-byte float, array size: nchan1 x nscan):
The mean Hot Load Count. Averaged over all Hot samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanHotLoadCntnDiode (4-byte float, array size: nchan1 x nscan):
The mean coupled Hot Load Plus Noise Diode counts Averaged over all samples and closest 5 scans. Values range from 0 to 65535. Special values are defined as:
-9999.9 Missing value

meanColdSkyCount (4-byte float, array size: nchan1 x nscan):
The mean Cold Sky Count.Averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanColdSkyCntnDiode (4-byte float, array size: nchan1 x nscan):
The mean coupled Cold Sky Plus Noise Diode counts, averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

diodeExcessTemp (4-byte float, array size: nchan1 x nscan):
The Noise Diode Excess Temperature. Cold and diode Coupled Temperature=diodeExcessTemp

+ coldSkyTemp. Hot and diode Coupled Temperature=diodeExcessTemp + hotLoadTemp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan1 x nscan):
gain[0] determine the total Ta gain. Ta=offset[0]+gain[0]*earthCount+ nonLinearGaian*earthCount*earthCount. Nonlinearity=offset[1]+gain[1]*earthCount+ nonLinearGaian*earthCount*earthCount. Values range from 0 to 1 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan1 x nscan):
Offset[0] determine the total Ta offset. min=-999 K (from -1 K), max=999 K (from 1 K). Missing value is -9999.9.

nonLinearGain (4-byte float, array size: nchan1 x nscan):
The nonlinear gain. Values range from -1 to 1 K. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. value 0 indicates good calibration. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

```
Diode flag.
0, Noise Diode on
2, Noise Diode off
5, Noise Diode status unknown
```

receiverTemp (4-byte float, array size: nchan1 x nscan):
The receiver temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan1 x nscan):
The receiver gain. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

cal2 (Group in S1)

trayTemperatureCount (2-byte unsigned integer, array size: nscan):
Counts to derive hot load tray temperature. Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

trayTemperature (4-byte float, array size: nscan):
Derive hot load tray temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

moonIndex (2-byte unsigned integer, array size: nchan1 x nscan):
Index determined by the angle between moon vector and cold sample vectors. 0 means angles between moon vector and all cold view vectors are greater than 5 degrees. Non-zero value means the number of cold samples that may be contaminated by moon. Values range from 0 to 100. Special values are defined as:
0 Missing value

noiseDiodeTemp (4-byte float, array size: nndiode x nscan):
Physical temperature of noise diode. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

TEMP_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for PRT temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for PRT temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

RS_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for tray temperature and receiver temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

RS_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for tray temperature and receiver temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

BATC_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for noise diode temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

BATC_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for noise diode temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

NDIODE_MODE (2-byte unsigned integer, array size: nscan):
RS configuration of Noise Diode Mode. 0 = On every scan, 1 = On every other scan, 2

= Off. Values range from 0 to 2 count. Special values are defined as:
65535 Missing value

RSST_NDIODE_ST (2-byte unsigned integer, array size: nscan):
Noise diode state during the scan. 0 = Noise diodes OFF for the scan, 1 = Noise diodes ON for the scan. Values range from 0 to 1 count. Special values are defined as:
65535 Missing value

NDIODE10GHZNUM (2-byte unsigned integer, array size: nscan):
RS configuration of Noise Diode Start Sample Number, i.e., the sample number where noise diodes are turned on. Values range from 0 to 500 count. Special values are defined as:
65535 Missing value

hotLoadThermisterTemp (4-byte float, array size: ntherm x nchan1 x nscan):
Hot Load Thermister Temperature of 11 PRTs. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

TEMP_CALRES_4 (2-byte unsigned integer, array size: nscan):
Low calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_5 (2-byte unsigned integer, array size: nscan):
High calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_6 (2-byte unsigned integer, array size: nscan):
High calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_89GHZ_LO (4-byte float, array size: nscan):
89 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_166GHZ_LO (4-byte float, array size: nscan):
166 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_183GHZ_LO (4-byte float, array size: nscan):
183 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_V89GHZMXR (4-byte float, array size: nscan):
89 GHZ V channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_H89GHZMXR (4-byte float, array size: nscan):
89 GHZ H channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_V166GHZMXR (4-byte float, array size: nscan):
166 GHZ V channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_H166GHZMXR (4-byte float, array size: nscan):
166 GHZ H channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_183GHZMXR (4-byte float, array size: nscan):
183 GHZ Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_RS_MR1 (4-byte float, array size: nscan):
Main Reflector Temperature Read By RS 1 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_RS_MR2 (4-byte float, array size: nscan):
Main Reflector Temperature Read By RS 2 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_ICA_TEMP (4-byte float, array size: nscan):
Main Reflector Temperature Read By ICA Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_LEFT_TEMP (4-byte float, array size: nscan):
Main Reflector left Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_RGHT_TEMP (4-byte float, array size: nscan):
Main Reflector right Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_LOWR_TEMP (4-byte float, array size: nscan):
Main Reflector lower Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

CSR_TEMP1 (4-byte float, array size: nscan):
Cold Sky Reflector Temperature 1 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

CSR_TEMP2 (4-byte float, array size: nscan):
Cold Sky Reflector Temperature 2 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

onOrbitDiodeExcessTemp (4-byte float, array size: nchan1 x nscan):
Diode Excess Temperature derived from on orbit trended look-up tables as a function of noise diode temperature from telemetry. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

WarmIntrusionToColdViewIndex (2-byte unsigned integer, array size: nchan1 x ncolds1 x nscan):
Index flag to determine if a cold view sample is contaminated by certain warmer sources. If the value is 0, the sample is good and the count is used in calibration. If the value is non-zero, the sample is contaminated and excluded in calibration.

```
0:  Good sample
1:  Bad sample determined by limit check
2:  Bad sample determined by 2D medium filter
```

Values range from 0 to 2. Special values are defined as:
65535 Missing value

moonVectorInstFrame (4-byte float, array size: GMIxyz x nscan):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

calCounts (Group in S1)

hotLoadReading (2-byte unsigned integer, array size: nhots1 x nchan1 x nscan):
Hot Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

coldLoadReading (2-byte unsigned integer, array size: ncolds1 x nchan1 x nscan):
Cold Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadnDiodeReading (2-byte unsigned integer, array size: nhots1 x nchan1 x nscan):
Hot Load Plus Diode Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

coldLoadnDiodeReading (2-byte unsigned integer, array size: ncolds1 x nchan1 x nscan):
Cold Load Plus Diode Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadThermisterCount (2-byte unsigned integer, array size: ntherm x nscan):
Counts from 11 PRTs in the hot load Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

sunData (Group in S1)

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius.

Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: 3 x nscan):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix1 x nscan):
The angle at the center of the IFOV between the antenna boresight vector and the zenith vector normal to the Earth Ellipsiod. Also known as Satellite Zenith Angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npix1 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npix1 x nscan):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npix1 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npix1 x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location

on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

magneticFieldVector (4-byte float, array size: GMIxyz x nscan):
Magnetometer volt reading in TAM (x, y, z) coordinate system. Used to perform along-scan correction of earth view counts. (The TAM (x,y,z) coordinate system is similar to GPM S/C coordinate system but y and z axis are rotated by 180 degrees.) Values range from -500 to 500 V. Special values are defined as:
-9999.9 Missing value

earthViewCounts (2-byte unsigned integer, array size: nchan1 x npix1 x nscan):
Earth view counts. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

Ta (4-byte float, array size: nchan1 x npix1 x nscan):
Earth view antenna temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

RFIFlag (2-byte integer, array size: nfreq1 x npix1 x nscan):

```
Radio Frequency Interference (RFI) Flag.  The flag is set
to non-zero if the pixel is contaminated by RFI according
to certain filters.  Current values are:

0:     Not affected by RFI.
1:     Affected by RFI with X-cal filter.
2:     Affected by RFI with RSS filter.
3-7:   Spare
-9999: Missing
```

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S2)
A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix2 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix2 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value

-180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S2)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
```

```
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
```

```
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

sampleHeader (Group in S2)

blanking (1-byte integer, array size: nscan):

```
Value of 0 = Blanking off
Value of 1 = Blanking on
```

earthViewFirstSample (2-byte integer, array size: nscan):
Sample number of the first earth view. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

sampleNumber (2-byte integer, array size: nsamt x nchan2 x nscan):
Number of valid samples in scan. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

tachSeconds (4-byte unsigned integer, array size: ntach x nscan):
Tachometer seconds. Values are in second. Special values are defined as:
0 Missing value

tachSubSeconds (2-byte unsigned integer, array size: ntach x nscan):
Tachometer sub_seconds. Values range from 0 to 62499 in units of 16 microseconds. The missing value is 65535.

indexPulseSeconds (4-byte unsigned integer, array size: nscan):
Index Pulse seconds. Values are in second. Special values are defined as:
0 Missing value

indexPulseSubSeconds (2-byte unsigned integer, array size: nscan):
Index Pulse subseconds. Values range from 0 to 62499 in units of 16 microseconds. The missing value is 65535.

navigation (Group in S2)

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the

Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

nav2 (Group in S2)

SCE_SELECTION (2-byte unsigned integer, array size: nscan):
The current SCE selection setting. Special values are defined as:
0 Missing value

SCE_RATE (2-byte unsigned integer, array size: nscan):
The SMA rotational rate reported by the SCE. To obtain the spin rate in RPM, multiply SCE_RATE by 0.002999106 Values range from 1 to 65535 count. Special values are defined as:
0 Missing value

calibration (Group in S2)

hotLoadTemp (4-byte float, array size: nchan2 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load. For 10, 166, 183 GHZ channles, they are averages of PRT 1,7,8,9,10. For 18, 23, 36, 89 GHZ channels, they are averages of PRT 2,11,12,13,14. The values are corrected by tray temperature and averaged over closest 5 scans Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan2 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan2 x nscan):
The on Orbit Non-Linearity Tnl computed from ground calibrated u look-up table . Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan2 x nscan):
Non-Linearity Tnl derived from 4-point calibration. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (4-byte float, array size: nchan2 x nscan):
The mean Hot Load Count. Averaged over all Hot samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanHotLoadCntnDiode (4-byte float, array size: nchan2 x nscan):
The mean coupled Hot Load Plus Noise Diode counts Averaged over all samples and closest 5 scans. Values range from 0 to 65535. Special values are defined as:
-9999.9 Missing value

meanColdSkyCount (4-byte float, array size: nchan2 x nscan):
The mean Cold Sky Count.Averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanColdSkyCntnDiode (4-byte float, array size: nchan2 x nscan):
The mean coupled Cold Sky Plus Noise Diode counts, averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

diodeExcessTemp (4-byte float, array size: nchan2 x nscan):
The Noise Diode Excess Temperature. Cold and diode Coupled Temperature=diodeExcessTemp

+ coldSkyTemp. Hot and diode Coupled Temperature=diodeExcessTemp + hotLoadTemp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan2 x nscan):
gain[0] determine the total Ta gain. Ta=offset[0]+gain[0]*earthCount+ nonLinearGaian*earthCount*earthCount. Nonlinearity=offset[1]+gain[1]*earthCount+ nonLinearGaian*earthCount*earthCount. Values range from 0 to 1 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan2 x nscan):
Offset[0] determine the total Ta offset. min=-999 K (from -1 K), max=999 K (from 1 K). Missing value is -9999.9.

nonLinearGain (4-byte float, array size: nchan2 x nscan):
The nonlinear gain. Values range from -1 to 1 K. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. value 0 indicates good calibration. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

```
Diode flag.
0, Noise Diode on
2, Noise Diode off
5, Noise Diode status unknown
```

receiverTemp (4-byte float, array size: nchan2 x nscan):
The receiver temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan2 x nscan):
The receiver gain. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

cal2 (Group in S2)

trayTemperatureCount (2-byte unsigned integer, array size: nscan):
Counts to derive hot load tray temperature. Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

trayTemperature (4-byte float, array size: nscan):
Derive hot load tray temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

moonIndex (2-byte unsigned integer, array size: nchan2 x nscan):
Index determined by the angle between moon vector and cold sample vectors. 0 means angles between moon vector and all cold view vectors are greater than 5 degrees. Non-zero value means the number of cold samples that may be contaminated by moon. Values range from 0 to 100. Special values are defined as:
0 Missing value

noiseDiodeTemp (4-byte float, array size: nndiode x nscan):
Physical temperature of noise diode. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

TEMP_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for PRT temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for PRT temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

RS_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for tray temperature and receiver temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

RS_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for tray temperature and receiver temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

BATC_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for noise diode temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

BATC_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for noise diode temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

NDIODE_MODE (2-byte unsigned integer, array size: nscan):
RS configuration of Noise Diode Mode. 0 = On every scan, 1 = On every other scan, 2

= Off. Values range from 0 to 2 count. Special values are defined as:
65535 Missing value

RSST_NDIODE_ST (2-byte unsigned integer, array size: nscan):
Noise diode state during the scan. 0 = Noise diodes OFF for the scan, 1 = Noise diodes ON for the scan. Values range from 0 to 1 count. Special values are defined as:
65535 Missing value

NDIODE10GHZNUM (2-byte unsigned integer, array size: nscan):
RS configuration of Noise Diode Start Sample Number, i.e., the sample number where noise diodes are turned on. Values range from 0 to 500 count. Special values are defined as:
65535 Missing value

hotLoadThermisterTemp (4-byte float, array size: ntherm x nchan2 x nscan):
Hot Load Thermister Temperature of 11 PRTs. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

TEMP_CALRES_4 (2-byte unsigned integer, array size: nscan):
Low calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_5 (2-byte unsigned integer, array size: nscan):
High calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_6 (2-byte unsigned integer, array size: nscan):
High calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_89GHZ_LO (4-byte float, array size: nscan):
89 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_166GHZ_LO (4-byte float, array size: nscan):
166 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_183GHZ_LO (4-byte float, array size: nscan):
183 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_V89GHZMXR (4-byte float, array size: nscan):
89 GHZ V channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_H89GHZMXR (4-byte float, array size: nscan):
89 GHZ H channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_V166GHZMXR (4-byte float, array size: nscan):
166 GHZ V channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_H166GHZMXR (4-byte float, array size: nscan):
166 GHZ H channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_183GHZMXR (4-byte float, array size: nscan):
183 GHZ Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_RS_MR1 (4-byte float, array size: nscan):
Main Reflector Temperature Read By RS 1 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_RS_MR2 (4-byte float, array size: nscan):
Main Reflector Temperature Read By RS 2 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_ICA_TEMP (4-byte float, array size: nscan):
Main Reflector Temperature Read By ICA Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_LEFT_TEMP (4-byte float, array size: nscan):
Main Reflector left Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_RGHT_TEMP (4-byte float, array size: nscan):
Main Reflector right Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_LOWR_TEMP (4-byte float, array size: nscan):
Main Reflector lower Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

CSR_TEMP1 (4-byte float, array size: nscan):
Cold Sky Reflector Temperature 1 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

CSR_TEMP2 (4-byte float, array size: nscan):
Cold Sky Reflector Temperature 2 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

onOrbitDiodeExcessTemp (4-byte float, array size: nchan2 x nscan):
Diode Excess Temperature derived from on orbit trended look-up tables as a function of noise diode temperature from telemetry. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

WarmIntrusionToColdViewIndex (2-byte unsigned integer, array size: nchan2 x ncolds2 x nscan):
Index flag to determine if a cold view sample is contaminated by certain warmer sources. If the value is 0, the sample is good and the count is used in calibration. If the value is non-zero, the sample is contaminated and excluded in calibration.

```
0:  Good sample
1:  Bad sample determined by limit check
2:  Bad sample determined by 2D medium filter
```

Values range from 0 to 2. Special values are defined as:
65535 Missing value

moonVectorInstFrame (4-byte float, array size: GMIxyz x nscan):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

calCounts (Group in S2)

hotLoadReading (2-byte unsigned integer, array size: nhots2 x nchan2 x nscan):
Hot Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

coldLoadReading (2-byte unsigned integer, array size: ncolds2 x nchan2 x nscan):
Cold Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadnDiodeReading (2-byte unsigned integer, array size: nhots2 x nchan2 x nscan):
Hot Load Plus Diode Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

coldLoadnDiodeReading (2-byte unsigned integer, array size: ncolds2 x nchan2 x nscan):
Cold Load Plus Diode Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadThermisterCount (2-byte unsigned integer, array size: ntherm x nscan):
Counts from 11 PRTs in the hot load Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

sunData (Group in S2)

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius.

Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: 3 x nscan):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix2 x nscan):
The angle at the center of the IFOV between the antenna boresight vector and the zenith vector normal to the Earth Ellipsiod. Also known as Satellite Zenith Angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npix2 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npix2 x nscan):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npix2 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npix2 x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location

on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

magneticFieldVector (4-byte float, array size: GMIxyz x nscan):
Magnetometer volt reading in TAM (x, y, z) coordinate system. Used to perform along-scan correction of earth view counts. (The TAM (x,y,z) coordinate system is similar to GPM S/C coordinate system but y and z axis are rotated by 180 degrees.) Values range from -500 to 500 V. Special values are defined as:
-9999.9 Missing value

earthViewCounts (2-byte unsigned integer, array size: nchan2 x npix2 x nscan):
Earth view counts. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

Ta (4-byte float, array size: nchan2 x npix2 x nscan):
Earth view antenna temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

RFIFlag (2-byte integer, array size: nfreq2 x npix2 x nscan):

```
Radio Frequency Interference (RFI) Flag.  The flag is set
to non-zero if the pixel is contaminated by RFI according
to certain filters.  Current values are:

0:     Not affected by RFI.
1:     Affected by RFI with X-cal filter.
2:     Affected by RFI with RSS filter.
3-7:   Spare
-9999: Missing
```

S3 (Swath)

S3_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S3)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix3 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix3 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value

-180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S3)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
```

```
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
```

```
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

calibration (Group in S3)

hotLoadTemp (4-byte float, array size: nchan1 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load.

For 10, 166, 183 GHZ channles, they are averages of PRT 1,7,8,9,10. For 18, 23, 36, 89 GHZ channels, they are averages of PRT 2,11,12,13,14. The values are corrected by tray temperature and averaged over closest 5 scans Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan1 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan1 x nscan):
The on Orbit Non-Linearity Tnl computed from ground calibrated u look-up table . Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan1 x nscan):
Non-Linearity Tnl derived from 4-point calibration. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (4-byte float, array size: nchan1 x nscan):
The mean Hot Load Count. Averaged over all Hot samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanHotLoadCntnDiode (4-byte float, array size: nchan1 x nscan):
The mean coupled Hot Load Plus Noise Diode counts Averaged over all samples and closest 5 scans. Values range from 0 to 65535. Special values are defined as:
-9999.9 Missing value

meanColdSkyCount (4-byte float, array size: nchan1 x nscan):
The mean Cold Sky Count.Averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanColdSkyCntnDiode (4-byte float, array size: nchan1 x nscan):
The mean coupled Cold Sky Plus Noise Diode counts, averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

diodeExcessTemp (4-byte float, array size: nchan1 x nscan):
The Noise Diode Excess Temperature. Cold and diode Coupled Temperature=diodeExcessTemp + coldSkyTemp. Hot and diode Coupled Temperature=diodeExcessTemp + hotLoadTemp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan1 x nscan):
gain[0] determine the total Ta gain. Ta=offset[0]+gain[0]*earthCount+ nonLinearGaian*earthCount*earthCount. Nonlinearity=offset[1]+gain[1]*earthCount+ nonLinearGa-

ian*earthCount*earthCount. Values range from 0 to 1 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan1 x nscan):
Offset[0] determine the total Ta offset. min=-999 K (from -1 K), max=999 K (from 1 K). Missing value is -9999.9.

nonLinearGain (4-byte float, array size: nchan1 x nscan):
The nonlinear gain. Values range from -1 to 1 K. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. value 0 indicates good calibration. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

```
Diode flag.
0, Noise Diode on
2, Noise Diode off
5, Noise Diode status unknown
```

receiverTemp (4-byte float, array size: nchan1 x nscan):
The receiver temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan1 x nscan):
The receiver gain. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix3 x nscan):
The angle at the center of the IFOV between the antenna boresight vector and the zenith vector normal to the Earth Ellipsiod. Also known as Satellite Zenith Angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Ta (4-byte float, array size: nchan1 x npix3 x nscan):
Earth view antenna temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

count (2-byte unsigned integer, array size: nchan1 x npix3 x nscan):
Full scan count. Values range from 0 to 65534. Special values are defined as:
65535 Missing value

S4 (Swath)

S4_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S4)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix4 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude

is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix4 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S4)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be

useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

calibration (Group in S4)

hotLoadTemp (4-byte float, array size: nchan2 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load. For 10, 166, 183 GHZ channles, they are averages of PRT 1,7,8,9,10. For 18, 23, 36, 89 GHZ channels, they are averages of PRT 2,11,12,13,14. The values are corrected by tray temperature and averaged over closest 5 scans Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan2 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan2 x nscan):
The on Orbit Non-Linearity Tnl computed from ground calibrated u look-up table . Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan2 x nscan):
Non-Linearity Tnl derived from 4-point calibration. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (4-byte float, array size: nchan2 x nscan):
The mean Hot Load Count. Averaged over all Hot samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanHotLoadCntnDiode (4-byte float, array size: nchan2 x nscan):
The mean coupled Hot Load Plus Noise Diode counts Averaged over all samples and closest 5 scans. Values range from 0 to 65535. Special values are defined as:
-9999.9 Missing value

meanColdSkyCount (4-byte float, array size: nchan2 x nscan):
The mean Cold Sky Count.Averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanColdSkyCntnDiode (4-byte float, array size: nchan2 x nscan):
The mean coupled Cold Sky Plus Noise Diode counts, averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

diodeExcessTemp (4-byte float, array size: nchan2 x nscan):
The Noise Diode Excess Temperature. Cold and diode Coupled Temperature=diodeExcessTemp

+ coldSkyTemp. Hot and diode Coupled Temperature=diodeExcessTemp + hotLoadTemp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan2 x nscan):
gain[0] determine the total Ta gain. Ta=offset[0]+gain[0]*earthCount+ nonLinearGain*earthCount*earthCount. Nonlinearity=offset[1]+gain[1]*earthCount+ nonLinearGain*earthCount*earthCount. Values range from 0 to 1 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan2 x nscan):
Offset[0] determine the total Ta offset. min=-999 K (from -1 K), max=999 K (from 1 K). Missing value is -9999.9.

nonLinearGain (4-byte float, array size: nchan2 x nscan):
The nonlinear gain. Values range from -1 to 1 K. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. value 0 indicates good calibration. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

```
Diode flag.
0, Noise Diode on
2, Noise Diode off
5, Noise Diode status unknown
```

receiverTemp (4-byte float, array size: nchan2 x nscan):
The receiver temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan2 x nscan):
The receiver gain. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix4 x nscan):
The angle at the center of the IFOV between the antenna boresight vector and the zenith vector normal to the Earth Ellipsiod. Also known as Satellite Zenith Angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Ta (4-byte float, array size: nchan2 x npix4 x nscan):
Earth view antenna temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

count (2-byte unsigned integer, array size: nchan2 x npix4 x nscan):
Full scan count. Values range from 0 to 65534. Special values are defined as:
65535 Missing value

C Structure Header file:

```
#ifndef _TK_GMIBASERSS_H_
#define _TK_GMIBASERSS_H_

#ifndef _LGMIBASERSS_S4_CALIBRATION_
#define _LGMIBASERSS_S4_CALIBRATION_

typedef struct {
    float hotLoadTemp[4];
    float coldSkyTemp[4];
    float onOrbitNonLinearity[4];
    float derivedNonLinearity[4];
    float meanHotLoadCount[4];
    float meanHotLoadCntnDiode[4];
    float meanColdSkyCount[4];
    float meanColdSkyCntnDiode[4];
    float diodeExcessTemp[4];
    float gain[4][2];
    float offset[4][2];
    float nonLinearGain[4];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[4];
    float receiverGain[4];
} LGMIBASERSS_S4_CALIBRATION;

#endif

#ifndef _LGMIBASERSS_S4_SCANSTATUS_
#define _LGMIBASERSS_S4_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
```

```
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} LGMIBASERSS_S4_SCANSTATUS;

#endif

#ifndef _LGMIBASERSS_S4_
#define _LGMIBASERSS_S4_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[500];
    float Longitude[500];
    LGMIBASERSS_S4_SCANSTATUS scanStatus;
    LGMIBASERSS_S4_CALIBRATION calibration;
    float incidenceAngle[500];
    float Ta[500][4];
    unsigned short count[500][4];
} LGMIBASERSS_S4;

#endif

#ifndef _LGMIBASERSS_S3_CALIBRATION_
#define _LGMIBASERSS_S3_CALIBRATION_

typedef struct {
    float hotLoadTemp[9];
    float coldSkyTemp[9];
    float onOrbitNonLinearity[9];
    float derivedNonLinearity[9];
    float meanHotLoadCount[9];
    float meanHotLoadCntnDiode[9];
    float meanColdSkyCount[9];
    float meanColdSkyCntnDiode[9];
    float diodeExcessTemp[9];
    float gain[9][2];
    float offset[9][2];
    float nonLinearGain[9];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[9];
```

```
    float receiverGain[9];
} LGMIBASERSS_S3_CALIBRATION;

#endif

#ifndef _LGMIBASERSS_S3_SCANSTATUS_
#define _LGMIBASERSS_S3_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} LGMIBASERSS_S3_SCANSTATUS;

#endif

#ifndef _LGMIBASERSS_S3_
#define _LGMIBASERSS_S3_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[500];
    float Longitude[500];
    LGMIBASERSS_S3_SCANSTATUS scanStatus;
    LGMIBASERSS_S3_CALIBRATION calibration;
    float incidenceAngle[500];
    float Ta[500][9];
    unsigned short count[500][9];
} LGMIBASERSS_S3;

#endif

#ifndef _LGMIBASERSS_S2_SUNDATA_
#define _LGMIBASERSS_S2_SUNDATA_
```

```
typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} LGMIBASERSS_S2_SUNDATA;

#endif

#ifndef _LGMIBASERSS_S2_CALCOUNTS_
#define _LGMIBASERSS_S2_CALCOUNTS_

typedef struct {
    unsigned short hotLoadReading[4][65];
    unsigned short coldLoadReading[4][85];
    unsigned short hotLoadnDiodeReading[4][65];
    unsigned short coldLoadnDiodeReading[4][85];
    unsigned short hotLoadThermisterCount[11];
} LGMIBASERSS_S2_CALCOUNTS;

#endif

#ifndef _LGMIBASERSS_S2_CAL2_
#define _LGMIBASERSS_S2_CAL2_

typedef struct {
    unsigned short trayTemperatureCount;
    float trayTemperature;
    unsigned short moonIndex[4];
    float noiseDiodeTemp[6];
    unsigned short TEMP_CALRES_2;
    unsigned short TEMP_CALRES_1;
    unsigned short RS_CALRES_2;
    unsigned short RS_CALRES_1;
    unsigned short BATC_CALRES_2;
    unsigned short BATC_CALRES_1;
    unsigned short NDIODE_MODE;
    unsigned short RSST_NDIODE_ST;
    unsigned short NDIODE10GHZNUM;
```

```
    float hotLoadThermisterTemp[4][11];
    unsigned short TEMP_CALRES_4;
    unsigned short TEMP_CALRES_5;
    unsigned short TEMP_CALRES_6;
    float TEMP_89GHZ_LO;
    float TEMP_166GHZ_LO;
    float TEMP_183GHZ_LO;
    float TEMP_V89GHZMXR;
    float TEMP_H89GHZMXR;
    float TEMP_V166GHZMXR;
    float TEMP_H166GHZMXR;
    float TEMP_183GHZMXR;
    float TEMP_RS_MR1;
    float TEMP_RS_MR2;
    float MR_ICA_TEMP;
    float MR_LR_LEFT_TEMP;
    float MR_LR_RGHT_TEMP;
    float MR_LR_LOWR_TEMP;
    float CSR_TEMP1;
    float CSR_TEMP2;
    float onOrbitDiodeExcessTemp[4];
    unsigned short WarmIntrusionToColdViewIndex[85][4];
} LGMIBASERSS_S2_CAL2;

#endif

#ifndef _LGMIBASERSS_S2_CALIBRATION_
#define _LGMIBASERSS_S2_CALIBRATION_

typedef struct {
    float hotLoadTemp[4];
    float coldSkyTemp[4];
    float onOrbitNonLinearity[4];
    float derivedNonLinearity[4];
    float meanHotLoadCount[4];
    float meanHotLoadCntnDiode[4];
    float meanColdSkyCount[4];
    float meanColdSkyCntnDiode[4];
    float diodeExcessTemp[4];
    float gain[4][2];
    float offset[4][2];
    float nonLinearGain[4];
    short calibrationQCflag;
```

```
    short diodeFlag;
    float receiverTemp[4];
    float receiverGain[4];
} LGMIBASERSS_S2_CALIBRATION;

#endif

#ifndef _LGMIBASERSS_S2_NAV2_
#define _LGMIBASERSS_S2_NAV2_

typedef struct {
    unsigned short SCE_SELECTION;
    unsigned short SCE_RATE;
} LGMIBASERSS_S2_NAV2;

#endif

#ifndef _LGMIBASERSS_S2_SAMPLEHEADER_
#define _LGMIBASERSS_S2_SAMPLEHEADER_

typedef struct {
    signed char blanking;
    short earthViewFirstSample;
    short sampleNumber[4][4];
    unsigned int tachSeconds[32];
    unsigned short tachSubSeconds[32];
    unsigned int indexPulseSeconds;
    unsigned short indexPulseSubSeconds;
} LGMIBASERSS_S2_SAMPLEHEADER;

#endif

#ifndef _LGMIBASERSS_S2_SCANSTATUS_
#define _LGMIBASERSS_S2_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
```

```
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} LGMIBASERSS_S2_SCANSTATUS;

#endif

#ifndef _LGMIBASERSS_S2_
#define _LGMIBASERSS_S2_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    LGMIBASERSS_S2_SCANSTATUS scanStatus;
    LGMIBASERSS_S2_SAMPLEHEADER sampleHeader;
    NAVIGATION navigation;
    LGMIBASERSS_S2_NAV2 nav2;
    LGMIBASERSS_S2_CALIBRATION calibration;
    LGMIBASERSS_S2_CAL2 cal2;
    float moonVectorInstFrame[3];
    LGMIBASERSS_S2_CALCOUNTS calCounts;
    LGMIBASERSS_S2_SUNDATA sunData;
    float incidenceAngle[221];
    float satAzimuthAngle[221];
    float solarZenAngle[221];
    float solarAzimuthAngle[221];
    float sunGlintAngle[221];
    float magneticFieldVector[3];
    unsigned short earthViewCounts[221][4];
    float Ta[221][4];
    short RFIFlag[221][2];
} LGMIBASERSS_S2;

#endif

#ifndef _LGMIBASERSS_S1_SUNDATA_
#define _LGMIBASERSS_S1_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
```

```
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} LGMIBASERSS_S1_SUNDATA;

#endif

#ifndef _LGMIBASERSS_S1_CALCOUNTS_
#define _LGMIBASERSS_S1_CALCOUNTS_

typedef struct {
    unsigned short hotLoadReading[9][65];
    unsigned short coldLoadReading[9][85];
    unsigned short hotLoadnDiodeReading[9][65];
    unsigned short coldLoadnDiodeReading[9][85];
    unsigned short hotLoadThermisterCount[11];
} LGMIBASERSS_S1_CALCOUNTS;

#endif

#ifndef _LGMIBASERSS_S1_CAL2_
#define _LGMIBASERSS_S1_CAL2_

typedef struct {
    unsigned short trayTemperatureCount;
    float trayTemperature;
    unsigned short moonIndex[9];
    float noiseDiodeTemp[6];
    unsigned short TEMP_CALRES_2;
    unsigned short TEMP_CALRES_1;
    unsigned short RS_CALRES_2;
    unsigned short RS_CALRES_1;
    unsigned short BATC_CALRES_2;
    unsigned short BATC_CALRES_1;
    unsigned short NDIODE_MODE;
    unsigned short RSST_NDIODE_ST;
    unsigned short NDIODE10GHZNUM;
    float hotLoadThermisterTemp[9][11];
    unsigned short TEMP_CALRES_4;
    unsigned short TEMP_CALRES_5;
```

```
    unsigned short TEMP_CALRES_6;
    float TEMP_89GHZ_LO;
    float TEMP_166GHZ_LO;
    float TEMP_183GHZ_LO;
    float TEMP_V89GHZMXR;
    float TEMP_H89GHZMXR;
    float TEMP_V166GHZMXR;
    float TEMP_H166GHZMXR;
    float TEMP_183GHZMXR;
    float TEMP_RS_MR1;
    float TEMP_RS_MR2;
    float MR_ICA_TEMP;
    float MR_LR_LEFT_TEMP;
    float MR_LR_RGHT_TEMP;
    float MR_LR_LOWR_TEMP;
    float CSR_TEMP1;
    float CSR_TEMP2;
    float onOrbitDiodeExcessTemp[9];
    unsigned short WarmIntrusionToColdViewIndex[85][9];
} LGMIBASERSS_S1_CAL2;

#endif

#ifndef _LGMIBASERSS_S1_CALIBRATION_
#define _LGMIBASERSS_S1_CALIBRATION_

typedef struct {
    float hotLoadTemp[9];
    float coldSkyTemp[9];
    float onOrbitNonLinearity[9];
    float derivedNonLinearity[9];
    float meanHotLoadCount[9];
    float meanHotLoadCntnDiode[9];
    float meanColdSkyCount[9];
    float meanColdSkyCntnDiode[9];
    float diodeExcessTemp[9];
    float gain[9][2];
    float offset[9][2];
    float nonLinearGain[9];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[9];
    float receiverGain[9];
```

```
} LGMIBASERSS_S1_CALIBRATION;

#endif

#ifndef _LGMIBASERSS_S1_NAV2_
#define _LGMIBASERSS_S1_NAV2_

typedef struct {
    unsigned short SCE_SELECTION;
    unsigned short SCE_RATE;
} LGMIBASERSS_S1_NAV2;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _LGMIBASERSS_S1_SAMPLEHEADER_
#define _LGMIBASERSS_S1_SAMPLEHEADER_

typedef struct {
    signed char blanking;
    short earthViewFirstSample;
```

```
    short sampleNumber[9][4];
    unsigned int tachSeconds[32];
    unsigned short tachSubSeconds[32];
    unsigned int indexPulseSeconds;
    unsigned short indexPulseSubSeconds;
} LGMIBASERSS_S1_SAMPLEHEADER;

#endif

#ifndef _LGMIBASERSS_S1_SCANSTATUS_
#define _LGMIBASERSS_S1_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} LGMIBASERSS_S1_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;
```

```
#endif

#ifndef _LGMIBASERSS_S1_
#define _LGMIBASERSS_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    LGMIBASERSS_S1_SCANSTATUS scanStatus;
    LGMIBASERSS_S1_SAMPLEHEADER sampleHeader;
    NAVIGATION navigation;
    LGMIBASERSS_S1_NAV2 nav2;
    LGMIBASERSS_S1_CALIBRATION calibration;
    LGMIBASERSS_S1_CAL2 cal2;
    float moonVectorInstFrame[3];
    LGMIBASERSS_S1_CALCOUNTS calCounts;
    LGMIBASERSS_S1_SUNDATA sunData;
    float incidenceAngle[221];
    float satAzimuthAngle[221];
    float solarZenAngle[221];
    float solarAzimuthAngle[221];
    float sunGlintAngle[221];
    float magneticFieldVector[3];
    unsigned short earthViewCounts[221][9];
    float Ta[221][9];
    short RFIFlag[221][5];
} LGMIBASERSS_S1;

#endif

#ifndef _LGMIBASERSS_SWATHS_
#define _LGMIBASERSS_SWATHS_

typedef struct {
    LGMIBASERSS_S1 S1;
    LGMIBASERSS_S2 S2;
    LGMIBASERSS_S3 S3;
    LGMIBASERSS_S4 S4;
} LGMIBASERSS_SWATHS;

#endif
```

```
#endif
```

Fortran Structure Header file:

```
STRUCTURE /LGMIBASERSS_S4_CALIBRATION/
    REAL*4 hotLoadTemp(4)
    REAL*4 coldSkyTemp(4)
    REAL*4 onOrbitNonLinearity(4)
    REAL*4 derivedNonLinearity(4)
    REAL*4 meanHotLoadCount(4)
    REAL*4 meanHotLoadCntnDiode(4)
    REAL*4 meanColdSkyCount(4)
    REAL*4 meanColdSkyCntnDiode(4)
    REAL*4 diodeExcessTemp(4)
    REAL*4 gain(2,4)
    REAL*4 offset(2,4)
    REAL*4 nonLinearGain(4)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(4)
    REAL*4 receiverGain(4)
END STRUCTURE

STRUCTURE /LGMIBASERSS_S4_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /LGMIBASERSS_S4/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(500)
    REAL*4 Longitude(500)
    RECORD /LGMIBASERSS_S4_SCANSTATUS/ scanStatus
    RECORD /LGMIBASERSS_S4_CALIBRATION/ calibration
```

```
    REAL*4 incidenceAngle(500)
    REAL*4 Ta(4,500)
    INTEGER*2 count(4,500)
END STRUCTURE

STRUCTURE /LGMIBASERSS_S3_CALIBRATION/
    REAL*4 hotLoadTemp(9)
    REAL*4 coldSkyTemp(9)
    REAL*4 onOrbitNonLinearity(9)
    REAL*4 derivedNonLinearity(9)
    REAL*4 meanHotLoadCount(9)
    REAL*4 meanHotLoadCntnDiode(9)
    REAL*4 meanColdSkyCount(9)
    REAL*4 meanColdSkyCntnDiode(9)
    REAL*4 diodeExcessTemp(9)
    REAL*4 gain(2,9)
    REAL*4 offset(2,9)
    REAL*4 nonLinearGain(9)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(9)
    REAL*4 receiverGain(9)
END STRUCTURE

STRUCTURE /LGMIBASERSS_S3_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /LGMIBASERSS_S3/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(500)
    REAL*4 Longitude(500)
    RECORD /LGMIBASERSS_S3_SCANSTATUS/ scanStatus
```

```
    RECORD /LGMIBASERSS_S3_CALIBRATION/ calibration
    REAL*4 incidenceAngle(500)
    REAL*4 Ta(9,500)
    INTEGER*2 count(9,500)
END STRUCTURE

STRUCTURE /LGMIBASERSS_S2_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /LGMIBASERSS_S2_CALCOUNTS/
    INTEGER*2 hotLoadReading(65,4)
    INTEGER*2 coldLoadReading(85,4)
    INTEGER*2 hotLoadnDiodeReading(65,4)
    INTEGER*2 coldLoadnDiodeReading(85,4)
    INTEGER*2 hotLoadThermisterCount(11)
END STRUCTURE

STRUCTURE /LGMIBASERSS_S2_CAL2/
    INTEGER*2 trayTemperatureCount
    REAL*4 trayTemperature
    INTEGER*2 moonIndex(4)
    REAL*4 noiseDiodeTemp(6)
    INTEGER*2 TEMP_CALRES_2
    INTEGER*2 TEMP_CALRES_1
    INTEGER*2 RS_CALRES_2
    INTEGER*2 RS_CALRES_1
    INTEGER*2 BATC_CALRES_2
    INTEGER*2 BATC_CALRES_1
    INTEGER*2 NDIODE_MODE
    INTEGER*2 RSST_NDIODE_ST
    INTEGER*2 NDIODE10GHZNUM
    REAL*4 hotLoadThermisterTemp(11,4)
    INTEGER*2 TEMP_CALRES_4
    INTEGER*2 TEMP_CALRES_5
    INTEGER*2 TEMP_CALRES_6
```

```
    REAL*4 TEMP_89GHZ_LO
    REAL*4 TEMP_166GHZ_LO
    REAL*4 TEMP_183GHZ_LO
    REAL*4 TEMP_V89GHZMXR
    REAL*4 TEMP_H89GHZMXR
    REAL*4 TEMP_V166GHZMXR
    REAL*4 TEMP_H166GHZMXR
    REAL*4 TEMP_183GHZMXR
    REAL*4 TEMP_RS_MR1
    REAL*4 TEMP_RS_MR2
    REAL*4 MR_ICA_TEMP
    REAL*4 MR_LR_LEFT_TEMP
    REAL*4 MR_LR_RGHT_TEMP
    REAL*4 MR_LR_LOWR_TEMP
    REAL*4 CSR_TEMP1
    REAL*4 CSR_TEMP2
    REAL*4 onOrbitDiodeExcessTemp(4)
    INTEGER*2 WarmIntrusionToColdViewIndex(4,85)
END STRUCTURE

STRUCTURE /LGMIBASERSS_S2_CALIBRATION/
    REAL*4 hotLoadTemp(4)
    REAL*4 coldSkyTemp(4)
    REAL*4 onOrbitNonLinearity(4)
    REAL*4 derivedNonLinearity(4)
    REAL*4 meanHotLoadCount(4)
    REAL*4 meanHotLoadCntnDiode(4)
    REAL*4 meanColdSkyCount(4)
    REAL*4 meanColdSkyCntnDiode(4)
    REAL*4 diodeExcessTemp(4)
    REAL*4 gain(2,4)
    REAL*4 offset(2,4)
    REAL*4 nonLinearGain(4)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(4)
    REAL*4 receiverGain(4)
END STRUCTURE

STRUCTURE /LGMIBASERSS_S2_NAV2/
    INTEGER*2 SCE_SELECTION
    INTEGER*2 SCE_RATE
END STRUCTURE
```

```
STRUCTURE /LGMIBASERSS_S2_SAMPLEHEADER/
    BYTE blanking
    INTEGER*2 earthViewFirstSample
    INTEGER*2 sampleNumber(4,4)
    INTEGER*4 tachSeconds(32)
    INTEGER*2 tachSubSeconds(32)
    INTEGER*4 indexPulseSeconds
    INTEGER*2 indexPulseSubSeconds
END STRUCTURE

STRUCTURE /LGMIBASERSS_S2_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /LGMIBASERSS_S2/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    RECORD /LGMIBASERSS_S2_SCANSTATUS/ scanStatus
    RECORD /LGMIBASERSS_S2_SAMPLEHEADER/ sampleHeader
    RECORD /NAVIGATION/ navigation
    RECORD /LGMIBASERSS_S2_NAV2/ nav2
    RECORD /LGMIBASERSS_S2_CALIBRATION/ calibration
    RECORD /LGMIBASERSS_S2_CAL2/ cal2
    REAL*4 moonVectorInstFrame(3)
    RECORD /LGMIBASERSS_S2_CALCOUNTS/ calCounts
    RECORD /LGMIBASERSS_S2_SUNDATA/ sunData
    REAL*4 incidenceAngle(221)
    REAL*4 satAzimuthAngle(221)
    REAL*4 solarZenAngle(221)
    REAL*4 solarAzimuthAngle(221)
    REAL*4 sunGlintAngle(221)
```

```
    REAL*4 magneticFieldVector(3)
    INTEGER*2 earthViewCounts(4,221)
    REAL*4 Ta(4,221)
    INTEGER*2 RFIFlag(2,221)
END STRUCTURE

STRUCTURE /LGMIBASERSS_S1_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /LGMIBASERSS_S1_CALCOUNTS/
    INTEGER*2 hotLoadReading(65,9)
    INTEGER*2 coldLoadReading(85,9)
    INTEGER*2 hotLoadnDiodeReading(65,9)
    INTEGER*2 coldLoadnDiodeReading(85,9)
    INTEGER*2 hotLoadThermisterCount(11)
END STRUCTURE

STRUCTURE /LGMIBASERSS_S1_CAL2/
    INTEGER*2 trayTemperatureCount
    REAL*4 trayTemperature
    INTEGER*2 moonIndex(9)
    REAL*4 noiseDiodeTemp(6)
    INTEGER*2 TEMP_CALRES_2
    INTEGER*2 TEMP_CALRES_1
    INTEGER*2 RS_CALRES_2
    INTEGER*2 RS_CALRES_1
    INTEGER*2 BATC_CALRES_2
    INTEGER*2 BATC_CALRES_1
    INTEGER*2 NDIODE_MODE
    INTEGER*2 RSST_NDIODE_ST
    INTEGER*2 NDIODE10GHZNUM
    REAL*4 hotLoadThermisterTemp(11,9)
    INTEGER*2 TEMP_CALRES_4
    INTEGER*2 TEMP_CALRES_5
    INTEGER*2 TEMP_CALRES_6
```

```
    REAL*4 TEMP_89GHZ_LO
    REAL*4 TEMP_166GHZ_LO
    REAL*4 TEMP_183GHZ_LO
    REAL*4 TEMP_V89GHZMXR
    REAL*4 TEMP_H89GHZMXR
    REAL*4 TEMP_V166GHZMXR
    REAL*4 TEMP_H166GHZMXR
    REAL*4 TEMP_183GHZMXR
    REAL*4 TEMP_RS_MR1
    REAL*4 TEMP_RS_MR2
    REAL*4 MR_ICA_TEMP
    REAL*4 MR_LR_LEFT_TEMP
    REAL*4 MR_LR_RGHT_TEMP
    REAL*4 MR_LR_LOWR_TEMP
    REAL*4 CSR_TEMP1
    REAL*4 CSR_TEMP2
    REAL*4 onOrbitDiodeExcessTemp(9)
    INTEGER*2 WarmIntrusionToColdViewIndex(9,85)
END STRUCTURE

STRUCTURE /LGMIBASERSS_S1_CALIBRATION/
    REAL*4 hotLoadTemp(9)
    REAL*4 coldSkyTemp(9)
    REAL*4 onOrbitNonLinearity(9)
    REAL*4 derivedNonLinearity(9)
    REAL*4 meanHotLoadCount(9)
    REAL*4 meanHotLoadCntnDiode(9)
    REAL*4 meanColdSkyCount(9)
    REAL*4 meanColdSkyCntnDiode(9)
    REAL*4 diodeExcessTemp(9)
    REAL*4 gain(2,9)
    REAL*4 offset(2,9)
    REAL*4 nonLinearGain(9)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(9)
    REAL*4 receiverGain(9)
END STRUCTURE

STRUCTURE /LGMIBASERSS_S1_NAV2/
    INTEGER*2 SCE_SELECTION
    INTEGER*2 SCE_RATE
END STRUCTURE
```

```
STRUCTURE /NAVIGATION/
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /LGMIBASERSS_S1_SAMPLEHEADER/
    BYTE blanking
    INTEGER*2 earthViewFirstSample
    INTEGER*2 sampleNumber(4,9)
    INTEGER*4 tachSeconds(32)
    INTEGER*2 tachSubSeconds(32)
    INTEGER*4 indexPulseSeconds
    INTEGER*2 indexPulseSubSeconds
END STRUCTURE

STRUCTURE /LGMIBASERSS_S1_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE
```

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /LGMIBASERSS_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    RECORD /LGMIBASERSS_S1_SCANSTATUS/ scanStatus
    RECORD /LGMIBASERSS_S1_SAMPLEHEADER/ sampleHeader
    RECORD /NAVIGATION/ navigation
    RECORD /LGMIBASERSS_S1_NAV2/ nav2
    RECORD /LGMIBASERSS_S1_CALIBRATION/ calibration
    RECORD /LGMIBASERSS_S1_CAL2/ cal2
    REAL*4 moonVectorInstFrame(3)
    RECORD /LGMIBASERSS_S1_CALCOUNTS/ calCounts
    RECORD /LGMIBASERSS_S1_SUNDATA/ sunData
    REAL*4 incidenceAngle(221)
    REAL*4 satAzimuthAngle(221)
    REAL*4 solarZenAngle(221)
    REAL*4 solarAzimuthAngle(221)
    REAL*4 sunGlintAngle(221)
    REAL*4 magneticFieldVector(3)
    INTEGER*2 earthViewCounts(9,221)
    REAL*4 Ta(9,221)
    INTEGER*2 RFIFlag(5,221)
END STRUCTURE

STRUCTURE /LGMIBASERSS_SWATHS/
    RECORD /LGMIBASERSS_S1/ S1
    RECORD /LGMIBASERSS_S2/ S2
    RECORD /LGMIBASERSS_S3/ S3
    RECORD /LGMIBASERSS_S4/ S4
END STRUCTURE
```

5.4 GMIBASEXCAL - GMI Antenna Temperatures

The GMI BASE Product, GMIBASEXCAL, "GMI Antenna Temperatures," is written as a multi-Swath Structure. Swath S1 has channels 1-9: 10V 10H 19V 19H 23V 37V 37H 89V 89H. Swath S2 has channels 10-13: 166V 166H 183+/-3V 183+/-8V. S3 S4 are full rotation versions of S1 S2. GMIBASEXCAL is like GMIBASE but has overlap of 200 scans on each end of S3 and S4. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nchan1	9	Number of channels in Swath 1.
nchan2	4	Number of channels in Swath 2.
nfreq1	5	Number of frequencies in Swath 1.
nfreq2	2	Number of frequencies in Swath 2.
npix1	221	Number of pixels in Swath 1.
npix2	221	Number of pixels in Swath 2.
npix3	500	Number of pixels in Swath 3.
npix4	500	Number of pixels in Swath 4.
ncolds1	85	Maximum number of cold samples in Swath 1.
ncolds2	85	Maximum number of cold samples in Swath 2.
nhots1	65	Maximum number of hot samples in Swath 1.
nhots2	65	Maximum number of hot samples in Swath 2.
ntherm	11	Number of hot load thermisters.
LNL	2	Linear and non-linear.
nsamt	4	Number of sample types. The types are: total science GSDR, earth-view, hot load, cold sky.
ntach	32	Number of tachometer readings.
GMIxyz	3	x, y, z components in GMI instrument coordinate system.
nndiode	6	Number of noise diodes.
n7	7	Number seven.

Figure 70 through Figure 100 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

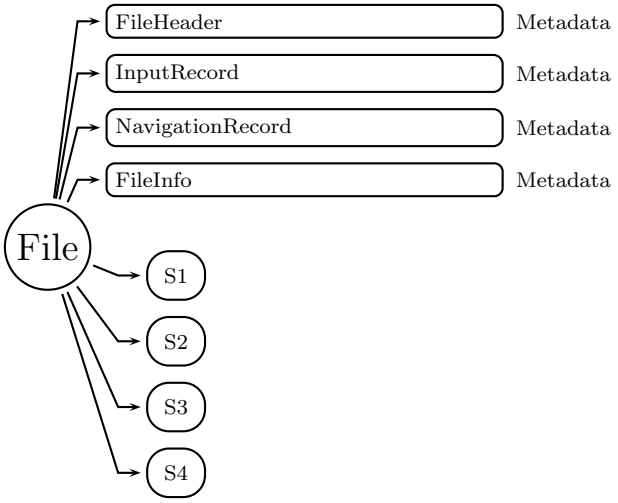


Figure 70: Data Format Structure for GMIBASEXCAL, GMI Antenna Temperatures

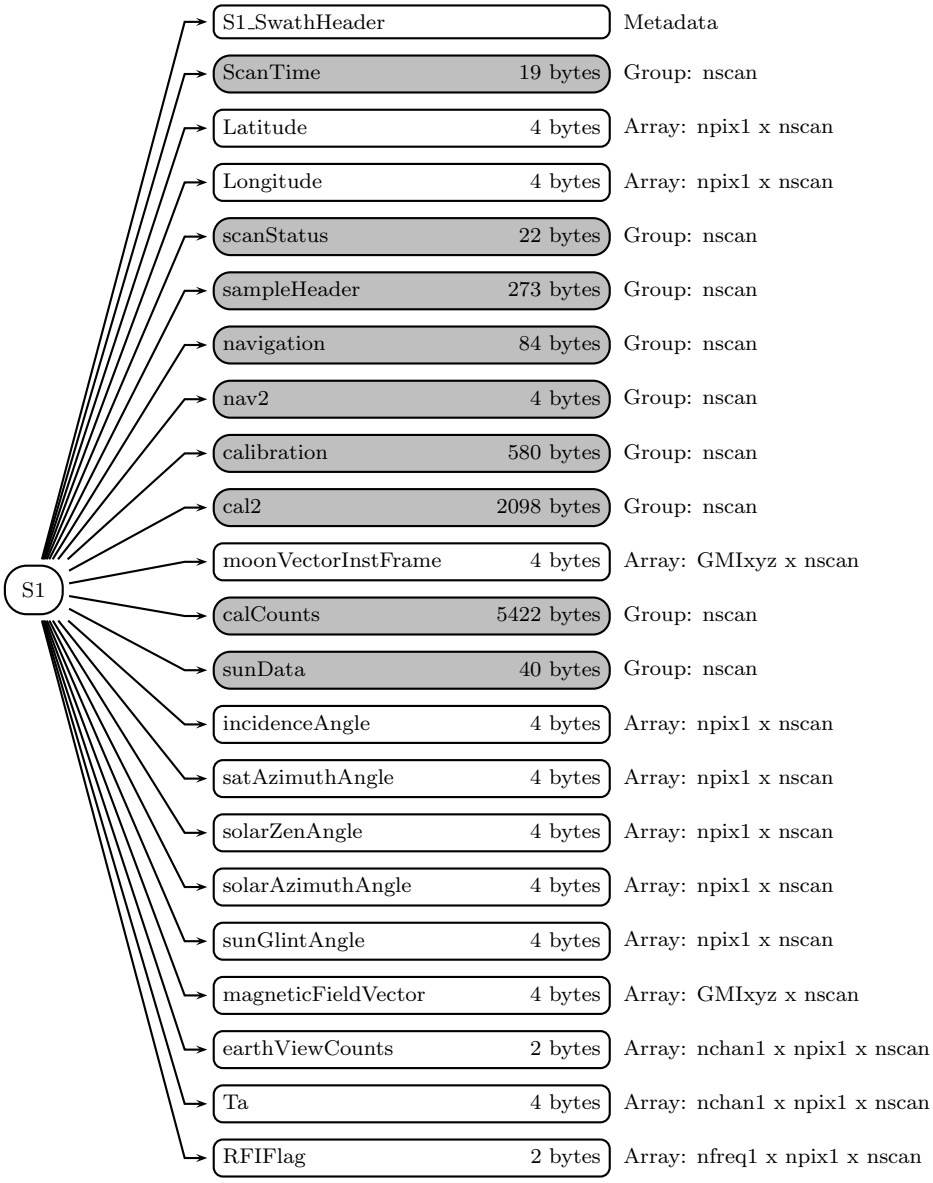


Figure 71: Data Format Structure for GMIBASEXCAL, S1

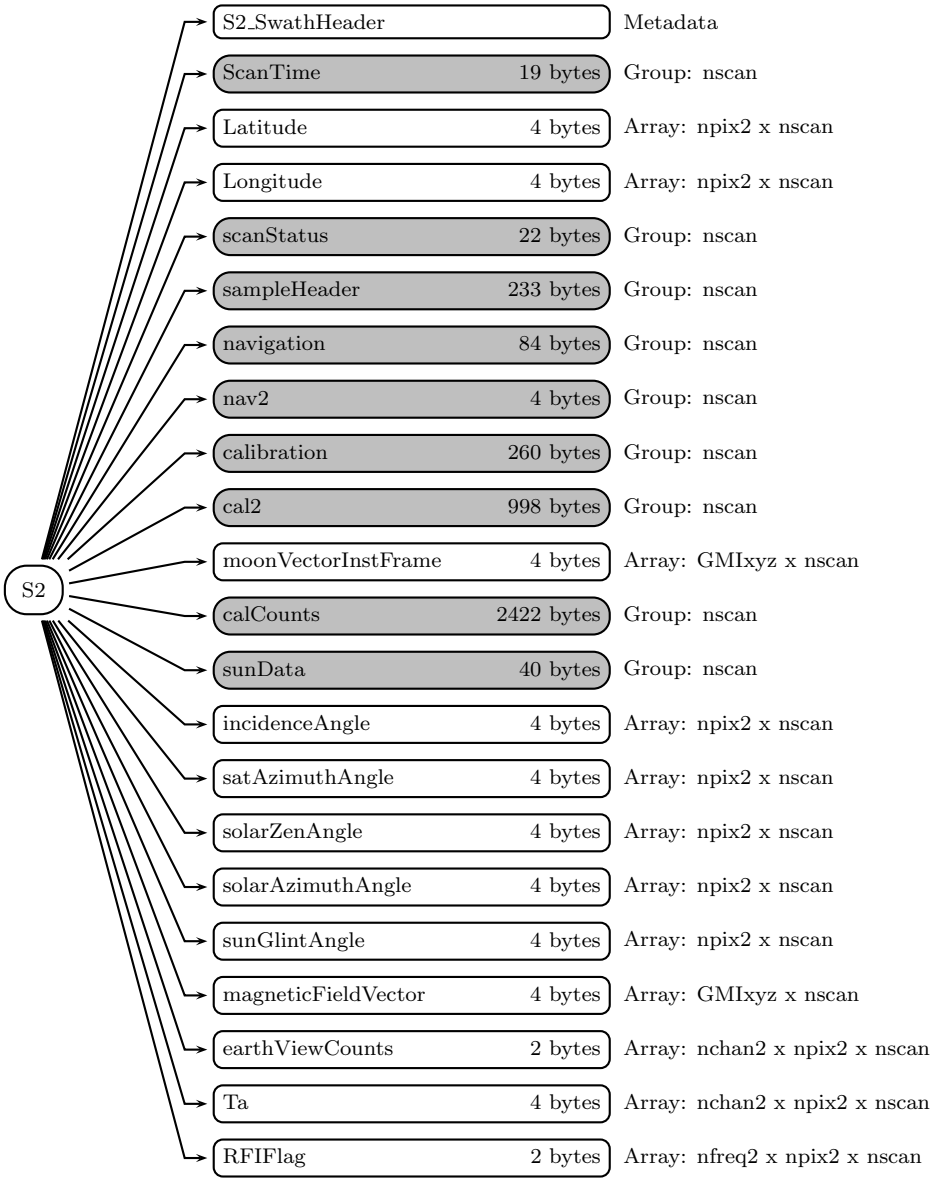


Figure 72: Data Format Structure for GMIBASEXCAL, S2

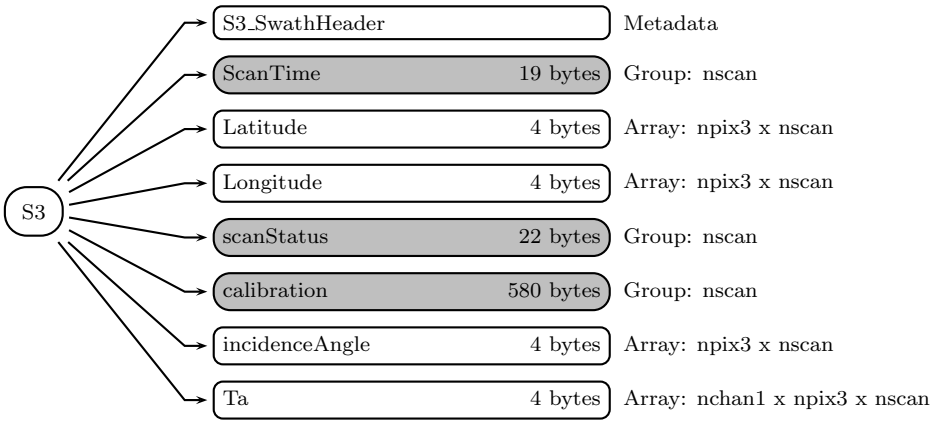


Figure 73: Data Format Structure for GMIBASEXCAL, S3

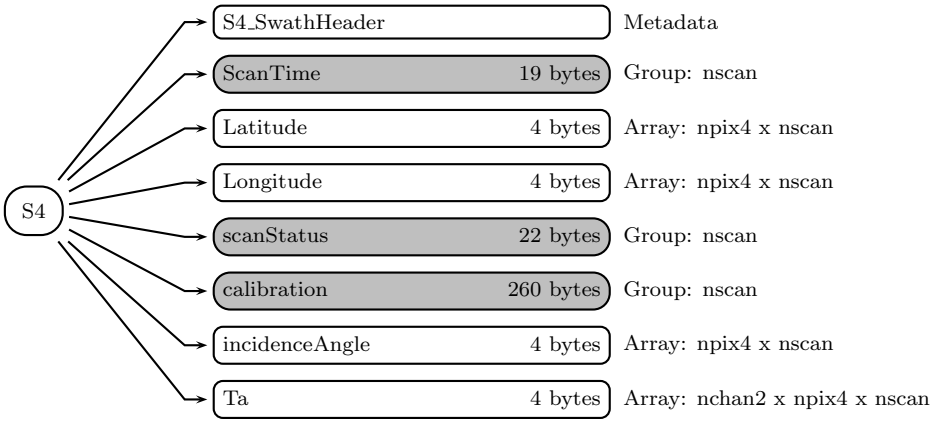


Figure 74: Data Format Structure for GMIBASEXCAL, S4

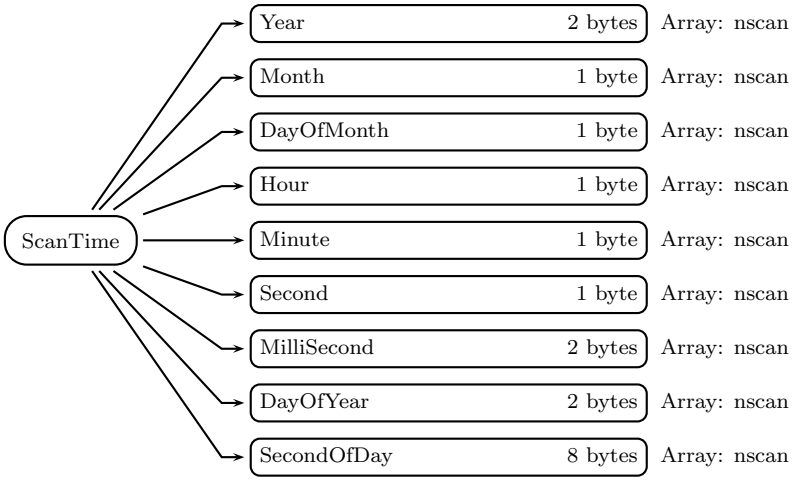


Figure 75: Data Format Structure for GMIBASEXCAL, S1, ScanTime

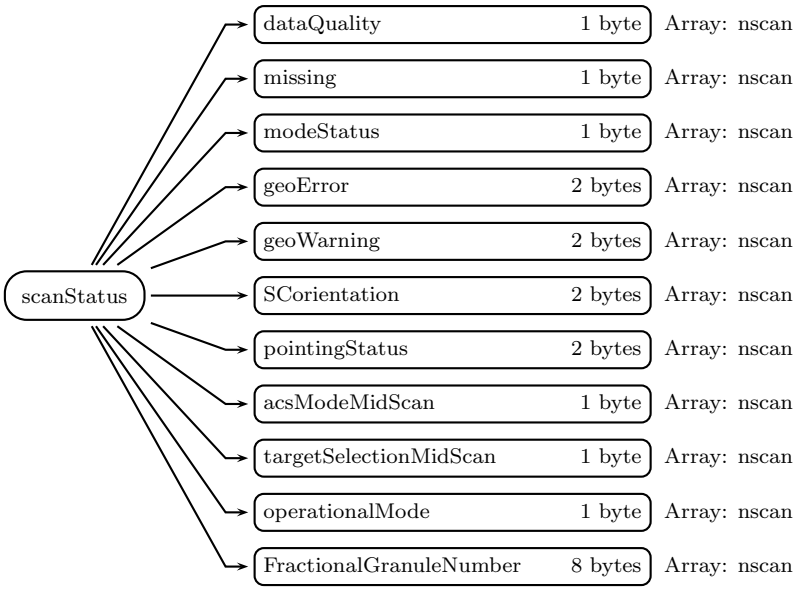


Figure 76: Data Format Structure for GMIBASEXCAL, S1, scanStatus

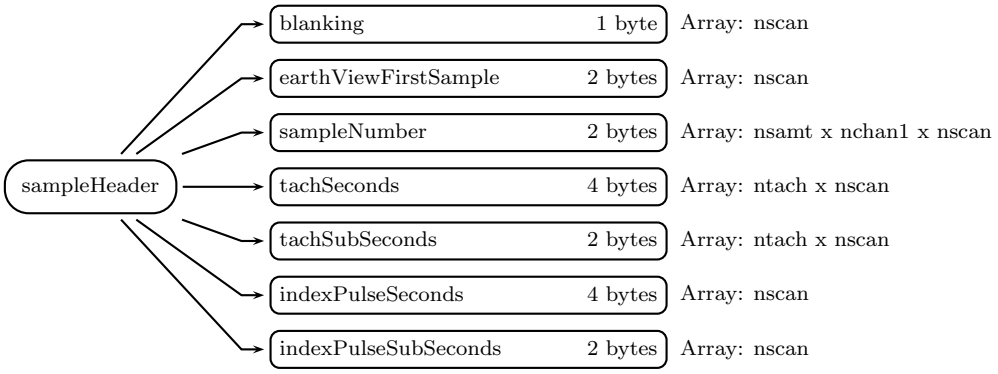


Figure 77: Data Format Structure for GMIBASEXCAL, S1, sampleHeader

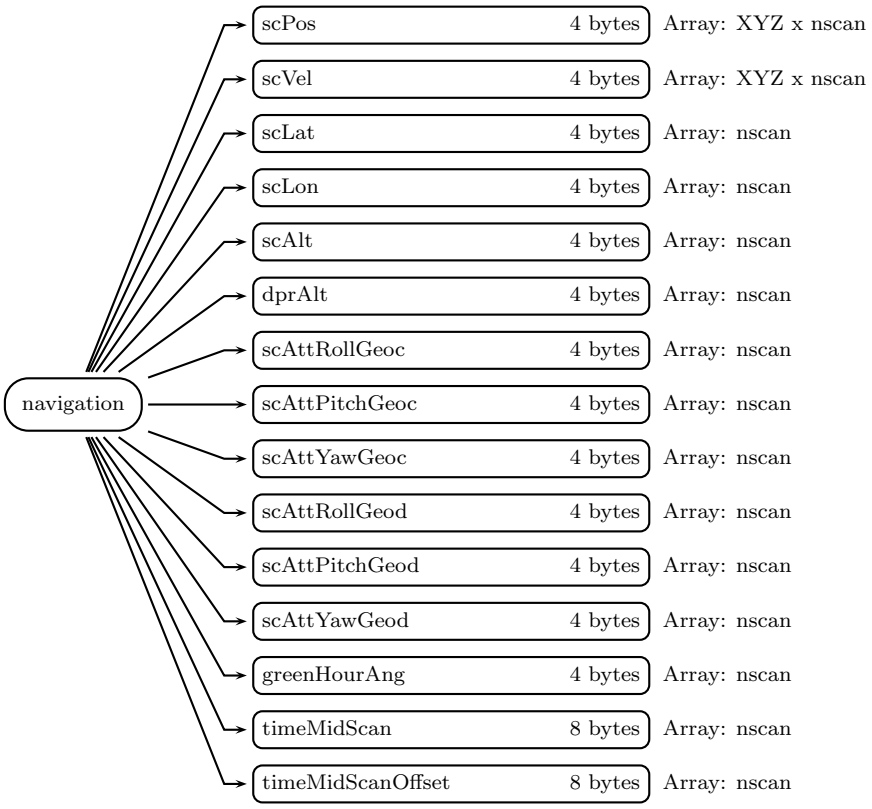


Figure 78: Data Format Structure for GMIBASEXCAL, S1, navigation

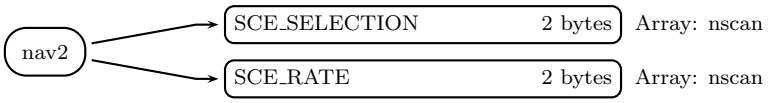


Figure 79: Data Format Structure for GMIBASEXCAL, S1, nav2

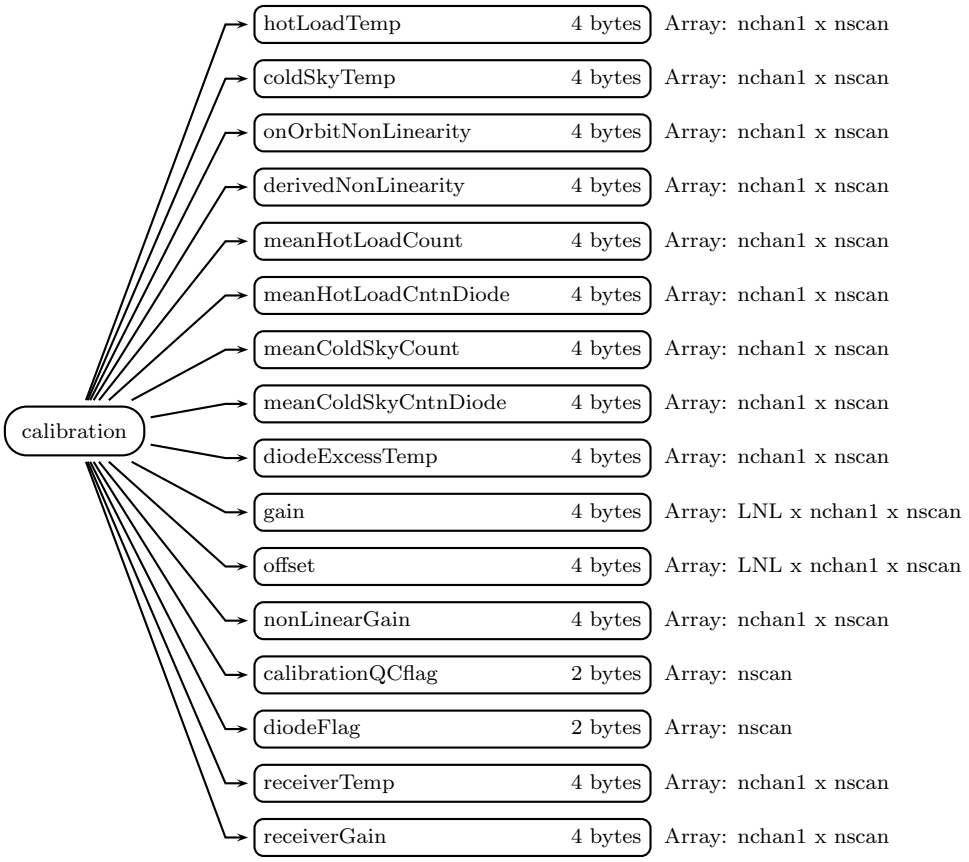
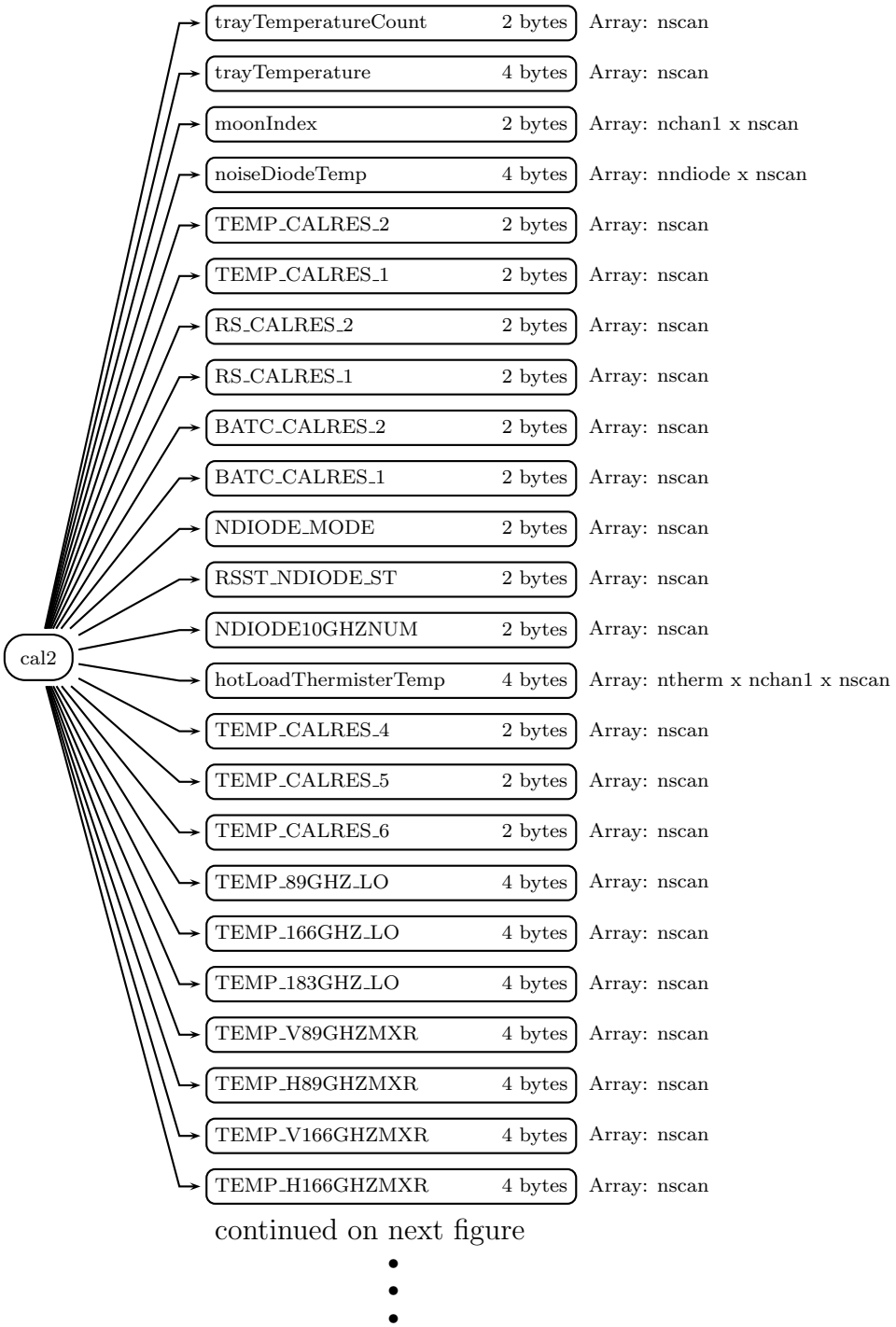


Figure 80: Data Format Structure for GMIBASEXCAL, S1, calibration



continued on next figure

Figure 81: Data Format Structure for GMIBASEXCAL, cal2

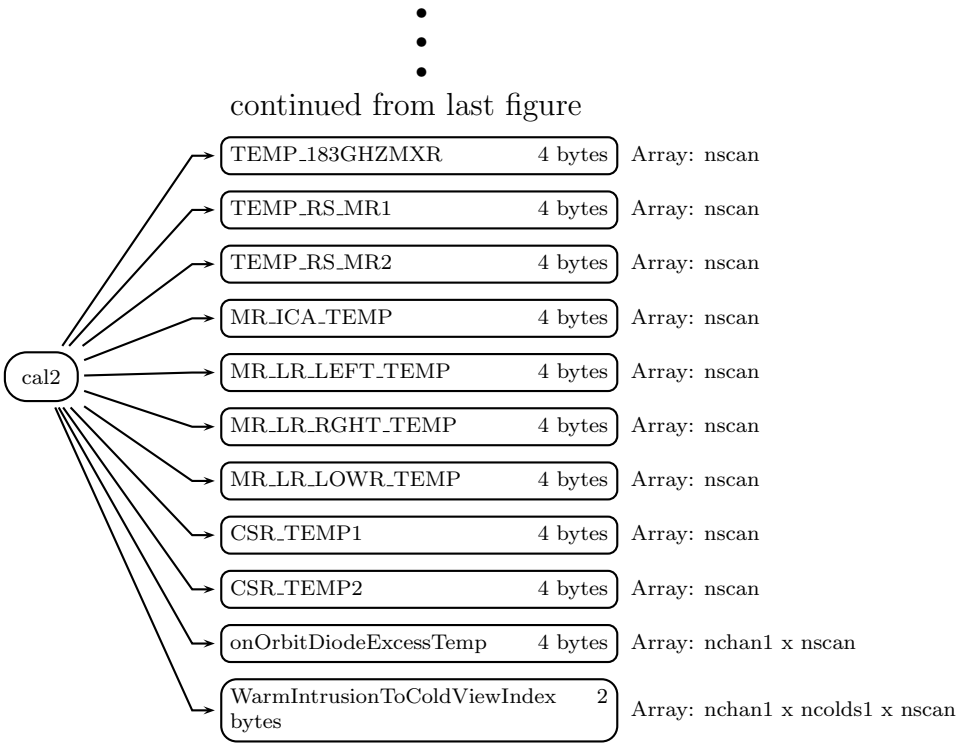


Figure 82: Data Format Structure for GMIBASEXCAL, S1, cal2

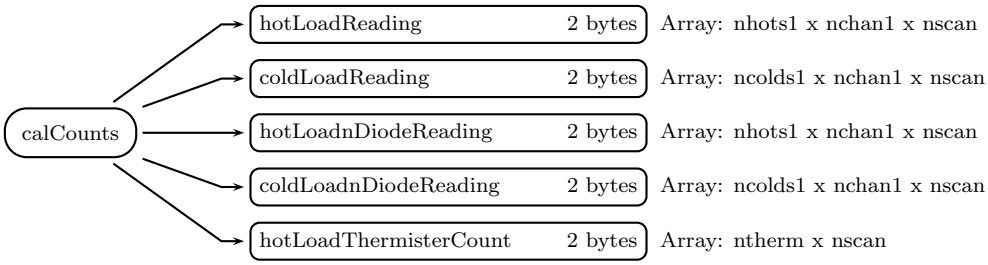


Figure 83: Data Format Structure for GMIBASEXCAL, S1, calCounts

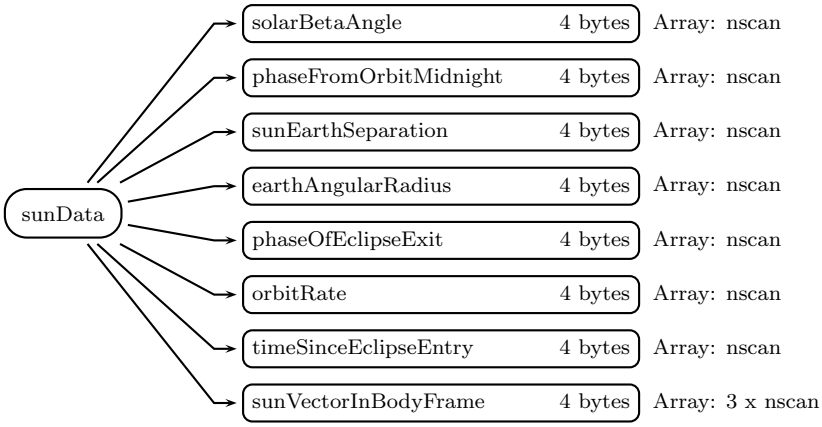


Figure 84: Data Format Structure for GMIBASEXCAL, S1, sunData

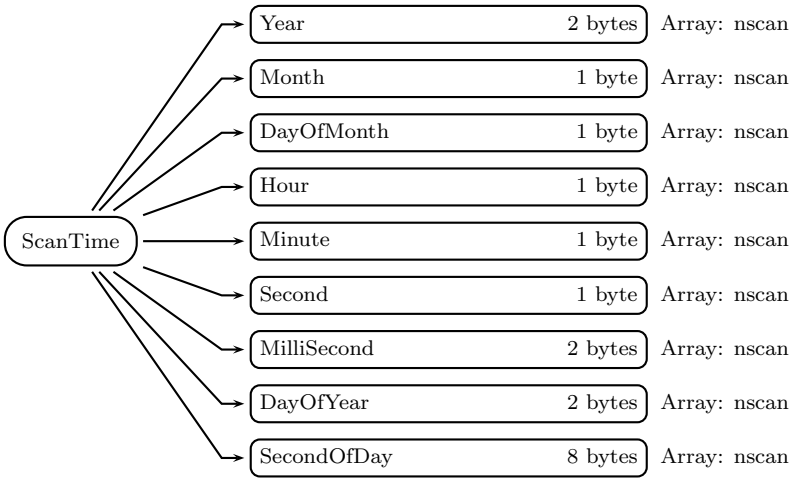


Figure 85: Data Format Structure for GMIBASEXCAL, S2, ScanTime

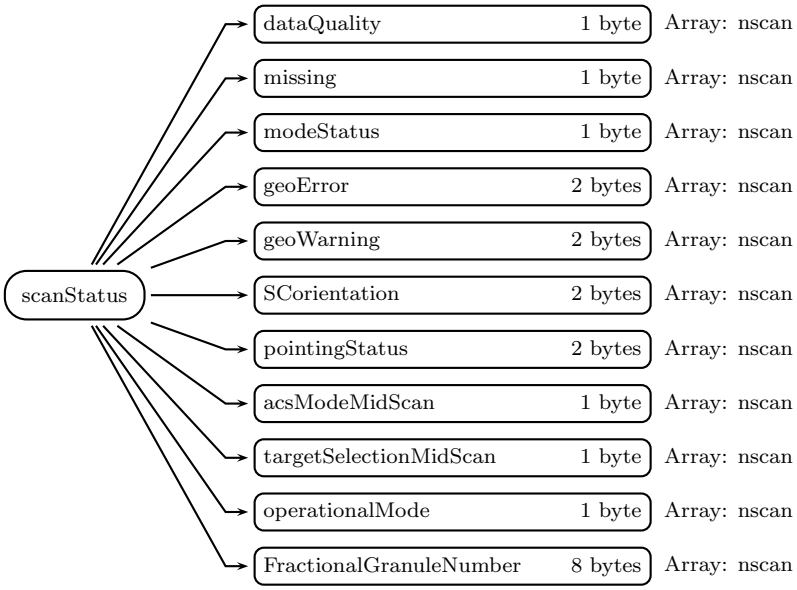


Figure 86: Data Format Structure for GMIBASEXCAL, S2, scanStatus

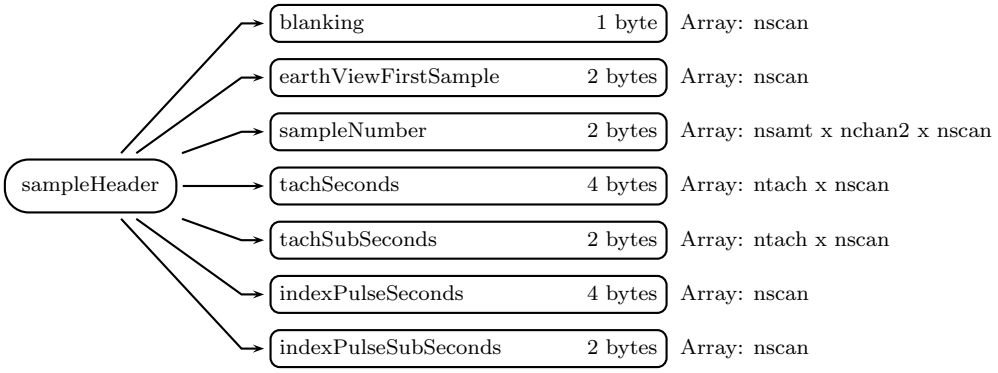


Figure 87: Data Format Structure for GMIBASEXCAL, S2, sampleHeader

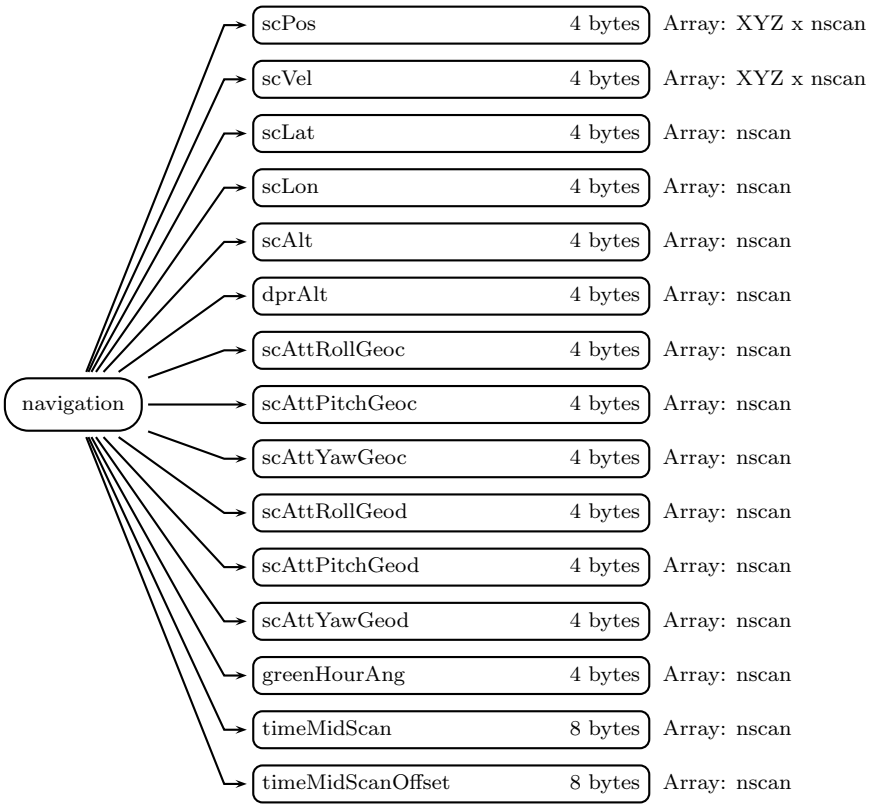


Figure 88: Data Format Structure for GMIBASEXCAL, S2, navigation

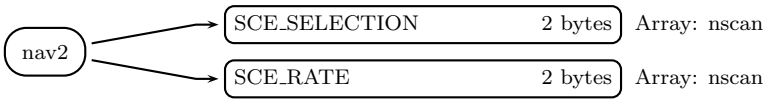


Figure 89: Data Format Structure for GMIBASEXCAL, S2, nav2

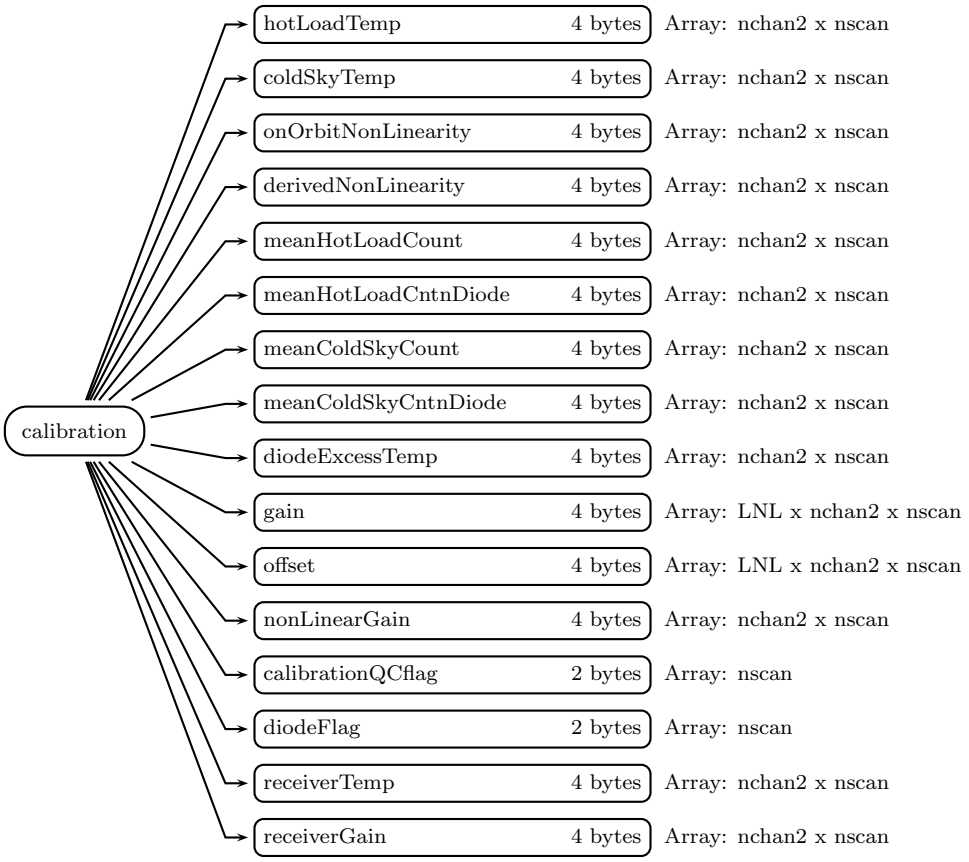


Figure 90: Data Format Structure for GMIBASEXCAL, S2, calibration

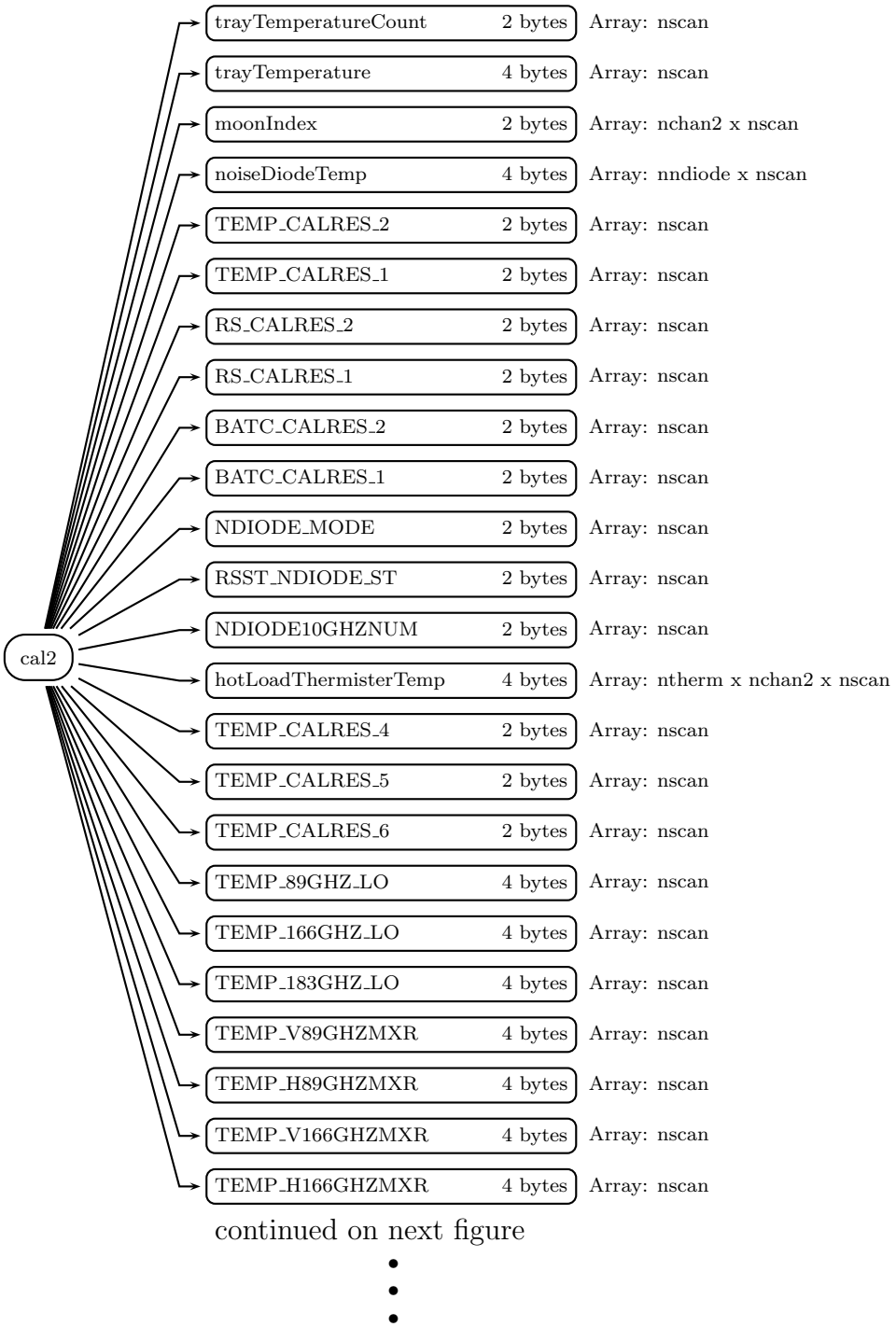


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Figure 91: Data Format Structure for GMIBASEXCAL, cal2

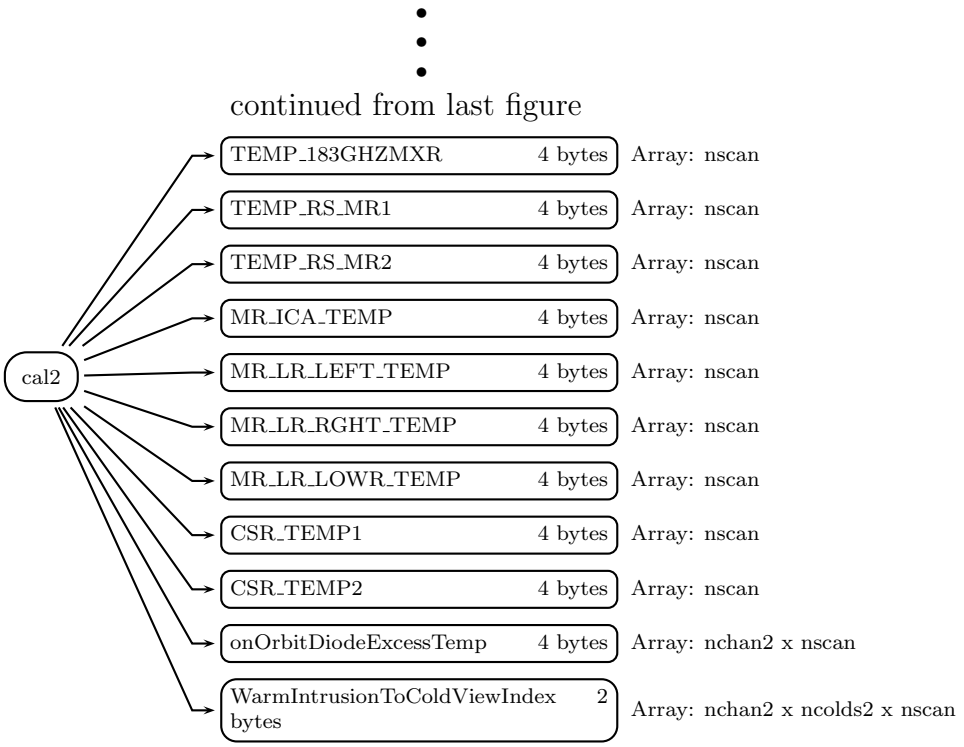


Figure 92: Data Format Structure for GMIBASEXCAL, S2, cal2

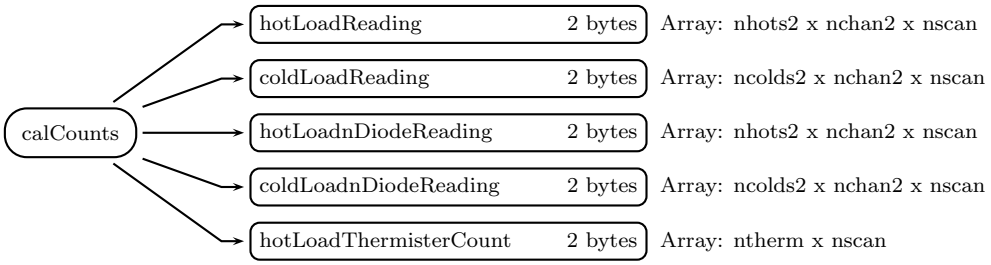


Figure 93: Data Format Structure for GMIBASEXCAL, S2, calCounts

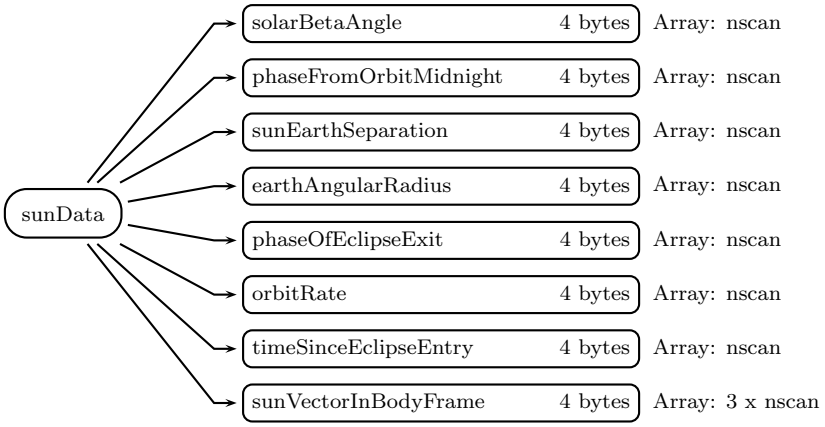


Figure 94: Data Format Structure for GMIBASEXCAL, S2, sunData

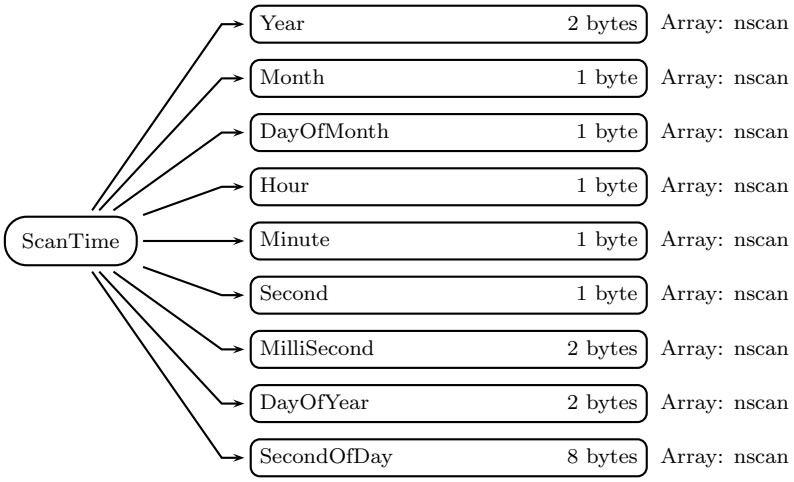


Figure 95: Data Format Structure for GMIBASEXCAL, S3, ScanTime

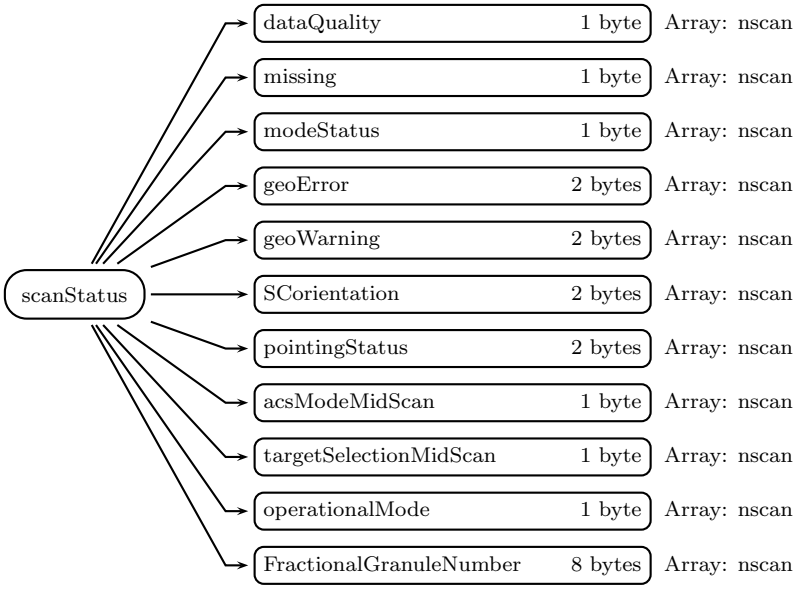


Figure 96: Data Format Structure for GMIBASEXCAL, S3, scanStatus

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

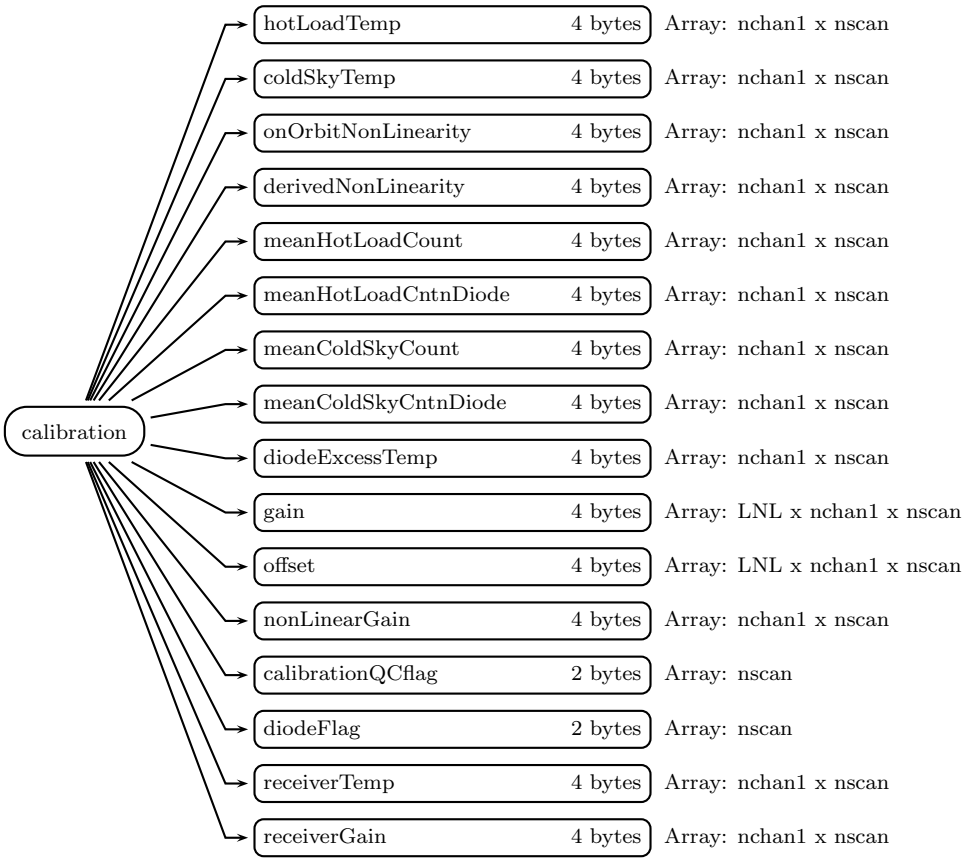


Figure 97: Data Format Structure for GMIBASEXCAL, S3, calibration

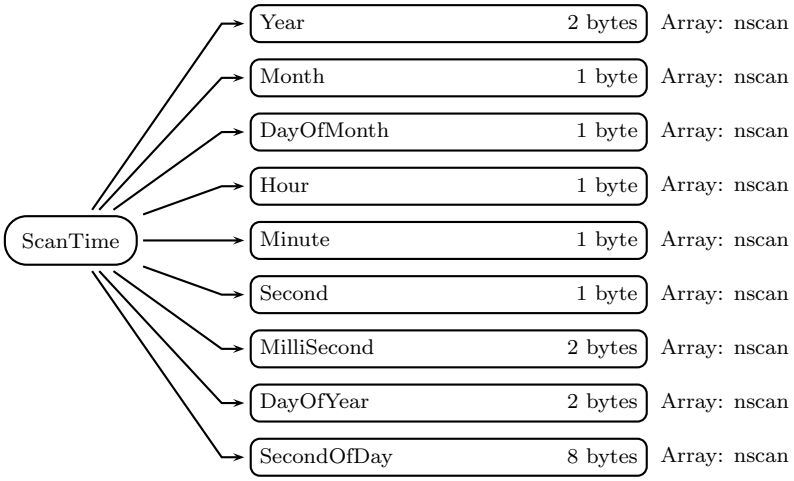


Figure 98: Data Format Structure for GMIBASEXCAL, S4, ScanTime

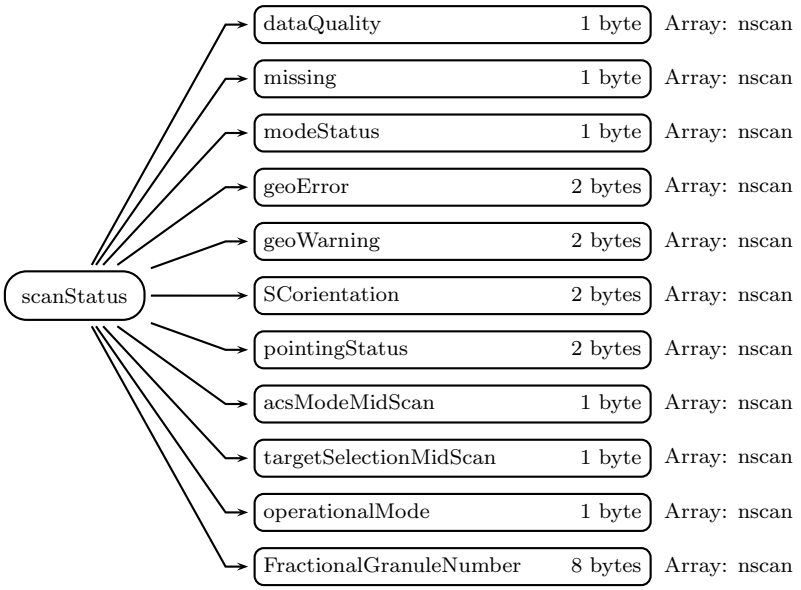


Figure 99: Data Format Structure for GMIBASEXCAL, S4, scanStatus

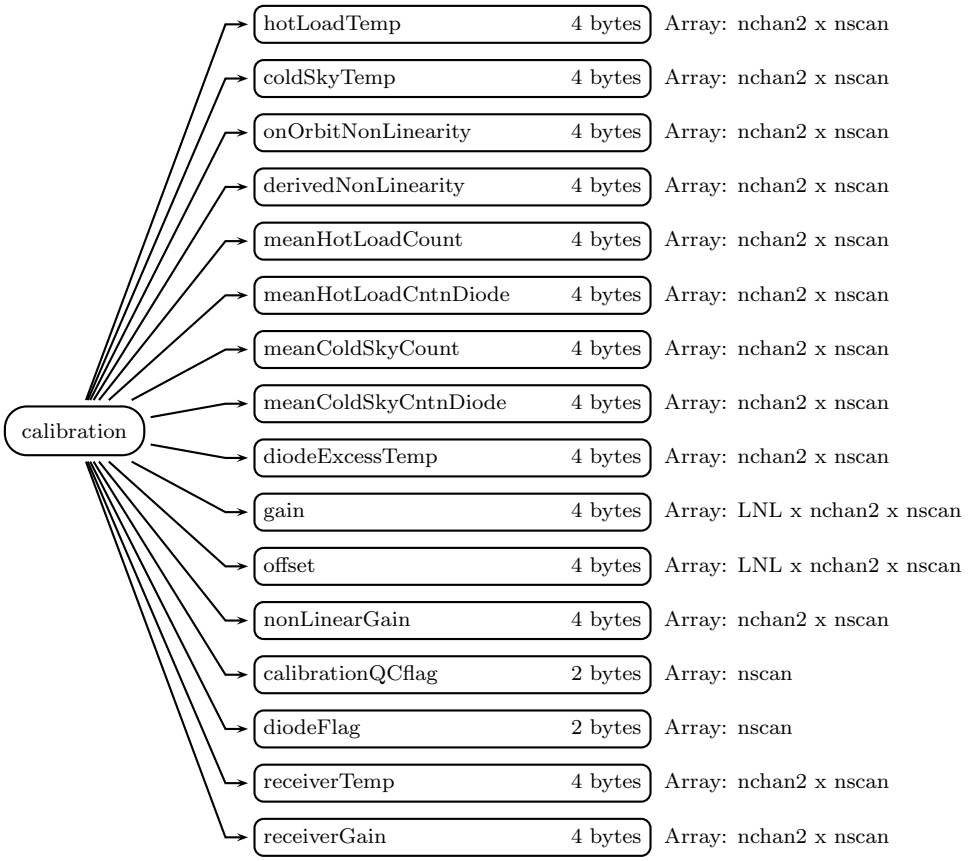


Figure 100: Data Format Structure for GMIBASEXCAL, S4, calibration

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix1 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix1 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value

-180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S1)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
```

```
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
```

```
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

sampleHeader (Group in S1)

blanking (1-byte integer, array size: nscan):

```
Value of 0 = Blanking off
Value of 1 = Blanking on
```

earthViewFirstSample (2-byte integer, array size: nscan):
Sample number of the first earth view. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

sampleNumber (2-byte integer, array size: nsamt x nchan1 x nscan):
Number of valid samples in scan. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

tachSeconds (4-byte unsigned integer, array size: ntach x nscan):
Tachometer seconds. Values are in second. Special values are defined as:
0 Missing value

tachSubSeconds (2-byte unsigned integer, array size: ntach x nscan):
Tachometer sub_seconds. Values range from 0 to 62499 in units of 16 microseconds. The missing value is 65535.

indexPulseSeconds (4-byte unsigned integer, array size: nscan):
Index Pulse seconds. Values are in second. Special values are defined as:
0 Missing value

indexPulseSubSeconds (2-byte unsigned integer, array size: nscan):
Index Pulse subseconds. Values range from 0 to 62499 in units of 16 microseconds. The missing value is 65535.

navigation (Group in S1)

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the

Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

nav2 (Group in S1)

SCE_SELECTION (2-byte unsigned integer, array size: nscan):
The current SCE selection setting. Special values are defined as:
0 Missing value

SCE_RATE (2-byte unsigned integer, array size: nscan):
The SMA rotational rate reported by the SCE. To obtain the spin rate in RPM, multiply SCE_RATE by 0.002999106 Values range from 1 to 65535 count. Special values are defined as:
0 Missing value

calibration (Group in S1)

hotLoadTemp (4-byte float, array size: nchan1 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load. For 10, 166, 183 GHZ channles, they are averages of PRT 1,7,8,9,10. For 18, 23, 36, 89 GHZ channels, they are averages of PRT 2,11,12,13,14. The values are corrected by tray temperature and averaged over closest 5 scans Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan1 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan1 x nscan):
The on Orbit Non-Linearity Tnl computed from ground calibrated u look-up table . Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan1 x nscan):
Non-Linearity Tnl derived from 4-point calibration. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (4-byte float, array size: nchan1 x nscan):
The mean Hot Load Count. Averaged over all Hot samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanHotLoadCntnDiode (4-byte float, array size: nchan1 x nscan):
The mean coupled Hot Load Plus Noise Diode counts Averaged over all samples and closest 5 scans. Values range from 0 to 65535. Special values are defined as:
-9999.9 Missing value

meanColdSkyCount (4-byte float, array size: nchan1 x nscan):
The mean Cold Sky Count.Averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanColdSkyCntnDiode (4-byte float, array size: nchan1 x nscan):
The mean coupled Cold Sky Plus Noise Diode counts, averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

diodeExcessTemp (4-byte float, array size: nchan1 x nscan):
The Noise Diode Excess Temperature. Cold and diode Coupled Temperature=diodeExcessTemp

+ coldSkyTemp. Hot and diode Coupled Temperature=diodeExcessTemp + hotLoadTemp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan1 x nscan):
gain[0] determine the total Ta gain. Ta=offset[0]+gain[0]*earthCount+ nonLinearGaian*earthCount*earthCount. Nonlinearity=offset[1]+gain[1]*earthCount+ nonLinearGaian*earthCount*earthCount. Values range from 0 to 1 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan1 x nscan):
Offset[0] determine the total Ta offset. min=-999 K (from -1 K), max=999 K (from 1 K). Missing value is -9999.9.

nonLinearGain (4-byte float, array size: nchan1 x nscan):
The nonlinear gain. Values range from -1 to 1 K. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. value 0 indicates good calibration. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

```
Diode flag.
0, Noise Diode on
2, Noise Diode off
5, Noise Diode status unknown
```

receiverTemp (4-byte float, array size: nchan1 x nscan):
The receiver temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan1 x nscan):
The receiver gain. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

cal2 (Group in S1)

trayTemperatureCount (2-byte unsigned integer, array size: nscan):
Counts to derive hot load tray temperature. Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

trayTemperature (4-byte float, array size: nscan):
Derive hot load tray temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

moonIndex (2-byte unsigned integer, array size: nchan1 x nscan):
Index determined by the angle between moon vector and cold sample vectors. 0 means angles between moon vector and all cold view vectors are greater than 5 degrees. Non-zero value means the number of cold samples that may be contaminated by moon. Values range from 0 to 100. Special values are defined as:
0 Missing value

noiseDiodeTemp (4-byte float, array size: nndiode x nscan):
Physical temperature of noise diode. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

TEMP_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for PRT temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for PRT temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

RS_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for tray temperature and receiver temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

RS_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for tray temperature and receiver temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

BATC_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for noise diode temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

BATC_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for noise diode temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

NDIODE_MODE (2-byte unsigned integer, array size: nscan):
RS configuration of Noise Diode Mode. 0 = On every scan, 1 = On every other scan, 2

= Off. Values range from 0 to 2 count. Special values are defined as:
65535 Missing value

RSST_NDIODE_ST (2-byte unsigned integer, array size: nscan):
Noise diode state during the scan. 0 = Noise diodes OFF for the scan, 1 = Noise diodes ON for the scan. Values range from 0 to 1 count. Special values are defined as:
65535 Missing value

NDIODE10GHZNUM (2-byte unsigned integer, array size: nscan):
RS configuration of Noise Diode Start Sample Number, i.e., the sample number where noise diodes are turned on. Values range from 0 to 500 count. Special values are defined as:
65535 Missing value

hotLoadThermisterTemp (4-byte float, array size: ntherm x nchan1 x nscan):
Hot Load Thermister Temperature of 11 PRTs. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

TEMP_CALRES_4 (2-byte unsigned integer, array size: nscan):
Low calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_5 (2-byte unsigned integer, array size: nscan):
High calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_6 (2-byte unsigned integer, array size: nscan):
High calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_89GHZ_LO (4-byte float, array size: nscan):
89 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_166GHZ_LO (4-byte float, array size: nscan):
166 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_183GHZ_LO (4-byte float, array size: nscan):
183 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_V89GHZMXR (4-byte float, array size: nscan):
89 GHZ V channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_H89GHZMXR (4-byte float, array size: nscan):
89 GHZ H channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_V166GHZMXR (4-byte float, array size: nscan):
166 GHZ V channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_H166GHZMXR (4-byte float, array size: nscan):
166 GHZ H channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_183GHZMXR (4-byte float, array size: nscan):
183 GHZ Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_RS_MR1 (4-byte float, array size: nscan):
Main Reflector Temperature Read By RS 1 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_RS_MR2 (4-byte float, array size: nscan):
Main Reflector Temperature Read By RS 2 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_ICA_TEMP (4-byte float, array size: nscan):
Main Reflector Temperature Read By ICA Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_LEFT_TEMP (4-byte float, array size: nscan):
Main Reflector left Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_RGHT_TEMP (4-byte float, array size: nscan):
Main Reflector right Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_LOWR_TEMP (4-byte float, array size: nscan):
Main Reflector lower Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

CSR_TEMP1 (4-byte float, array size: nscan):
Cold Sky Reflector Temperature 1 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

CSR_TEMP2 (4-byte float, array size: nscan):
Cold Sky Reflector Temperature 2 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

onOrbitDiodeExcessTemp (4-byte float, array size: nchan1 x nscan):
Diode Excess Temperature derived from on orbit trended look-up tables as a function of noise diode temperature from telemetry. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

WarmIntrusionToColdViewIndex (2-byte unsigned integer, array size: nchan1 x ncolds1 x nscan):
Index flag to determine if a cold view sample is contaminated by certain warmer sources. If the value is 0, the sample is good and the count is used in calibration. If the value is non-zero, the sample is contaminated and excluded in calibration.

```
0:  Good sample
1:  Bad sample determined by limit check
2:  Bad sample determined by 2D medium filter
```

Values range from 0 to 2. Special values are defined as:
65535 Missing value

moonVectorInstFrame (4-byte float, array size: GMIxyz x nscan):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

calCounts (Group in S1)

hotLoadReading (2-byte unsigned integer, array size: nhots1 x nchan1 x nscan):
Hot Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

coldLoadReading (2-byte unsigned integer, array size: ncolds1 x nchan1 x nscan):
Cold Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadnDiodeReading (2-byte unsigned integer, array size: nhots1 x nchan1 x nscan):
Hot Load Plus Diode Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

coldLoadnDiodeReading (2-byte unsigned integer, array size: ncolds1 x nchan1 x nscan):
Cold Load Plus Diode Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadThermisterCount (2-byte unsigned integer, array size: ntherm x nscan):
Counts from 11 PRTs in the hot load Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

sunData (Group in S1)

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius.

Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: 3 x nscan):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix1 x nscan):
The angle at the center of the IFOV between the antenna boresight vector and the zenith vector normal to the Earth Ellipsiod. Also known as Satellite Zenith Angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npix1 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npix1 x nscan):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npix1 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npix1 x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location

on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

magneticFieldVector (4-byte float, array size: GMIxyz x nscan):
Magnetometer volt reading in TAM (x, y, z) coordinate system. Used to perform along-scan correction of earth view counts. (The TAM (x,y,z) coordinate system is similar to GPM S/C coordinate system but y and z axis are rotated by 180 degrees.) Values range from -500 to 500 V. Special values are defined as:
-9999.9 Missing value

earthViewCounts (2-byte unsigned integer, array size: nchan1 x npix1 x nscan):
Earth view counts. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

Ta (4-byte float, array size: nchan1 x npix1 x nscan):
Earth view antenna temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

RFIFlag (2-byte integer, array size: nfreq1 x npix1 x nscan):

```
Radio Frequency Interference (RFI) Flag.  The flag is set
to non-zero if the pixel is contaminated by RFI according
to certain filters.  Current values are:

0:     Not affected by RFI.
1:     Affected by RFI with X-cal filter.
2:     Affected by RFI with RSS filter.
3-7:   Spare
-9999: Missing
```

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S2)
A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix2 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix2 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value

-180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S2)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
```

```
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
```

```
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

sampleHeader (Group in S2)

blanking (1-byte integer, array size: nscan):

```
Value of 0 = Blanking off
Value of 1 = Blanking on
```

earthViewFirstSample (2-byte integer, array size: nscan):
Sample number of the first earth view. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

sampleNumber (2-byte integer, array size: nsamt x nchan2 x nscan):
Number of valid samples in scan. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

tachSeconds (4-byte unsigned integer, array size: ntach x nscan):
Tachometer seconds. Values are in second. Special values are defined as:
0 Missing value

tachSubSeconds (2-byte unsigned integer, array size: ntach x nscan):
Tachometer sub_seconds. Values range from 0 to 62499 in units of 16 microseconds. The missing value is 65535.

indexPulseSeconds (4-byte unsigned integer, array size: nscan):
Index Pulse seconds. Values are in second. Special values are defined as:
0 Missing value

indexPulseSubSeconds (2-byte unsigned integer, array size: nscan):
Index Pulse subseconds. Values range from 0 to 62499 in units of 16 microseconds. The missing value is 65535.

navigation (Group in S2)

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the

Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

nav2 (Group in S2)

SCE_SELECTION (2-byte unsigned integer, array size: nscan):
The current SCE selection setting. Special values are defined as:
0 Missing value

SCE_RATE (2-byte unsigned integer, array size: nscan):
The SMA rotational rate reported by the SCE. To obtain the spin rate in RPM, multiply SCE_RATE by 0.002999106 Values range from 1 to 65535 count. Special values are defined as:
0 Missing value

calibration (Group in S2)

hotLoadTemp (4-byte float, array size: nchan2 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load. For 10, 166, 183 GHZ channles, they are averages of PRT 1,7,8,9,10. For 18, 23, 36, 89 GHZ channels, they are averages of PRT 2,11,12,13,14. The values are corrected by tray temperature and averaged over closest 5 scans Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan2 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan2 x nscan):
The on Orbit Non-Linearity Tnl computed from ground calibrated u look-up table . Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan2 x nscan):
Non-Linearity Tnl derived from 4-point calibration. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (4-byte float, array size: nchan2 x nscan):
The mean Hot Load Count. Averaged over all Hot samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanHotLoadCntnDiode (4-byte float, array size: nchan2 x nscan):
The mean coupled Hot Load Plus Noise Diode counts Averaged over all samples and closest 5 scans. Values range from 0 to 65535. Special values are defined as:
-9999.9 Missing value

meanColdSkyCount (4-byte float, array size: nchan2 x nscan):
The mean Cold Sky Count.Averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanColdSkyCntnDiode (4-byte float, array size: nchan2 x nscan):
The mean coupled Cold Sky Plus Noise Diode counts, averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

diodeExcessTemp (4-byte float, array size: nchan2 x nscan):
The Noise Diode Excess Temperature. Cold and diode Coupled Temperature=diodeExcessTemp

+ coldSkyTemp. Hot and diode Coupled Temperature=diodeExcessTemp + hotLoadTemp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan2 x nscan):
gain[0] determine the total Ta gain. Ta=offset[0]+gain[0]*earthCount+ nonLinearGaian*earthCount*earthCount. Nonlinearity=offset[1]+gain[1]*earthCount+ nonLinearGaian*earthCount*earthCount. Values range from 0 to 1 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan2 x nscan):
Offset[0] determine the total Ta offset. min=-999 K (from -1 K), max=999 K (from 1 K). Missing value is -9999.9.

nonLinearGain (4-byte float, array size: nchan2 x nscan):
The nonlinear gain. Values range from -1 to 1 K. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. value 0 indicates good calibration. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

```
Diode flag.
0, Noise Diode on
2, Noise Diode off
5, Noise Diode status unknown
```

receiverTemp (4-byte float, array size: nchan2 x nscan):
The receiver temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan2 x nscan):
The receiver gain. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

cal2 (Group in S2)

trayTemperatureCount (2-byte unsigned integer, array size: nscan):
Counts to derive hot load tray temperature. Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

trayTemperature (4-byte float, array size: nscan):
Derive hot load tray temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

moonIndex (2-byte unsigned integer, array size: nchan2 x nscan):
Index determined by the angle between moon vector and cold sample vectors. 0 means angles between moon vector and all cold view vectors are greater than 5 degrees. Non-zero value means the number of cold samples that may be contaminated by moon. Values range from 0 to 100. Special values are defined as:
0 Missing value

noiseDiodeTemp (4-byte float, array size: nndiode x nscan):
Physical temperature of noise diode. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

TEMP_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for PRT temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for PRT temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

RS_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for tray temperature and receiver temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

RS_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for tray temperature and receiver temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

BATC_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for noise diode temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

BATC_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for noise diode temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

NDIODE_MODE (2-byte unsigned integer, array size: nscan):
RS configuration of Noise Diode Mode. 0 = On every scan, 1 = On every other scan, 2

= Off. Values range from 0 to 2 count. Special values are defined as:
65535 Missing value

RSST_NDIODE_ST (2-byte unsigned integer, array size: nscan):
Noise diode state during the scan. 0 = Noise diodes OFF for the scan, 1 = Noise diodes ON for the scan. Values range from 0 to 1 count. Special values are defined as:
65535 Missing value

NDIODE10GHZNUM (2-byte unsigned integer, array size: nscan):
RS configuration of Noise Diode Start Sample Number, i.e., the sample number where noise diodes are turned on. Values range from 0 to 500 count. Special values are defined as:
65535 Missing value

hotLoadThermisterTemp (4-byte float, array size: ntherm x nchan2 x nscan):
Hot Load Thermister Temperature of 11 PRTs. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

TEMP_CALRES_4 (2-byte unsigned integer, array size: nscan):
Low calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_5 (2-byte unsigned integer, array size: nscan):
High calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_6 (2-byte unsigned integer, array size: nscan):
High calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_89GHZ_LO (4-byte float, array size: nscan):
89 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_166GHZ_LO (4-byte float, array size: nscan):
166 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_183GHZ_LO (4-byte float, array size: nscan):
183 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_V89GHZMXR (4-byte float, array size: nscan):
89 GHZ V channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_H89GHZMXR (4-byte float, array size: nscan):
89 GHZ H channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_V166GHZMXR (4-byte float, array size: nscan):
166 GHZ V channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_H166GHZMXR (4-byte float, array size: nscan):
166 GHZ H channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_183GHZMXR (4-byte float, array size: nscan):
183 GHZ Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_RS_MR1 (4-byte float, array size: nscan):
Main Reflector Temperature Read By RS 1 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_RS_MR2 (4-byte float, array size: nscan):
Main Reflector Temperature Read By RS 2 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_ICA_TEMP (4-byte float, array size: nscan):
Main Reflector Temperature Read By ICA Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_LEFT_TEMP (4-byte float, array size: nscan):
Main Reflector left Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_RGHT_TEMP (4-byte float, array size: nscan):
Main Reflector right Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_LOWR_TEMP (4-byte float, array size: nscan):
Main Reflector lower Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

CSR_TEMP1 (4-byte float, array size: nscan):
Cold Sky Reflector Temperature 1 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

CSR_TEMP2 (4-byte float, array size: nscan):
Cold Sky Reflector Temperature 2 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

onOrbitDiodeExcessTemp (4-byte float, array size: nchan2 x nscan):
Diode Excess Temperature derived from on orbit trended look-up tables as a function of noise diode temperature from telemetry. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

WarmIntrusionToColdViewIndex (2-byte unsigned integer, array size: nchan2 x ncolds2 x nscan):
Index flag to determine if a cold view sample is contaminated by certain warmer sources. If the value is 0, the sample is good and the count is used in calibration. If the value is non-zero, the sample is contaminated and excluded in calibration.

```
0:  Good sample
1:  Bad sample determined by limit check
2:  Bad sample determined by 2D medium filter
```

Values range from 0 to 2. Special values are defined as:
65535 Missing value

moonVectorInstFrame (4-byte float, array size: GMIxyz x nscan):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

calCounts (Group in S2)

hotLoadReading (2-byte unsigned integer, array size: nhots2 x nchan2 x nscan):
Hot Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

coldLoadReading (2-byte unsigned integer, array size: ncolds2 x nchan2 x nscan):
Cold Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadnDiodeReading (2-byte unsigned integer, array size: nhots2 x nchan2 x nscan):
Hot Load Plus Diode Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

coldLoadnDiodeReading (2-byte unsigned integer, array size: ncolds2 x nchan2 x nscan):
Cold Load Plus Diode Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadThermisterCount (2-byte unsigned integer, array size: ntherm x nscan):
Counts from 11 PRTs in the hot load Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

sunData (Group in S2)

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius.

Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: 3 x nscan):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix2 x nscan):
The angle at the center of the IFOV between the antenna boresight vector and the zenith vector normal to the Earth Ellipsiod. Also known as Satellite Zenith Angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npix2 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npix2 x nscan):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npix2 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npix2 x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location

on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

magneticFieldVector (4-byte float, array size: GMIxyz x nscan):
Magnetometer volt reading in TAM (x, y, z) coordinate system. Used to perform along-scan correction of earth view counts. (The TAM (x,y,z) coordinate system is similar to GPM S/C coordinate system but y and z axis are rotated by 180 degrees.) Values range from -500 to 500 V. Special values are defined as:
-9999.9 Missing value

earthViewCounts (2-byte unsigned integer, array size: nchan2 x npix2 x nscan):
Earth view counts. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

Ta (4-byte float, array size: nchan2 x npix2 x nscan):
Earth view antenna temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

RFIFlag (2-byte integer, array size: nfreq2 x npix2 x nscan):

```
Radio Frequency Interference (RFI) Flag.  The flag is set
to non-zero if the pixel is contaminated by RFI according
to certain filters.  Current values are:

0:     Not affected by RFI.
1:     Affected by RFI with X-cal filter.
2:     Affected by RFI with RSS filter.
3-7:   Spare
-9999: Missing
```

S3 (Swath)

S3_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S3)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix3 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix3 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value

-180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S3)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
```

```
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
```

```
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

calibration (Group in S3)

hotLoadTemp (4-byte float, array size: nchan1 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load.

For 10, 166, 183 GHZ channles, they are averages of PRT 1,7,8,9,10. For 18, 23, 36, 89 GHZ channels, they are averages of PRT 2,11,12,13,14. The values are corrected by tray temperature and averaged over closest 5 scans Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan1 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan1 x nscan):
The on Orbit Non-Linearity Tnl computed from ground calibrated u look-up table . Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan1 x nscan):
Non-Linearity Tnl derived from 4-point calibration. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (4-byte float, array size: nchan1 x nscan):
The mean Hot Load Count. Averaged over all Hot samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanHotLoadCntnDiode (4-byte float, array size: nchan1 x nscan):
The mean coupled Hot Load Plus Noise Diode counts Averaged over all samples and closest 5 scans. Values range from 0 to 65535. Special values are defined as:
-9999.9 Missing value

meanColdSkyCount (4-byte float, array size: nchan1 x nscan):
The mean Cold Sky Count.Averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanColdSkyCntnDiode (4-byte float, array size: nchan1 x nscan):
The mean coupled Cold Sky Plus Noise Diode counts, averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

diodeExcessTemp (4-byte float, array size: nchan1 x nscan):
The Noise Diode Excess Temperature. Cold and diode Coupled Temperature=diodeExcessTemp + coldSkyTemp. Hot and diode Coupled Temperature=diodeExcessTemp + hotLoadTemp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan1 x nscan):
gain[0] determine the total Ta gain. Ta=offset[0]+gain[0]*earthCount+ nonLinearGaian*earthCount*earthCount. Nonlinearity=offset[1]+gain[1]*earthCount+ nonLinearGa-

ian*earthCount*earthCount. Values range from 0 to 1 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan1 x nscan):
Offset[0] determine the total Ta offset. min=-999 K (from -1 K), max=999 K (from 1 K). Missing value is -9999.9.

nonLinearGain (4-byte float, array size: nchan1 x nscan):
The nonlinear gain. Values range from -1 to 1 K. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. value 0 indicates good calibration. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

```
Diode flag.
0, Noise Diode on
2, Noise Diode off
5, Noise Diode status unknown
```

receiverTemp (4-byte float, array size: nchan1 x nscan):
The receiver temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan1 x nscan):
The receiver gain. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix3 x nscan):
The angle at the center of the IFOV between the antenna boresight vector and the zenith vector normal to the Earth Ellipsiod. Also known as Satellite Zenith Angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Ta (4-byte float, array size: nchan1 x npix3 x nscan):
Earth view antenna temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

S4 (Swath)

S4_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S4)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix4 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are

defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix4 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S4)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be

useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

calibration (Group in S4)

hotLoadTemp (4-byte float, array size: nchan2 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load. For 10, 166, 183 GHZ channles, they are averages of PRT 1,7,8,9,10. For 18, 23, 36, 89 GHZ channels, they are averages of PRT 2,11,12,13,14. The values are corrected by tray temperature and averaged over closest 5 scans Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan2 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan2 x nscan):
The on Orbit Non-Linearity Tnl computed from ground calibrated u look-up table . Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan2 x nscan):
Non-Linearity Tnl derived from 4-point calibration. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (4-byte float, array size: nchan2 x nscan):
The mean Hot Load Count. Averaged over all Hot samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanHotLoadCntnDiode (4-byte float, array size: nchan2 x nscan):
The mean coupled Hot Load Plus Noise Diode counts Averaged over all samples and closest 5 scans. Values range from 0 to 65535. Special values are defined as:
-9999.9 Missing value

meanColdSkyCount (4-byte float, array size: nchan2 x nscan):
The mean Cold Sky Count.Averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanColdSkyCntnDiode (4-byte float, array size: nchan2 x nscan):
The mean coupled Cold Sky Plus Noise Diode counts, averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

diodeExcessTemp (4-byte float, array size: nchan2 x nscan):
The Noise Diode Excess Temperature. Cold and diode Coupled Temperature=diodeExcessTemp

+ coldSkyTemp. Hot and diode Coupled Temperature=diodeExcessTemp + hotLoadTemp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan2 x nscan):
gain[0] determine the total Ta gain. Ta=offset[0]+gain[0]*earthCount+ nonLinearGain*earthCount*earthCount. Nonlinearity=offset[1]+gain[1]*earthCount+ nonLinearGain*earthCount*earthCount. Values range from 0 to 1 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan2 x nscan):
Offset[0] determine the total Ta offset. min=-999 K (from -1 K), max=999 K (from 1 K). Missing value is -9999.9.

nonLinearGain (4-byte float, array size: nchan2 x nscan):
The nonlinear gain. Values range from -1 to 1 K. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. value 0 indicates good calibration. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

```
Diode flag.
0, Noise Diode on
2, Noise Diode off
5, Noise Diode status unknown
```

receiverTemp (4-byte float, array size: nchan2 x nscan):
The receiver temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan2 x nscan):
The receiver gain. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix4 x nscan):
The angle at the center of the IFOV between the antenna boresight vector and the zenith vector normal to the Earth Ellipsiod. Also known as Satellite Zenith Angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Ta (4-byte float, array size: nchan2 x npix4 x nscan):
Earth view antenna temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_GMIBASEXCAL_H_
#define _TK_GMIBASEXCAL_H_

#ifndef _LGMIBASEXCAL_S4_CALIBRATION_
#define _LGMIBASEXCAL_S4_CALIBRATION_

typedef struct {
    float hotLoadTemp[4];
    float coldSkyTemp[4];
    float onOrbitNonLinearity[4];
    float derivedNonLinearity[4];
    float meanHotLoadCount[4];
    float meanHotLoadCntnDiode[4];
    float meanColdSkyCount[4];
    float meanColdSkyCntnDiode[4];
    float diodeExcessTemp[4];
    float gain[4][2];
    float offset[4][2];
    float nonLinearGain[4];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[4];
    float receiverGain[4];
} LGMIBASEXCAL_S4_CALIBRATION;

#endif

#ifndef _LGMIBASEXCAL_S4_SCANSTATUS_
#define _LGMIBASEXCAL_S4_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
```

```
    double FractionalGranuleNumber;
} LGMIBASEXCAL_S4_SCANSTATUS;

#endif

#ifndef _LGMIBASEXCAL_S4_
#define _LGMIBASEXCAL_S4_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[500];
    float Longitude[500];
    LGMIBASEXCAL_S4_SCANSTATUS scanStatus;
    LGMIBASEXCAL_S4_CALIBRATION calibration;
    float incidenceAngle[500];
    float Ta[500][4];
} LGMIBASEXCAL_S4;

#endif

#ifndef _LGMIBASEXCAL_S3_CALIBRATION_
#define _LGMIBASEXCAL_S3_CALIBRATION_

typedef struct {
    float hotLoadTemp[9];
    float coldSkyTemp[9];
    float onOrbitNonLinearity[9];
    float derivedNonLinearity[9];
    float meanHotLoadCount[9];
    float meanHotLoadCntnDiode[9];
    float meanColdSkyCount[9];
    float meanColdSkyCntnDiode[9];
    float diodeExcessTemp[9];
    float gain[9][2];
    float offset[9][2];
    float nonLinearGain[9];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[9];
    float receiverGain[9];
} LGMIBASEXCAL_S3_CALIBRATION;

#endif
```

```
#ifndef _LGMIBASEXCAL_S3_SCANSTATUS_
#define _LGMIBASEXCAL_S3_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} LGMIBASEXCAL_S3_SCANSTATUS;

#endif

#ifndef _LGMIBASEXCAL_S3_
#define _LGMIBASEXCAL_S3_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[500];
    float Longitude[500];
    LGMIBASEXCAL_S3_SCANSTATUS scanStatus;
    LGMIBASEXCAL_S3_CALIBRATION calibration;
    float incidenceAngle[500];
    float Ta[500][9];
} LGMIBASEXCAL_S3;

#endif

#ifndef _LGMIBASEXCAL_S2_SUNDATA_
#define _LGMIBASEXCAL_S2_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
```

```
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} LGMIBASEXCAL_S2_SUNDATA;

#endif

#ifndef _LGMIBASEXCAL_S2_CALCOUNTS_
#define _LGMIBASEXCAL_S2_CALCOUNTS_

typedef struct {
    unsigned short hotLoadReading[4][65];
    unsigned short coldLoadReading[4][85];
    unsigned short hotLoadnDiodeReading[4][65];
    unsigned short coldLoadnDiodeReading[4][85];
    unsigned short hotLoadThermisterCount[11];
} LGMIBASEXCAL_S2_CALCOUNTS;

#endif

#ifndef _LGMIBASEXCAL_S2_CAL2_
#define _LGMIBASEXCAL_S2_CAL2_

typedef struct {
    unsigned short trayTemperatureCount;
    float trayTemperature;
    unsigned short moonIndex[4];
    float noiseDiodeTemp[6];
    unsigned short TEMP_CALRES_2;
    unsigned short TEMP_CALRES_1;
    unsigned short RS_CALRES_2;
    unsigned short RS_CALRES_1;
    unsigned short BATC_CALRES_2;
    unsigned short BATC_CALRES_1;
    unsigned short NDIODE_MODE;
    unsigned short RSST_NDIODE_ST;
    unsigned short NDIODE10GHZNUM;
    float hotLoadThermisterTemp[4][11];
    unsigned short TEMP_CALRES_4;
    unsigned short TEMP_CALRES_5;
    unsigned short TEMP_CALRES_6;
    float TEMP_89GHZ_LO;
```

```
    float TEMP_166GHZ_LO;
    float TEMP_183GHZ_LO;
    float TEMP_V89GHZMXR;
    float TEMP_H89GHZMXR;
    float TEMP_V166GHZMXR;
    float TEMP_H166GHZMXR;
    float TEMP_183GHZMXR;
    float TEMP_RS_MR1;
    float TEMP_RS_MR2;
    float MR_ICA_TEMP;
    float MR_LR_LEFT_TEMP;
    float MR_LR_RGHT_TEMP;
    float MR_LR_LOWR_TEMP;
    float CSR_TEMP1;
    float CSR_TEMP2;
    float onOrbitDiodeExcessTemp[4];
    unsigned short WarmIntrusionToColdViewIndex[85][4];
} LGMIBASEXCAL_S2_CAL2;

#endif

#ifndef _LGMIBASEXCAL_S2_CALIBRATION_
#define _LGMIBASEXCAL_S2_CALIBRATION_

typedef struct {
    float hotLoadTemp[4];
    float coldSkyTemp[4];
    float onOrbitNonLinearity[4];
    float derivedNonLinearity[4];
    float meanHotLoadCount[4];
    float meanHotLoadCntnDiode[4];
    float meanColdSkyCount[4];
    float meanColdSkyCntnDiode[4];
    float diodeExcessTemp[4];
    float gain[4][2];
    float offset[4][2];
    float nonLinearGain[4];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[4];
    float receiverGain[4];
} LGMIBASEXCAL_S2_CALIBRATION;
```

```
#endif

#ifndef _LGMIBASEXCAL_S2_NAV2_
#define _LGMIBASEXCAL_S2_NAV2_

typedef struct {
    unsigned short SCE_SELECTION;
    unsigned short SCE_RATE;
} LGMIBASEXCAL_S2_NAV2;

#endif

#ifndef _LGMIBASEXCAL_S2_SAMPLEHEADER_
#define _LGMIBASEXCAL_S2_SAMPLEHEADER_

typedef struct {
    signed char blanking;
    short earthViewFirstSample;
    short sampleNumber[4][4];
    unsigned int tachSeconds[32];
    unsigned short tachSubSeconds[32];
    unsigned int indexPulseSeconds;
    unsigned short indexPulseSubSeconds;
} LGMIBASEXCAL_S2_SAMPLEHEADER;

#endif

#ifndef _LGMIBASEXCAL_S2_SCANSTATUS_
#define _LGMIBASEXCAL_S2_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} LGMIBASEXCAL_S2_SCANSTATUS;
```

```
#endif

#ifndef _LGMIBASEXCAL_S2_
#define _LGMIBASEXCAL_S2_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    LGMIBASEXCAL_S2_SCANSTATUS scanStatus;
    LGMIBASEXCAL_S2_SAMPLEHEADER sampleHeader;
    NAVIGATION navigation;
    LGMIBASEXCAL_S2_NAV2 nav2;
    LGMIBASEXCAL_S2_CALIBRATION calibration;
    LGMIBASEXCAL_S2_CAL2 cal2;
    float moonVectorInstFrame[3];
    LGMIBASEXCAL_S2_CALCOUNTS calCounts;
    LGMIBASEXCAL_S2_SUNDATA sunData;
    float incidenceAngle[221];
    float satAzimuthAngle[221];
    float solarZenAngle[221];
    float solarAzimuthAngle[221];
    float sunGlintAngle[221];
    float magneticFieldVector[3];
    unsigned short earthViewCounts[221][4];
    float Ta[221][4];
    short RFIFlag[221][2];
} LGMIBASEXCAL_S2;

#endif

#ifndef _LGMIBASEXCAL_S1_SUNDATA_
#define _LGMIBASEXCAL_S1_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
```

```
    float sunVectorInBodyFrame[3];
} LGMIBASEXCAL_S1_SUNDATA;

#endif

#ifndef _LGMIBASEXCAL_S1_CALCOUNTS_
#define _LGMIBASEXCAL_S1_CALCOUNTS_

typedef struct {
    unsigned short hotLoadReading[9][65];
    unsigned short coldLoadReading[9][85];
    unsigned short hotLoadnDiodeReading[9][65];
    unsigned short coldLoadnDiodeReading[9][85];
    unsigned short hotLoadThermisterCount[11];
} LGMIBASEXCAL_S1_CALCOUNTS;

#endif

#ifndef _LGMIBASEXCAL_S1_CAL2_
#define _LGMIBASEXCAL_S1_CAL2_

typedef struct {
    unsigned short trayTemperatureCount;
    float trayTemperature;
    unsigned short moonIndex[9];
    float noiseDiodeTemp[6];
    unsigned short TEMP_CALRES_2;
    unsigned short TEMP_CALRES_1;
    unsigned short RS_CALRES_2;
    unsigned short RS_CALRES_1;
    unsigned short BATC_CALRES_2;
    unsigned short BATC_CALRES_1;
    unsigned short NDIODE_MODE;
    unsigned short RSST_NDIODE_ST;
    unsigned short NDIODE10GHZNUM;
    float hotLoadThermisterTemp[9][11];
    unsigned short TEMP_CALRES_4;
    unsigned short TEMP_CALRES_5;
    unsigned short TEMP_CALRES_6;
    float TEMP_89GHZ_LO;
    float TEMP_166GHZ_LO;
    float TEMP_183GHZ_LO;
    float TEMP_V89GHZMXR;
```

```
    float TEMP_H89GHZMXR;
    float TEMP_V166GHZMXR;
    float TEMP_H166GHZMXR;
    float TEMP_183GHZMXR;
    float TEMP_RS_MR1;
    float TEMP_RS_MR2;
    float MR_ICA_TEMP;
    float MR_LR_LEFT_TEMP;
    float MR_LR_RGHT_TEMP;
    float MR_LR_LOWR_TEMP;
    float CSR_TEMP1;
    float CSR_TEMP2;
    float onOrbitDiodeExcessTemp[9];
    unsigned short WarmIntrusionToColdViewIndex[85][9];
} LGMIBASEXCAL_S1_CAL2;

#endif

#ifndef _LGMIBASEXCAL_S1_CALIBRATION_
#define _LGMIBASEXCAL_S1_CALIBRATION_

typedef struct {
    float hotLoadTemp[9];
    float coldSkyTemp[9];
    float onOrbitNonLinearity[9];
    float derivedNonLinearity[9];
    float meanHotLoadCount[9];
    float meanHotLoadCntnDiode[9];
    float meanColdSkyCount[9];
    float meanColdSkyCntnDiode[9];
    float diodeExcessTemp[9];
    float gain[9][2];
    float offset[9][2];
    float nonLinearGain[9];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[9];
    float receiverGain[9];
} LGMIBASEXCAL_S1_CALIBRATION;

#endif

#ifndef _LGMIBASEXCAL_S1_NAV2_
```

```
#define _LGMIBASEXCAL_S1_NAV2_

typedef struct {
    unsigned short SCE_SELECTION;
    unsigned short SCE_RATE;
} LGMIBASEXCAL_S1_NAV2;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _LGMIBASEXCAL_S1_SAMPLEHEADER_
#define _LGMIBASEXCAL_S1_SAMPLEHEADER_

typedef struct {
    signed char blanking;
    short earthViewFirstSample;
    short sampleNumber[9][4];
    unsigned int tachSeconds[32];
    unsigned short tachSubSeconds[32];
    unsigned int indexPulseSeconds;
    unsigned short indexPulseSubSeconds;
```

```
} LGMIBASEXCAL_S1_SAMPLEHEADER;

#endif

#ifndef _LGMIBASEXCAL_S1_SCANSTATUS_
#define _LGMIBASEXCAL_S1_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} LGMIBASEXCAL_S1_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _LGMIBASEXCAL_S1_
#define _LGMIBASEXCAL_S1_
```

```
typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    LGMIBASEXCAL_S1_SCANSTATUS scanStatus;
    LGMIBASEXCAL_S1_SAMPLEHEADER sampleHeader;
    NAVIGATION navigation;
    LGMIBASEXCAL_S1_NAV2 nav2;
    LGMIBASEXCAL_S1_CALIBRATION calibration;
    LGMIBASEXCAL_S1_CAL2 cal2;
    float moonVectorInstFrame[3];
    LGMIBASEXCAL_S1_CALCOUNTS calCounts;
    LGMIBASEXCAL_S1_SUNDATA sunData;
    float incidenceAngle[221];
    float satAzimuthAngle[221];
    float solarZenAngle[221];
    float solarAzimuthAngle[221];
    float sunGlintAngle[221];
    float magneticFieldVector[3];
    unsigned short earthViewCounts[221][9];
    float Ta[221][9];
    short RFIFlag[221][5];
} LGMIBASEXCAL_S1;

#endif

#ifndef _LGMIBASEXCAL_SWATHS_
#define _LGMIBASEXCAL_SWATHS_

typedef struct {
    LGMIBASEXCAL_S1 S1;
    LGMIBASEXCAL_S2 S2;
    LGMIBASEXCAL_S3 S3;
    LGMIBASEXCAL_S4 S4;
} LGMIBASEXCAL_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /LGMIBASEXCAL_S4_CALIBRATION/
```

```
    REAL*4 hotLoadTemp(4)
    REAL*4 coldSkyTemp(4)
    REAL*4 onOrbitNonLinearity(4)
    REAL*4 derivedNonLinearity(4)
    REAL*4 meanHotLoadCount(4)
    REAL*4 meanHotLoadCntnDiode(4)
    REAL*4 meanColdSkyCount(4)
    REAL*4 meanColdSkyCntnDiode(4)
    REAL*4 diodeExcessTemp(4)
    REAL*4 gain(2,4)
    REAL*4 offset(2,4)
    REAL*4 nonLinearGain(4)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(4)
    REAL*4 receiverGain(4)
END STRUCTURE

STRUCTURE /LGMIBASEXCAL_S4_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /LGMIBASEXCAL_S4/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(500)
    REAL*4 Longitude(500)
    RECORD /LGMIBASEXCAL_S4_SCANSTATUS/ scanStatus
    RECORD /LGMIBASEXCAL_S4_CALIBRATION/ calibration
    REAL*4 incidenceAngle(500)
    REAL*4 Ta(4,500)
END STRUCTURE

STRUCTURE /LGMIBASEXCAL_S3_CALIBRATION/
```

```
    REAL*4 hotLoadTemp(9)
    REAL*4 coldSkyTemp(9)
    REAL*4 onOrbitNonLinearity(9)
    REAL*4 derivedNonLinearity(9)
    REAL*4 meanHotLoadCount(9)
    REAL*4 meanHotLoadCntnDiode(9)
    REAL*4 meanColdSkyCount(9)
    REAL*4 meanColdSkyCntnDiode(9)
    REAL*4 diodeExcessTemp(9)
    REAL*4 gain(2,9)
    REAL*4 offset(2,9)
    REAL*4 nonLinearGain(9)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(9)
    REAL*4 receiverGain(9)
END STRUCTURE

STRUCTURE /LGMIBASEXCAL_S3_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /LGMIBASEXCAL_S3/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(500)
    REAL*4 Longitude(500)
    RECORD /LGMIBASEXCAL_S3_SCANSTATUS/ scanStatus
    RECORD /LGMIBASEXCAL_S3_CALIBRATION/ calibration
    REAL*4 incidenceAngle(500)
    REAL*4 Ta(9,500)
END STRUCTURE

STRUCTURE /LGMIBASEXCAL_S2_SUNDATA/
```

```
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /LGMIBASEXCAL_S2_CALCOUNTS/
    INTEGER*2 hotLoadReading(65,4)
    INTEGER*2 coldLoadReading(85,4)
    INTEGER*2 hotLoadnDiodeReading(65,4)
    INTEGER*2 coldLoadnDiodeReading(85,4)
    INTEGER*2 hotLoadThermisterCount(11)
END STRUCTURE

STRUCTURE /LGMIBASEXCAL_S2_CAL2/
    INTEGER*2 trayTemperatureCount
    REAL*4 trayTemperature
    INTEGER*2 moonIndex(4)
    REAL*4 noiseDiodeTemp(6)
    INTEGER*2 TEMP_CALRES_2
    INTEGER*2 TEMP_CALRES_1
    INTEGER*2 RS_CALRES_2
    INTEGER*2 RS_CALRES_1
    INTEGER*2 BATC_CALRES_2
    INTEGER*2 BATC_CALRES_1
    INTEGER*2 NDIODE_MODE
    INTEGER*2 RSST_NDIODE_ST
    INTEGER*2 NDIODE10GHZNUM
    REAL*4 hotLoadThermisterTemp(11,4)
    INTEGER*2 TEMP_CALRES_4
    INTEGER*2 TEMP_CALRES_5
    INTEGER*2 TEMP_CALRES_6
    REAL*4 TEMP_89GHZ_LO
    REAL*4 TEMP_166GHZ_LO
    REAL*4 TEMP_183GHZ_LO
    REAL*4 TEMP_V89GHZMXR
    REAL*4 TEMP_H89GHZMXR
    REAL*4 TEMP_V166GHZMXR
    REAL*4 TEMP_H166GHZMXR
```

```
    REAL*4 TEMP_183GHZMXR
    REAL*4 TEMP_RS_MR1
    REAL*4 TEMP_RS_MR2
    REAL*4 MR_ICA_TEMP
    REAL*4 MR_LR_LEFT_TEMP
    REAL*4 MR_LR_RGHT_TEMP
    REAL*4 MR_LR_LOWR_TEMP
    REAL*4 CSR_TEMP1
    REAL*4 CSR_TEMP2
    REAL*4 onOrbitDiodeExcessTemp(4)
    INTEGER*2 WarmIntrusionToColdViewIndex(4,85)
END STRUCTURE

STRUCTURE /LGMIBASEXCAL_S2_CALIBRATION/
    REAL*4 hotLoadTemp(4)
    REAL*4 coldSkyTemp(4)
    REAL*4 onOrbitNonLinearity(4)
    REAL*4 derivedNonLinearity(4)
    REAL*4 meanHotLoadCount(4)
    REAL*4 meanHotLoadCntnDiode(4)
    REAL*4 meanColdSkyCount(4)
    REAL*4 meanColdSkyCntnDiode(4)
    REAL*4 diodeExcessTemp(4)
    REAL*4 gain(2,4)
    REAL*4 offset(2,4)
    REAL*4 nonLinearGain(4)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(4)
    REAL*4 receiverGain(4)
END STRUCTURE

STRUCTURE /LGMIBASEXCAL_S2_NAV2/
    INTEGER*2 SCE_SELECTION
    INTEGER*2 SCE_RATE
END STRUCTURE

STRUCTURE /LGMIBASEXCAL_S2_SAMPLEHEADER/
    BYTE blanking
    INTEGER*2 earthViewFirstSample
    INTEGER*2 sampleNumber(4,4)
    INTEGER*4 tachSeconds(32)
    INTEGER*2 tachSubSeconds(32)
```

```
    INTEGER*4 indexPulseSeconds
    INTEGER*2 indexPulseSubSeconds
END STRUCTURE

STRUCTURE /LGMIBASEXCAL_S2_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /LGMIBASEXCAL_S2/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    RECORD /LGMIBASEXCAL_S2_SCANSTATUS/ scanStatus
    RECORD /LGMIBASEXCAL_S2_SAMPLEHEADER/ sampleHeader
    RECORD /NAVIGATION/ navigation
    RECORD /LGMIBASEXCAL_S2_NAV2/ nav2
    RECORD /LGMIBASEXCAL_S2_CALIBRATION/ calibration
    RECORD /LGMIBASEXCAL_S2_CAL2/ cal2
    REAL*4 moonVectorInstFrame(3)
    RECORD /LGMIBASEXCAL_S2_CALCOUNTS/ calCounts
    RECORD /LGMIBASEXCAL_S2_SUNDATA/ sunData
    REAL*4 incidenceAngle(221)
    REAL*4 satAzimuthAngle(221)
    REAL*4 solarZenAngle(221)
    REAL*4 solarAzimuthAngle(221)
    REAL*4 sunGlintAngle(221)
    REAL*4 magneticFieldVector(3)
    INTEGER*2 earthViewCounts(4,221)
    REAL*4 Ta(4,221)
    INTEGER*2 RFIFlag(2,221)
END STRUCTURE

STRUCTURE /LGMIBASEXCAL_S1_SUNDATA/
```

```
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /LGMIBASEXCAL_S1_CALCOUNTS/
    INTEGER*2 hotLoadReading(65,9)
    INTEGER*2 coldLoadReading(85,9)
    INTEGER*2 hotLoadnDiodeReading(65,9)
    INTEGER*2 coldLoadnDiodeReading(85,9)
    INTEGER*2 hotLoadThermisterCount(11)
END STRUCTURE

STRUCTURE /LGMIBASEXCAL_S1_CAL2/
    INTEGER*2 trayTemperatureCount
    REAL*4 trayTemperature
    INTEGER*2 moonIndex(9)
    REAL*4 noiseDiodeTemp(6)
    INTEGER*2 TEMP_CALRES_2
    INTEGER*2 TEMP_CALRES_1
    INTEGER*2 RS_CALRES_2
    INTEGER*2 RS_CALRES_1
    INTEGER*2 BATC_CALRES_2
    INTEGER*2 BATC_CALRES_1
    INTEGER*2 NDIODE_MODE
    INTEGER*2 RSST_NDIODE_ST
    INTEGER*2 NDIODE10GHZNUM
    REAL*4 hotLoadThermisterTemp(11,9)
    INTEGER*2 TEMP_CALRES_4
    INTEGER*2 TEMP_CALRES_5
    INTEGER*2 TEMP_CALRES_6
    REAL*4 TEMP_89GHZ_LO
    REAL*4 TEMP_166GHZ_LO
    REAL*4 TEMP_183GHZ_LO
    REAL*4 TEMP_V89GHZMXR
    REAL*4 TEMP_H89GHZMXR
    REAL*4 TEMP_V166GHZMXR
    REAL*4 TEMP_H166GHZMXR
```

```
    REAL*4 TEMP_183GHZMXR
    REAL*4 TEMP_RS_MR1
    REAL*4 TEMP_RS_MR2
    REAL*4 MR_ICA_TEMP
    REAL*4 MR_LR_LEFT_TEMP
    REAL*4 MR_LR_RGHT_TEMP
    REAL*4 MR_LR_LOWR_TEMP
    REAL*4 CSR_TEMP1
    REAL*4 CSR_TEMP2
    REAL*4 onOrbitDiodeExcessTemp(9)
    INTEGER*2 WarmIntrusionToColdViewIndex(9,85)
END STRUCTURE

STRUCTURE /LGMIBASEXCAL_S1_CALIBRATION/
    REAL*4 hotLoadTemp(9)
    REAL*4 coldSkyTemp(9)
    REAL*4 onOrbitNonLinearity(9)
    REAL*4 derivedNonLinearity(9)
    REAL*4 meanHotLoadCount(9)
    REAL*4 meanHotLoadCntnDiode(9)
    REAL*4 meanColdSkyCount(9)
    REAL*4 meanColdSkyCntnDiode(9)
    REAL*4 diodeExcessTemp(9)
    REAL*4 gain(2,9)
    REAL*4 offset(2,9)
    REAL*4 nonLinearGain(9)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(9)
    REAL*4 receiverGain(9)
END STRUCTURE

STRUCTURE /LGMIBASEXCAL_S1_NAV2/
    INTEGER*2 SCE_SELECTION
    INTEGER*2 SCE_RATE
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
```

```
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /LGMIBASEXCAL_S1_SAMPLEHEADER/
    BYTE blanking
    INTEGER*2 earthViewFirstSample
    INTEGER*2 sampleNumber(4,9)
    INTEGER*4 tachSeconds(32)
    INTEGER*2 tachSubSeconds(32)
    INTEGER*4 indexPulseSeconds
    INTEGER*2 indexPulseSubSeconds
END STRUCTURE

STRUCTURE /LGMIBASEXCAL_S1_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
```

```
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /LGMIBASEXCAL_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    RECORD /LGMIBASEXCAL_S1_SCANSTATUS/ scanStatus
    RECORD /LGMIBASEXCAL_S1_SAMPLEHEADER/ sampleHeader
    RECORD /NAVIGATION/ navigation
    RECORD /LGMIBASEXCAL_S1_NAV2/ nav2
    RECORD /LGMIBASEXCAL_S1_CALIBRATION/ calibration
    RECORD /LGMIBASEXCAL_S1_CAL2/ cal2
    REAL*4 moonVectorInstFrame(3)
    RECORD /LGMIBASEXCAL_S1_CALCOUNTS/ calCounts
    RECORD /LGMIBASEXCAL_S1_SUNDATA/ sunData
    REAL*4 incidenceAngle(221)
    REAL*4 satAzimuthAngle(221)
    REAL*4 solarZenAngle(221)
    REAL*4 solarAzimuthAngle(221)
    REAL*4 sunGlintAngle(221)
    REAL*4 magneticFieldVector(3)
    INTEGER*2 earthViewCounts(9,221)
    REAL*4 Ta(9,221)
    INTEGER*2 RFIFlag(5,221)
END STRUCTURE

STRUCTURE /LGMIBASEXCAL_SWATHS/
    RECORD /LGMIBASEXCAL_S1/ S1
    RECORD /LGMIBASEXCAL_S2/ S2
    RECORD /LGMIBASEXCAL_S3/ S3
    RECORD /LGMIBASEXCAL_S4/ S4
END STRUCTURE
```

5.5 SSMISBASE - SSMIS base

SSMISBASE contains antenna temperature. These files contain all the information from the TDR files plus additions Wesley Berg made creating his base files plus the isMissing flag. SSMISBASE is written as one swath, but the 1C product will have 4 swaths.

NOTE: the filespec does not draw the swath. NOTE: ranges may be wrong

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel_img	180	Number samples per imager scanline.
npixel_env	90	Number samples per environmental scanline.
nephem	3	Number ephem.
ndate	6	Number date.
ntime	7	Number of time array dim (year, month, day, hour, minute, second, and millisecond)
nsunvec	3	Number sun vector.
nsatpos	2	Number satellite position.
nchannel	24	Number channels.
nwarmload	3	Number of warm load array dimension.
nmuxhouse	4	Number mux housing.
nbasepoint	28	Number basepoint.
ntest	8	Number test.
nsensor	6	Number sensor.

Figure 101 through Figure 108 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains metadata of general interest. This group appears in all data products. See Metadata for GPM Products for details.

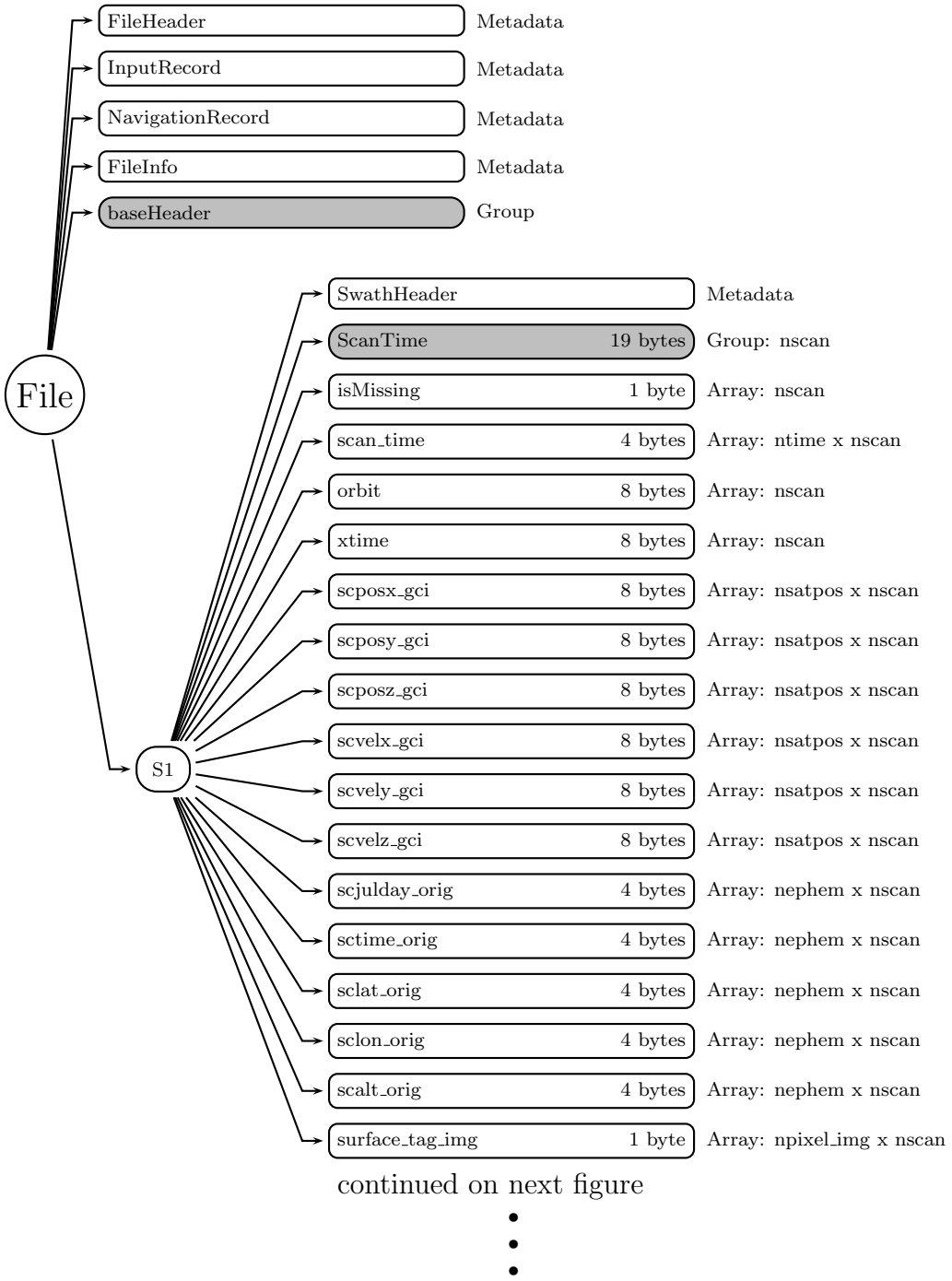
InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

baseHeader (Group)

spacecraft_id (4-byte integer, array size: 1):
Satellite ID number.



continued on next figure

Figure 101: Data Format Structure for SSMISBASE, SSMIS base

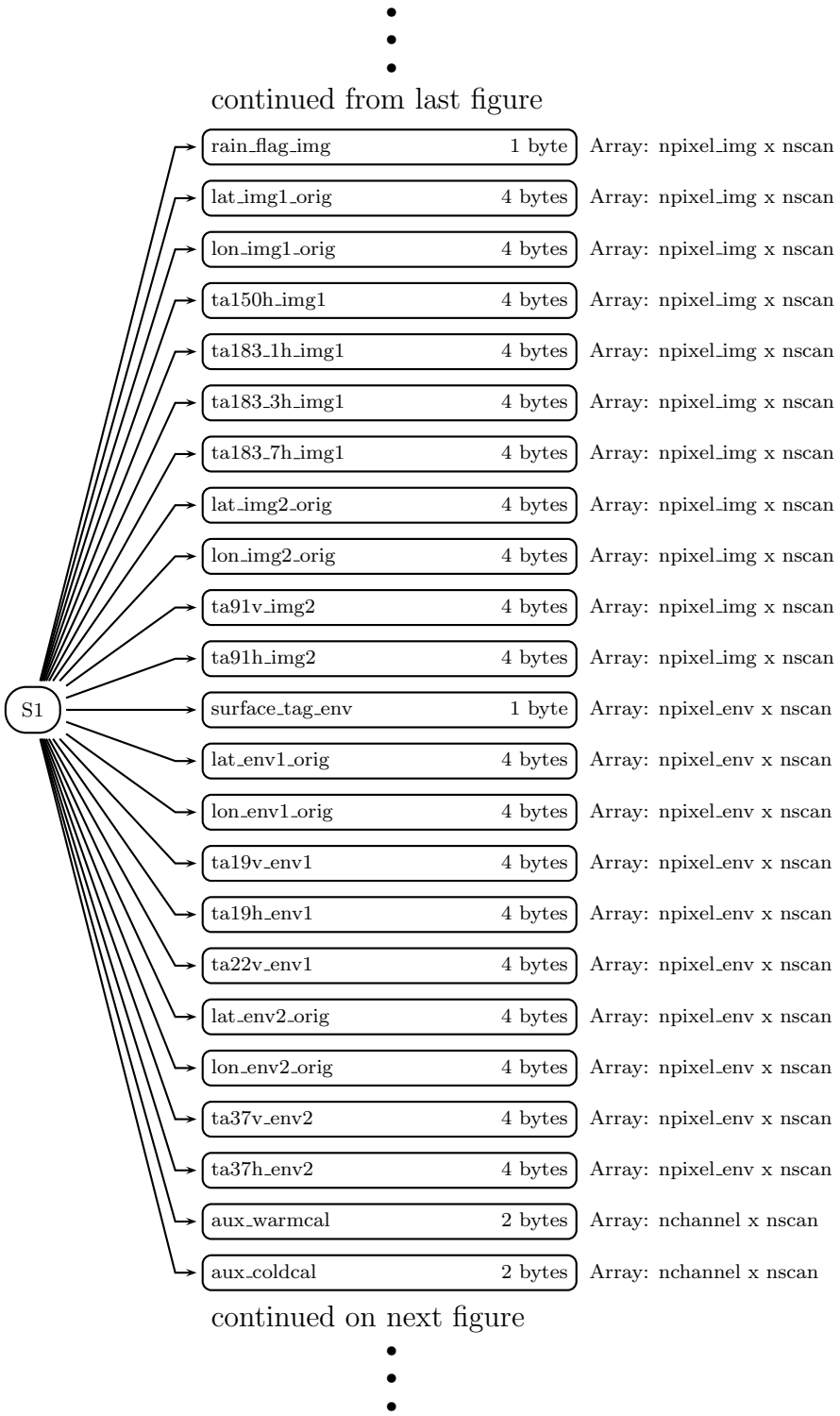


Figure 102: Data Format Structure for SSMISBASE, SSMIS base

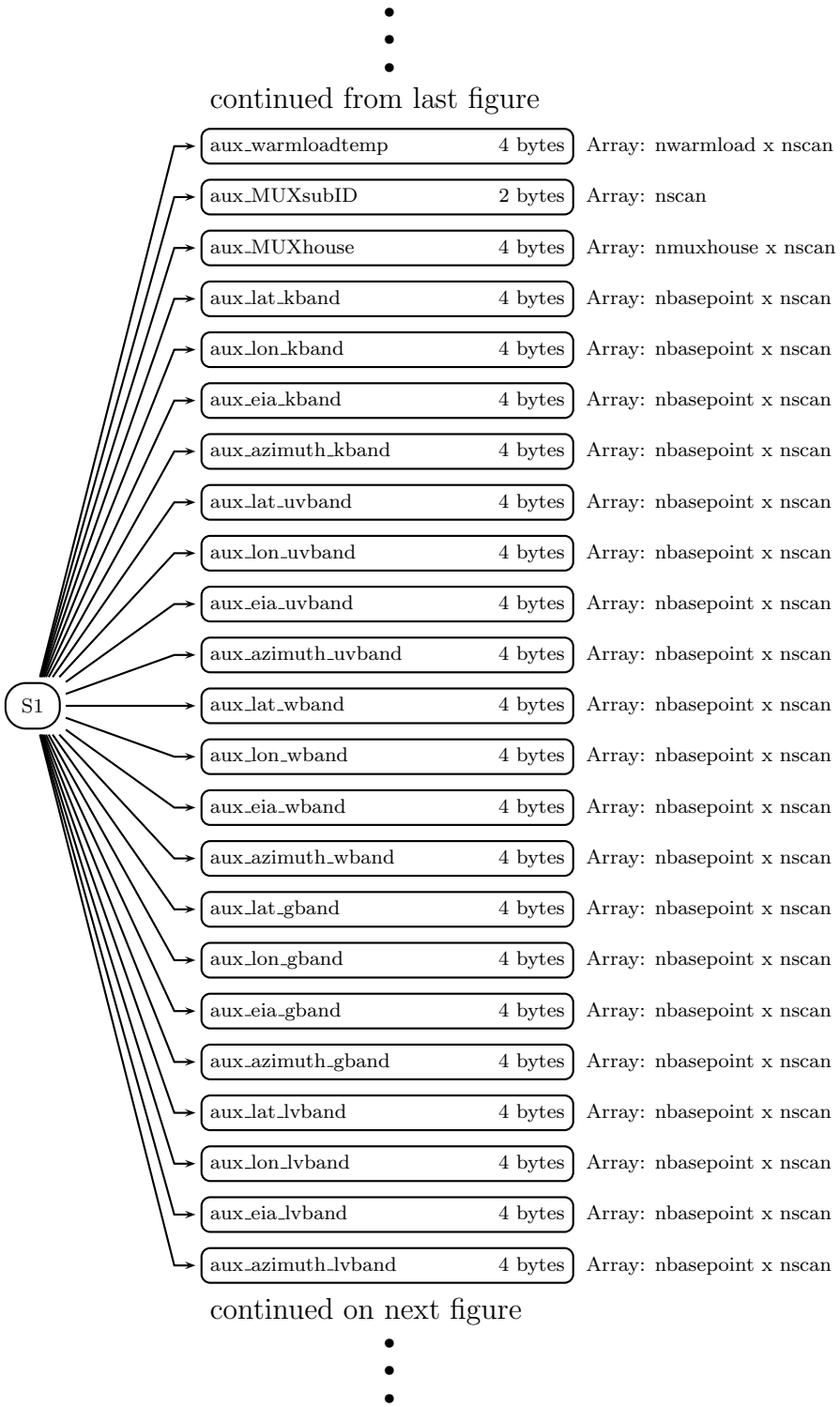


Figure 103: Data Format Structure for SSMISBASE, SSMIS base

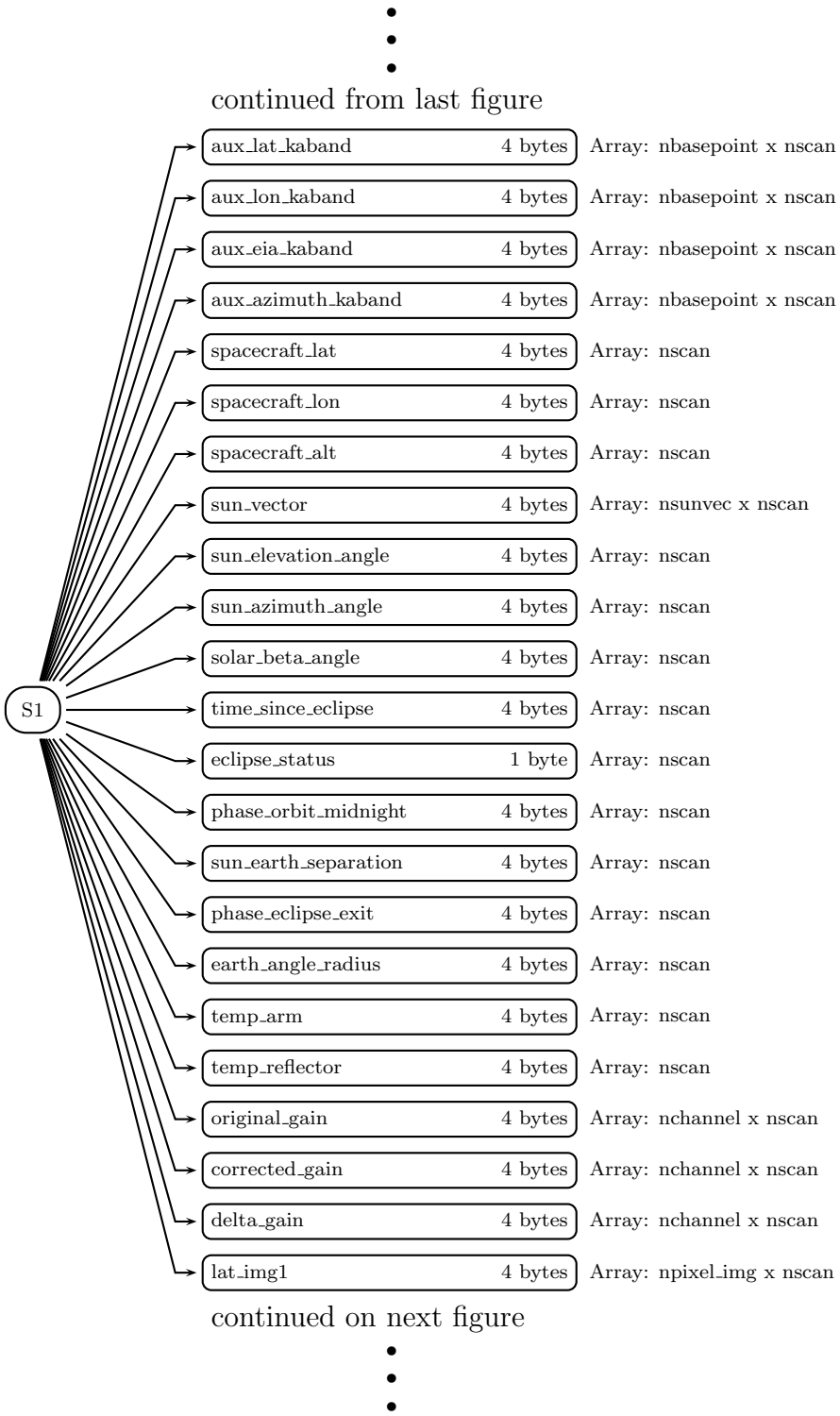


Figure 104: Data Format Structure for SSMISBASE, SSMIS base

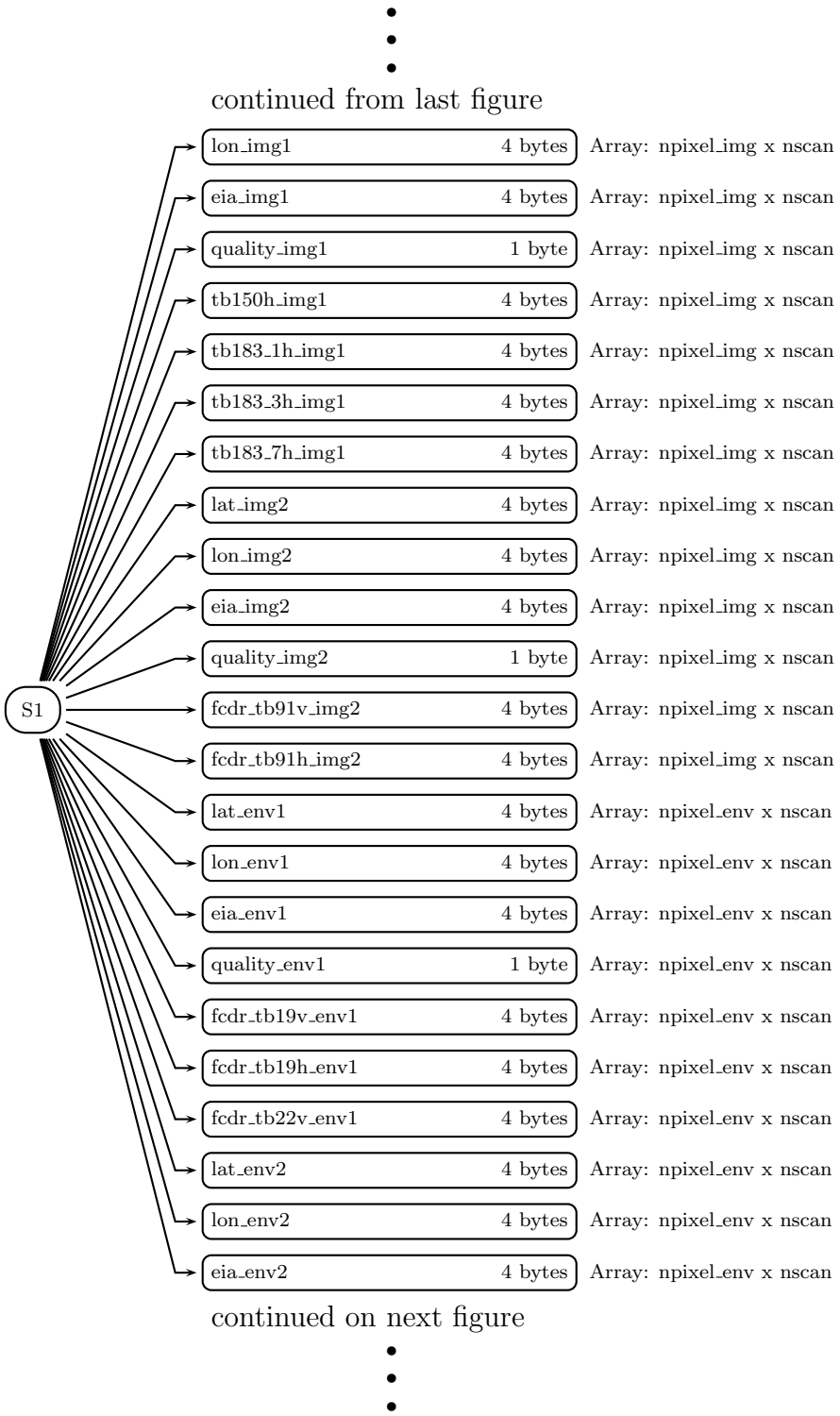


Figure 105: Data Format Structure for SSMISBASE, SSMIS base

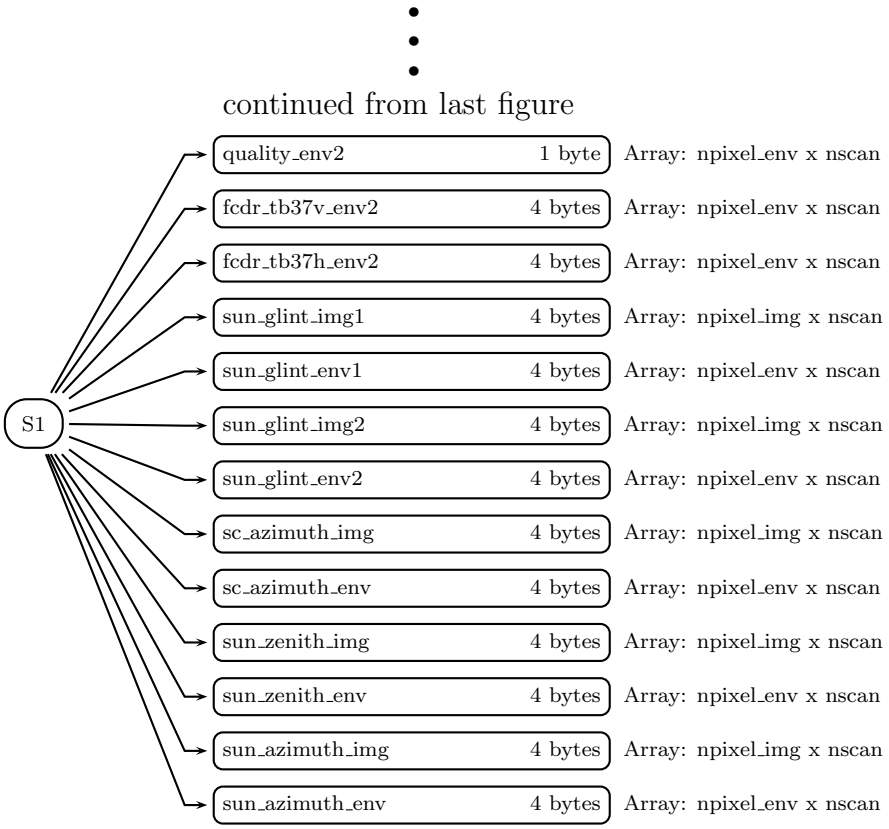


Figure 106: Data Format Structure for SSMISBASE, SSMIS base

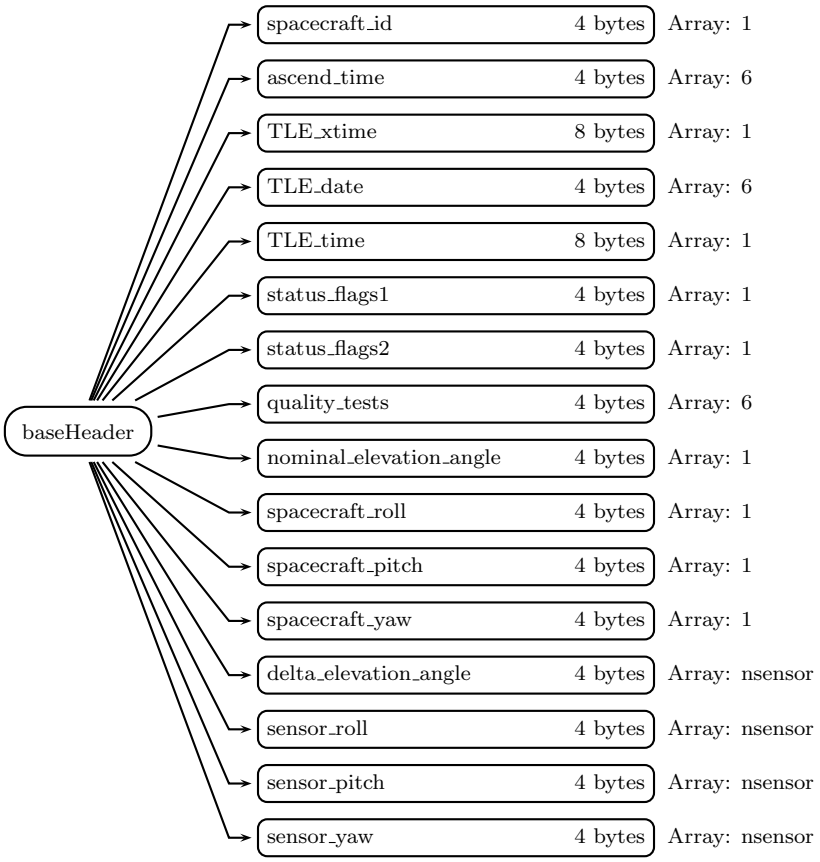


Figure 107: Data Format Structure for SSMISBASE, baseHeader

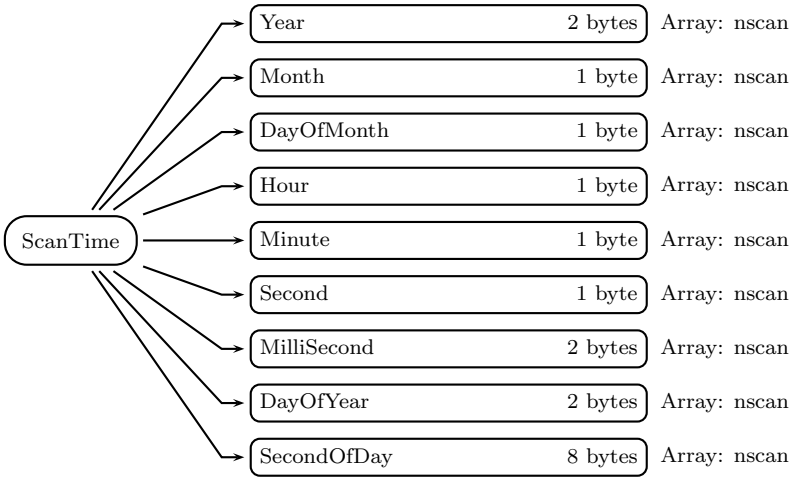


Figure 108: Data Format Structure for SSMISBASE, ScanTime

ascend_time (4-byte integer, array size: 6):
Ascending time.

TLE_xtime (8-byte float, array size: 1):
TLE time.

TLE_date (4-byte integer, array size: 6):
TLE date time arrays.

TLE_time (8-byte float, array size: 1):
TLE time as in two line element.

status_flags1 (4-byte integer, array size: 1):
Processing status flags 1.

status_flags2 (4-byte integer, array size: 1):
Processing status flags 2.

quality_tests (4-byte integer, array size: 6):

nominal_elevation_angle (4-byte float, array size: 1):

spacecraft_roll (4-byte float, array size: 1):

spacecraft_pitch (4-byte float, array size: 1):

spacecraft_yaw (4-byte float, array size: 1):

delta_elevation_angle (4-byte float, array size: nsensor):

sensor_roll (4-byte float, array size: nsensor):

sensor_pitch (4-byte float, array size: nsensor):

sensor_yaw (4-byte float, array size: nsensor):

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

isMissing (1-byte integer, array size: nscan):
Missing scan flag.

scan_time (4-byte integer, array size: ntime x nscan):

orbit (8-byte float, array size: nscan):

xtime (8-byte float, array size: nscan):

scposx_gci (8-byte float, array size: nsatpos x nscan):

scposy_gci (8-byte float, array size: nsatpos x nscan):

scposz_gci (8-byte float, array size: nsatpos x nscan):

scvelx_gci (8-byte float, array size: nsatpos x nscan):

scvely_gci (8-byte float, array size: nsatpos x nscan):

scvelz_gci (8-byte float, array size: nsatpos x nscan):

scjulday_orig (4-byte integer, array size: nephem x nscan):

sctime_orig (4-byte float, array size: nephem x nscan):

sclat_orig (4-byte float, array size: nephem x nscan):

sclon_orig (4-byte float, array size: nephem x nscan):

scalt_orig (4-byte float, array size: nephem x nscan):

surface_tag_img (1-byte integer, array size: npixel_img x nscan):

rain_flag_img (1-byte integer, array size: npixel_img x nscan):

lat_img1_orig (4-byte float, array size: npixel_img x nscan):

lon_img1_orig (4-byte float, array size: npixel_img x nscan):

ta150h_img1 (4-byte float, array size: npixel_img x nscan):

ta183_1h_img1 (4-byte float, array size: npixel_img x nscan):

ta183_3h_img1 (4-byte float, array size: npixel_img x nscan):

ta183_7h_img1 (4-byte float, array size: npixel_img x nscan):

lat_img2_orig (4-byte float, array size: npixel_img x nscan):

lon_img2_orig (4-byte float, array size: npixel_img x nscan):

ta91v_img2 (4-byte float, array size: npixel_img x nscan):

ta91h_img2 (4-byte float, array size: npixel_img x nscan):

surface_tag_env (1-byte integer, array size: npixel_env x nscan):

lat_env1_orig (4-byte float, array size: npixel_env x nscan):

lon_env1_orig (4-byte float, array size: npixel_env x nscan):

ta19v_env1 (4-byte float, array size: npixel_env x nscan):

ta19h_env1 (4-byte float, array size: npixel_env x nscan):

ta22v_env1 (4-byte float, array size: npixel_env x nscan):

lat_env2_orig (4-byte float, array size: npixel_env x nscan):

lon_env2_orig (4-byte float, array size: npixel_env x nscan):

ta37v_env2 (4-byte float, array size: npixel_env x nscan):

ta37h_env2 (4-byte float, array size: npixel_env x nscan):

aux_warmcal (2-byte integer, array size: nchannel x nscan):

aux_coldcal (2-byte integer, array size: nchannel x nscan):

aux_warmloadtemp (4-byte float, array size: nwarmload x nscan):

aux_MUXsubID (2-byte integer, array size: nscan):

aux_MUXhouse (4-byte float, array size: nmuxhouse x nscan):

aux_lat_kband (4-byte float, array size: nbasepoint x nscan):

aux_lon_kband (4-byte float, array size: nbasepoint x nscan):

aux_eia_kband (4-byte float, array size: nbasepoint x nscan):

aux_azimuth_kband (4-byte float, array size: nbasepoint x nscan):

aux_lat_uvband (4-byte float, array size: nbasepoint x nscan):

aux_lon_uvband (4-byte float, array size: nbasepoint x nscan):

aux_eia_uvband (4-byte float, array size: nbasepoint x nscan):

aux_azimuth_uvband (4-byte float, array size: nbasepoint x nscan):

aux_lat_wband (4-byte float, array size: nbasepoint x nscan):

aux_lon_wband (4-byte float, array size: nbasepoint x nscan):

aux_eia_wband (4-byte float, array size: nbasepoint x nscan):

aux_azimuth_wband (4-byte float, array size: nbasepoint x nscan):

aux_lat_gband (4-byte float, array size: nbasepoint x nscan):

aux_lon_gband (4-byte float, array size: nbasepoint x nscan):

aux_eia_gband (4-byte float, array size: nbasepoint x nscan):

aux_azimuth_gband (4-byte float, array size: nbasepoint x nscan):

aux_lat_lvband (4-byte float, array size: nbasepoint x nscan):

aux_lon_lvband (4-byte float, array size: nbasepoint x nscan):

aux_eia_lvband (4-byte float, array size: nbasepoint x nscan):

aux_azimuth_lvband (4-byte float, array size: nbasepoint x nscan):

aux_lat_kaband (4-byte float, array size: nbasepoint x nscan):

aux_lon_kaband (4-byte float, array size: nbasepoint x nscan):

aux_eia_kaband (4-byte float, array size: nbasepoint x nscan):

aux_azimuth_kaband (4-byte float, array size: nbasepoint x nscan):

spacecraft_lat (4-byte float, array size: nscan):

spacecraft_lon (4-byte float, array size: nscan):

spacecraft_alt (4-byte float, array size: nscan):

sun_vector (4-byte float, array size: nsunvec x nscan):

sun_elevation_angle (4-byte float, array size: nscan):

sun_azimuth_angle (4-byte float, array size: nscan):

solar_beta_angle (4-byte float, array size: nscan):

time_since_eclipse (4-byte float, array size: nscan):

eclipse_status (1-byte integer, array size: nscan):

phase_orbit_midnight (4-byte float, array size: nscan):

sun_earth_separation (4-byte float, array size: nscan):

phase_eclipse_exit (4-byte float, array size: nscan):

earth_angle_radius (4-byte float, array size: nscan):

temp_arm (4-byte float, array size: nscan):

temp_reflector (4-byte float, array size: nscan):

original_gain (4-byte float, array size: nchannel x nscan):

corrected_gain (4-byte float, array size: nchannel x nscan):

delta_gain (4-byte float, array size: nchannel x nscan):

lat_img1 (4-byte float, array size: npixel_img x nscan):

lon_img1 (4-byte float, array size: npixel_img x nscan):

eia_img1 (4-byte float, array size: npixel_img x nscan):

quality_img1 (1-byte integer, array size: npixel_img x nscan):

tb150h_img1 (4-byte float, array size: npixel_img x nscan):

tb183_1h_img1 (4-byte float, array size: npixel_img x nscan):

tb183_3h_img1 (4-byte float, array size: npixel_img x nscan):

tb183_7h_img1 (4-byte float, array size: npixel_img x nscan):

lat_img2 (4-byte float, array size: npixel_img x nscan):

lon_img2 (4-byte float, array size: npixel_img x nscan):

eia_img2 (4-byte float, array size: npixel_img x nscan):

quality_img2 (1-byte integer, array size: npixel_img x nscan):

fcdr_tb91v_img2 (4-byte float, array size: npixel_img x nscan):

fcdr_tb91h_img2 (4-byte float, array size: npixel_img x nscan):

lat_env1 (4-byte float, array size: npixel_env x nscan):

lon_env1 (4-byte float, array size: npixel_env x nscan):

eia_env1 (4-byte float, array size: npixel_env x nscan):

quality_env1 (1-byte integer, array size: npixel_env x nscan):

fcdr_tb19v_env1 (4-byte float, array size: npixel_env x nscan):

fcdr_tb19h_env1 (4-byte float, array size: npixel_env x nscan):

fcdr_tb22v_env1 (4-byte float, array size: npixel_env x nscan):

lat_env2 (4-byte float, array size: npixel_env x nscan):

lon_env2 (4-byte float, array size: npixel_env x nscan):

eia_env2 (4-byte float, array size: npixel_env x nscan):

quality_env2 (1-byte integer, array size: npixel_env x nscan):

fcdr_tb37v_env2 (4-byte float, array size: npixel_env x nscan):

fcdr_tb37h_env2 (4-byte float, array size: npixel_env x nscan):

sun_glint_img1 (4-byte float, array size: npixel_img x nscan):

sun_glint_env1 (4-byte float, array size: npixel_env x nscan):

sun_glint_img2 (4-byte float, array size: npixel_img x nscan):

sun_glint_env2 (4-byte float, array size: npixel_env x nscan):

sc_azimuth_img (4-byte float, array size: npixel_img x nscan):

sc_azimuth_env (4-byte float, array size: npixel_env x nscan):

sun_zenith_img (4-byte float, array size: npixel_img x nscan):

sun_zenith_env (4-byte float, array size: npixel_env x nscan):

sun_azimuth_img (4-byte float, array size: npixel_img x nscan):

sun_azimuth_env (4-byte float, array size: npixel_env x nscan):

C Structure Header file:

```
#ifndef _TK_SSMISBASE_H_
#define _TK_SSMISBASE_H_

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _LSSMISBASE_S1_
#define _LSSMISBASE_S1_

typedef struct {
    SCANTIME ScanTime;
    signed char isMissing;
    int scan_time[7];
    double orbit;
    double xtime;
    double scposx_gci[2];
    double scposy_gci[2];
    double scposz_gci[2];
```

```
double scvelx_gci[2];
double scvely_gci[2];
double scvelz_gci[2];
int scjulday_orig[3];
float sctime_orig[3];
float sclat_orig[3];
float sclon_orig[3];
float scalt_orig[3];
signed char surface_tag_img[180];
signed char rain_flag_img[180];
float lat_img1_orig[180];
float lon_img1_orig[180];
float ta150h_img1[180];
float ta183_1h_img1[180];
float ta183_3h_img1[180];
float ta183_7h_img1[180];
float lat_img2_orig[180];
float lon_img2_orig[180];
float ta91v_img2[180];
float ta91h_img2[180];
signed char surface_tag_env[90];
float lat_env1_orig[90];
float lon_env1_orig[90];
float ta19v_env1[90];
float ta19h_env1[90];
float ta22v_env1[90];
float lat_env2_orig[90];
float lon_env2_orig[90];
float ta37v_env2[90];
float ta37h_env2[90];
short aux_warmcal[24];
short aux_coldcal[24];
float aux_warmloadtemp[3];
short aux_MUXsubID;
float aux_MUXhouse[4];
float aux_lat_kband[28];
float aux_lon_kband[28];
float aux_eia_kband[28];
float aux_azimuth_kband[28];
float aux_lat_uvband[28];
float aux_lon_uvband[28];
float aux_eia_uvband[28];
float aux_azimuth_uvband[28];
```

```
float aux_lat_wband[28];
float aux_lon_wband[28];
float aux_eia_wband[28];
float aux_azimuth_wband[28];
float aux_lat_gband[28];
float aux_lon_gband[28];
float aux_eia_gband[28];
float aux_azimuth_gband[28];
float aux_lat_lvband[28];
float aux_lon_lvband[28];
float aux_eia_lvband[28];
float aux_azimuth_lvband[28];
float aux_lat_kaband[28];
float aux_lon_kaband[28];
float aux_eia_kaband[28];
float aux_azimuth_kaband[28];
float spacecraft_lat;
float spacecraft_lon;
float spacecraft_alt;
float sun_vector[3];
float sun_elevation_angle;
float sun_azimuth_angle;
float solar_beta_angle;
float time_since_eclipse;
signed char eclipse_status;
float phase_orbit_midnight;
float sun_earth_separation;
float phase_eclipse_exit;
float earth_angle_radius;
float temp_arm;
float temp_reflector;
float original_gain[24];
float corrected_gain[24];
float delta_gain[24];
float lat_img1[180];
float lon_img1[180];
float eia_img1[180];
signed char quality_img1[180];
float tb150h_img1[180];
float tb183_1h_img1[180];
float tb183_3h_img1[180];
float tb183_7h_img1[180];
float lat_img2[180];
```

```
    float lon_img2[180];
    float eia_img2[180];
    signed char quality_img2[180];
    float fcdr_tb91v_img2[180];
    float fcdr_tb91h_img2[180];
    float lat_env1[90];
    float lon_env1[90];
    float eia_env1[90];
    signed char quality_env1[90];
    float fcdr_tb19v_env1[90];
    float fcdr_tb19h_env1[90];
    float fcdr_tb22v_env1[90];
    float lat_env2[90];
    float lon_env2[90];
    float eia_env2[90];
    signed char quality_env2[90];
    float fcdr_tb37v_env2[90];
    float fcdr_tb37h_env2[90];
    float sun_glint_img1[180];
    float sun_glint_env1[90];
    float sun_glint_img2[180];
    float sun_glint_env2[90];
    float sc_azimuth_img[180];
    float sc_azimuth_env[90];
    float sun_zenith_img[180];
    float sun_zenith_env[90];
    float sun_azimuth_img[180];
    float sun_azimuth_env[90];
} LSSMISBASE_S1;

#endif

#ifndef _LSSMISBASE_BASEHEADER_
#define _LSSMISBASE_BASEHEADER_

typedef struct {
    int spacecraft_id[1];
    int ascend_time[6];
    double TLE_xtime[1];
    int TLE_date[6];
    double TLE_time[1];
    int status_flags1[1];
    int status_flags2[1];
```

```
    int quality_tests[6];
    float nominal_elevation_angle[1];
    float spacecraft_roll[1];
    float spacecraft_pitch[1];
    float spacecraft_yaw[1];
    float delta_elevation_angle[6];
    float sensor_roll[6];
    float sensor_pitch[6];
    float sensor_yaw[6];
} LSSMISBASE_BASEHEADER;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /LSSMISBASE_S1/
    RECORD /SCANTIME/ ScanTime
    BYTE isMissing
    INTEGER*4 scan_time(7)
    REAL*8 orbit
    REAL*8 xtime
    REAL*8 scposx_gci(2)
    REAL*8 scposy_gci(2)
    REAL*8 scposz_gci(2)
    REAL*8 scvelx_gci(2)
    REAL*8 scvely_gci(2)
    REAL*8 scvelz_gci(2)
    INTEGER*4 scjulday_orig(3)
    REAL*4 sctime_orig(3)
```

```
REAL*4 sclat_orig(3)
REAL*4 sclon_orig(3)
REAL*4 scalt_orig(3)
BYTE surface_tag_img(180)
BYTE rain_flag_img(180)
REAL*4 lat_img1_orig(180)
REAL*4 lon_img1_orig(180)
REAL*4 ta150h_img1(180)
REAL*4 ta183_1h_img1(180)
REAL*4 ta183_3h_img1(180)
REAL*4 ta183_7h_img1(180)
REAL*4 lat_img2_orig(180)
REAL*4 lon_img2_orig(180)
REAL*4 ta91v_img2(180)
REAL*4 ta91h_img2(180)
BYTE surface_tag_env(90)
REAL*4 lat_env1_orig(90)
REAL*4 lon_env1_orig(90)
REAL*4 ta19v_env1(90)
REAL*4 ta19h_env1(90)
REAL*4 ta22v_env1(90)
REAL*4 lat_env2_orig(90)
REAL*4 lon_env2_orig(90)
REAL*4 ta37v_env2(90)
REAL*4 ta37h_env2(90)
INTEGER*2 aux_warmcal(24)
INTEGER*2 aux_coldcal(24)
REAL*4 aux_warmloadtemp(3)
INTEGER*2 aux_MUXsubID
REAL*4 aux_MUXhouse(4)
REAL*4 aux_lat_kband(28)
REAL*4 aux_lon_kband(28)
REAL*4 aux_eia_kband(28)
REAL*4 aux_azimuth_kband(28)
REAL*4 aux_lat_uvband(28)
REAL*4 aux_lon_uvband(28)
REAL*4 aux_eia_uvband(28)
REAL*4 aux_azimuth_uvband(28)
REAL*4 aux_lat_wband(28)
REAL*4 aux_lon_wband(28)
REAL*4 aux_eia_wband(28)
REAL*4 aux_azimuth_wband(28)
REAL*4 aux_lat_gband(28)
```

```
REAL*4 aux_lon_gband(28)
REAL*4 aux_eia_gband(28)
REAL*4 aux_azimuth_gband(28)
REAL*4 aux_lat_lvband(28)
REAL*4 aux_lon_lvband(28)
REAL*4 aux_eia_lvband(28)
REAL*4 aux_azimuth_lvband(28)
REAL*4 aux_lat_kaband(28)
REAL*4 aux_lon_kaband(28)
REAL*4 aux_eia_kaband(28)
REAL*4 aux_azimuth_kaband(28)
REAL*4 spacecraft_lat
REAL*4 spacecraft_lon
REAL*4 spacecraft_alt
REAL*4 sun_vector(3)
REAL*4 sun_elevation_angle
REAL*4 sun_azimuth_angle
REAL*4 solar_beta_angle
REAL*4 time_since_eclipse
BYTE eclipse_status
REAL*4 phase_orbit_midnight
REAL*4 sun_earth_separation
REAL*4 phase_eclipse_exit
REAL*4 earth_angle_radius
REAL*4 temp_arm
REAL*4 temp_reflector
REAL*4 original_gain(24)
REAL*4 corrected_gain(24)
REAL*4 delta_gain(24)
REAL*4 lat_img1(180)
REAL*4 lon_img1(180)
REAL*4 eia_img1(180)
BYTE quality_img1(180)
REAL*4 tb150h_img1(180)
REAL*4 tb183_1h_img1(180)
REAL*4 tb183_3h_img1(180)
REAL*4 tb183_7h_img1(180)
REAL*4 lat_img2(180)
REAL*4 lon_img2(180)
REAL*4 eia_img2(180)
BYTE quality_img2(180)
REAL*4 fcdr_tb91v_img2(180)
REAL*4 fcdr_tb91h_img2(180)
```

```
    REAL*4 lat_env1(90)
    REAL*4 lon_env1(90)
    REAL*4 eia_env1(90)
    BYTE quality_env1(90)
    REAL*4 fcdr_tb19v_env1(90)
    REAL*4 fcdr_tb19h_env1(90)
    REAL*4 fcdr_tb22v_env1(90)
    REAL*4 lat_env2(90)
    REAL*4 lon_env2(90)
    REAL*4 eia_env2(90)
    BYTE quality_env2(90)
    REAL*4 fcdr_tb37v_env2(90)
    REAL*4 fcdr_tb37h_env2(90)
    REAL*4 sun_glint_img1(180)
    REAL*4 sun_glint_env1(90)
    REAL*4 sun_glint_img2(180)
    REAL*4 sun_glint_env2(90)
    REAL*4 sc_azimuth_img(180)
    REAL*4 sc_azimuth_env(90)
    REAL*4 sun_zenith_img(180)
    REAL*4 sun_zenith_env(90)
    REAL*4 sun_azimuth_img(180)
    REAL*4 sun_azimuth_env(90)
END STRUCTURE

STRUCTURE /LSSMISBASE_BASEHEADER/
    INTEGER*4 spacecraft_id(1)
    INTEGER*4 ascend_time(6)
    REAL*8 TLE_xtime(1)
    INTEGER*4 TLE_date(6)
    REAL*8 TLE_time(1)
    INTEGER*4 status_flags1(1)
    INTEGER*4 status_flags2(1)
    INTEGER*4 quality_tests(6)
    REAL*4 nominal_elevation_angle(1)
    REAL*4 spacecraft_roll(1)
    REAL*4 spacecraft_pitch(1)
    REAL*4 spacecraft_yaw(1)
    REAL*4 delta_elevation_angle(6)
    REAL*4 sensor_roll(6)
    REAL*4 sensor_pitch(6)
    REAL*4 sensor_yaw(6)
END STRUCTURE
```

5.6 AMSR2BASE - AMSR2 base

AMSR2BASE contains antenna temperature. AMSR2BASE is written as one swath, but the 1C product will have 6 swaths. More detailed information on some variables may be found in the document

```
Global Change Observation Mission Water (GCOM-W1)
AMSR2 Level 1 Product Format Specification
written by JAXA
```

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel1	243	Number pixels for low res.
npixel2	486	Number pixels for high res.
count1	16	Number of (hot or cold) load for 6GHz to 36GHz.
count2	32	Number of (hot or cold) load for 89GHz.
freq1	12	Number of freq. for 6GHz to 36GHz.
freq2	4	Number of freq. for 89GHz.

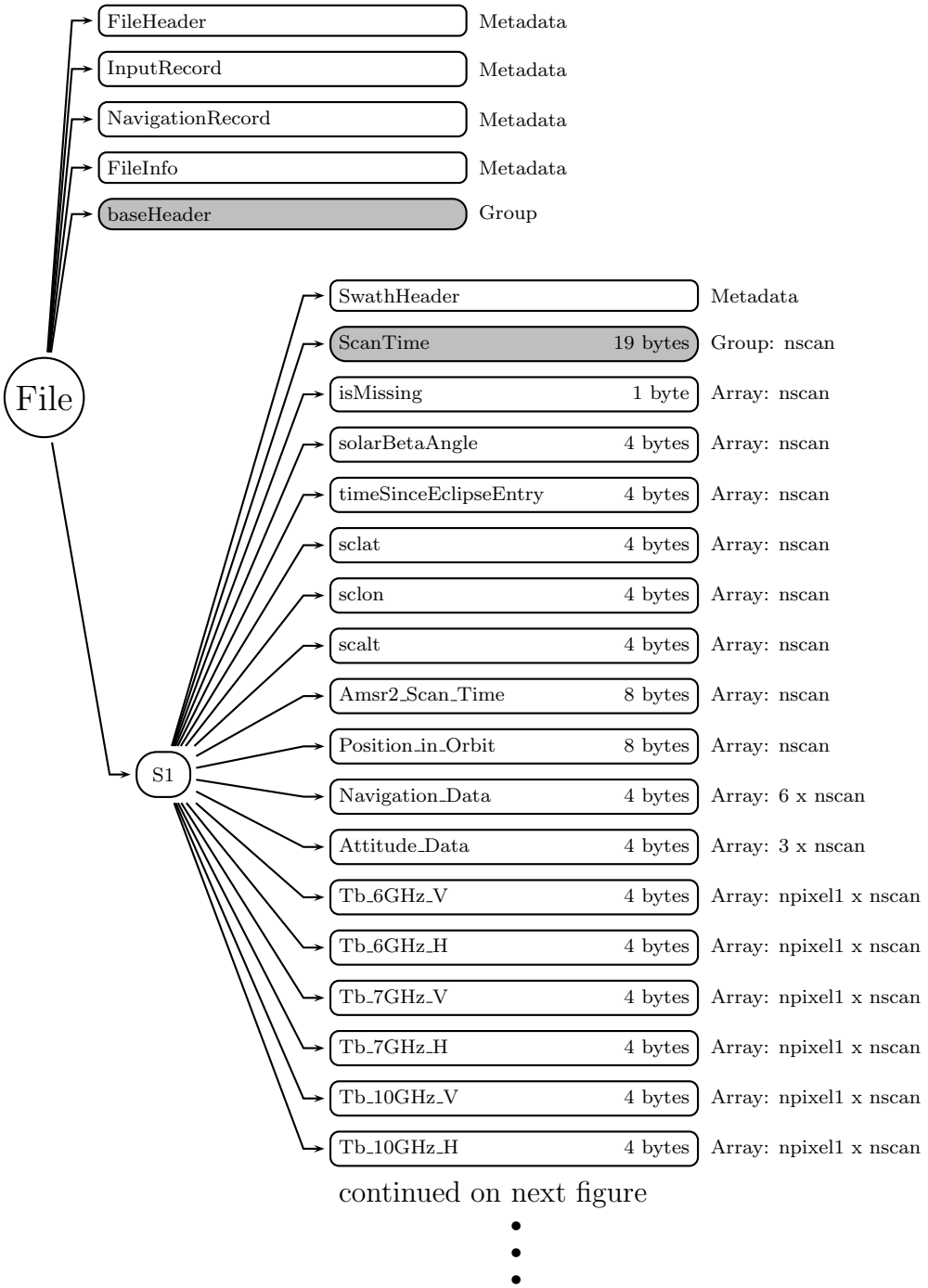
Figure 109 through Figure 114 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains metadata of general interest. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.



continued on next figure

Figure 109: Data Format Structure for AMSR2BASE, AMSR2 base

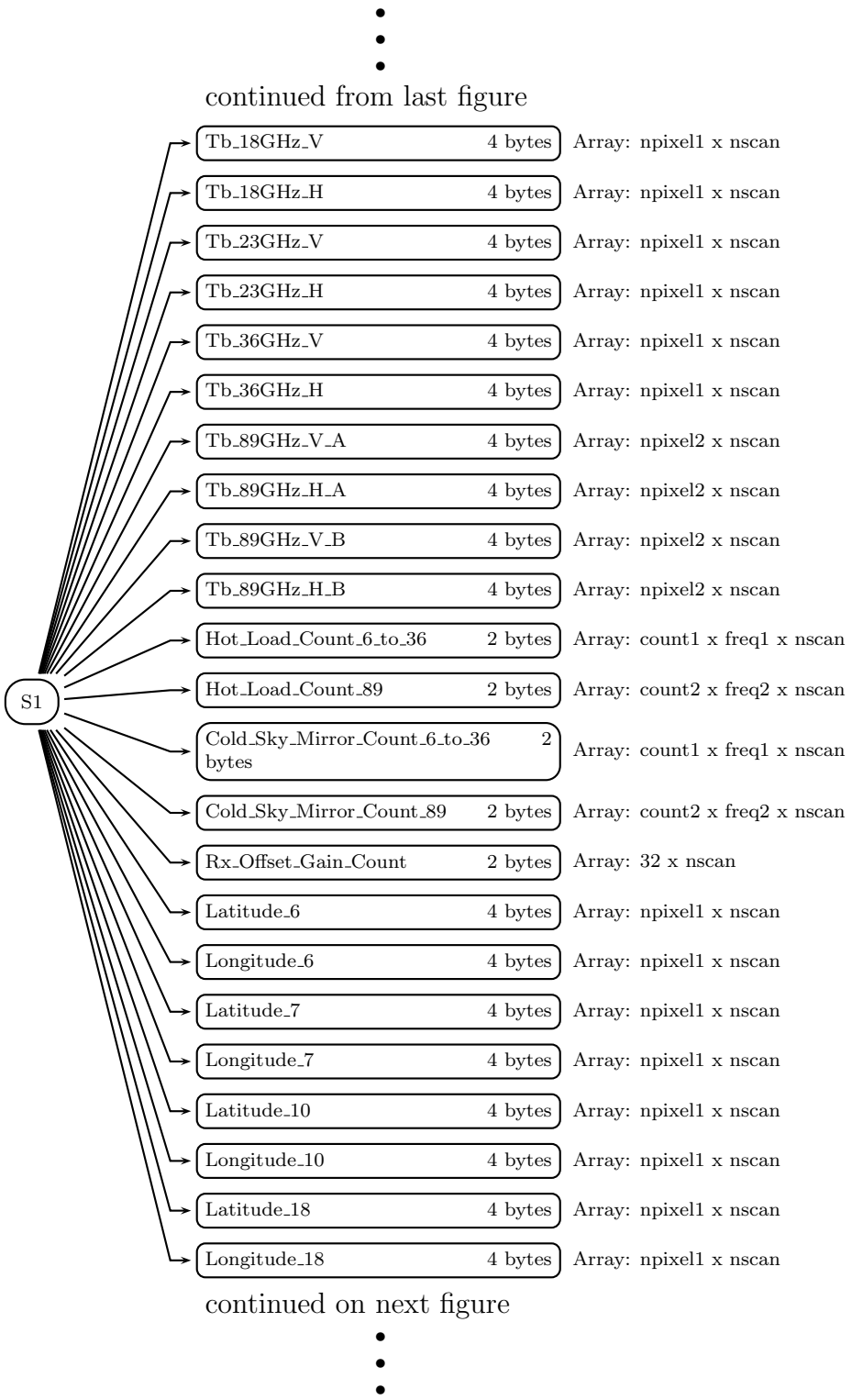


Figure 110: Data Format Structure for AMSR2BASE, AMSR2 base

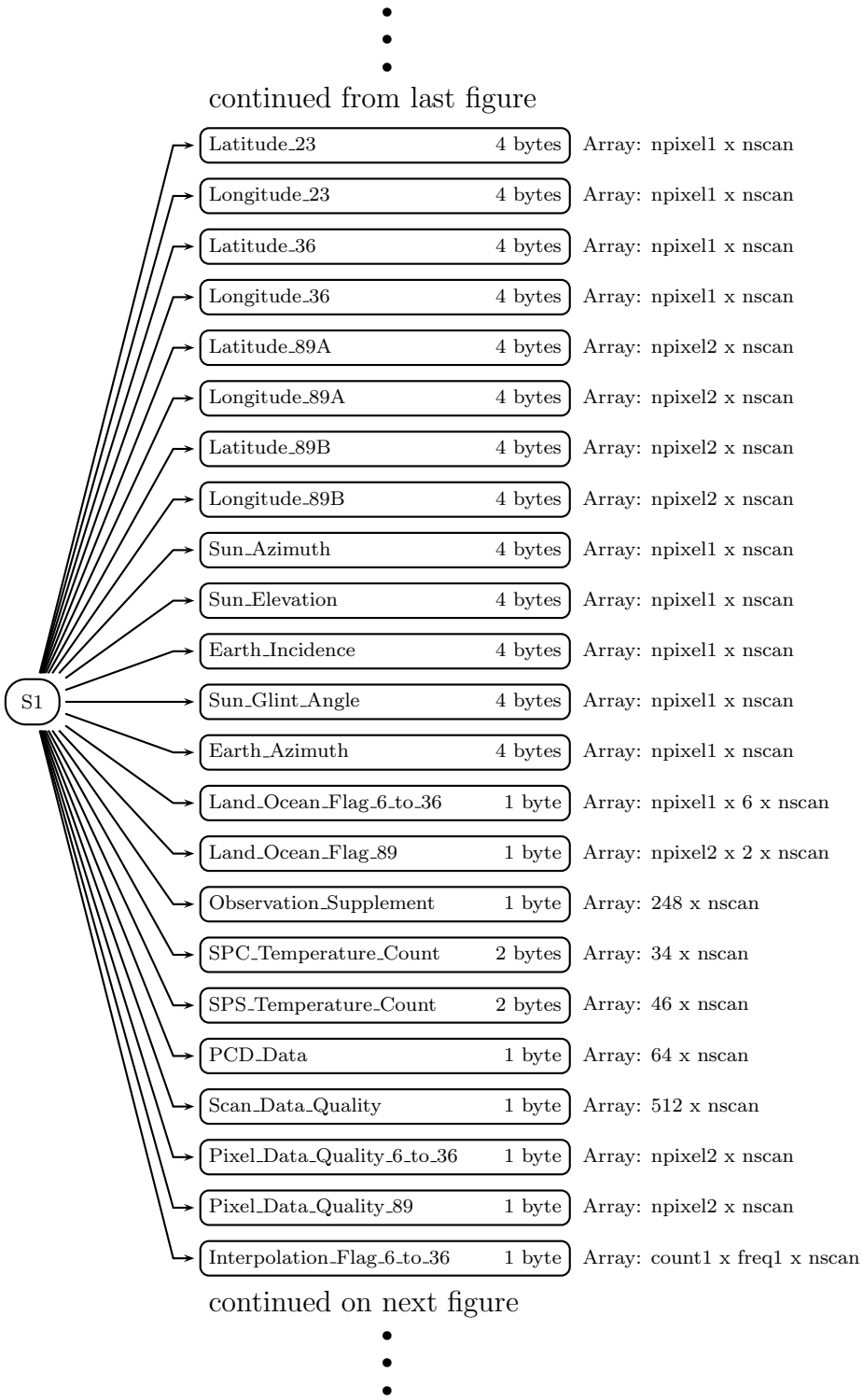


Figure 111: Data Format Structure for AMSR2BASE, AMSR2 base

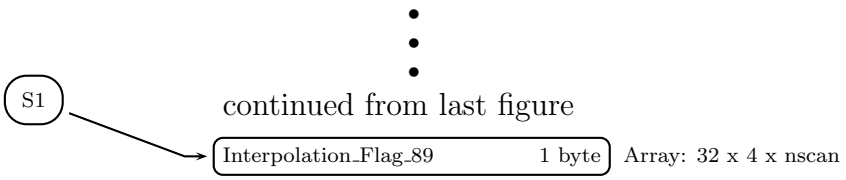


Figure 112: Data Format Structure for AMSR2BASE, AMSR2 base

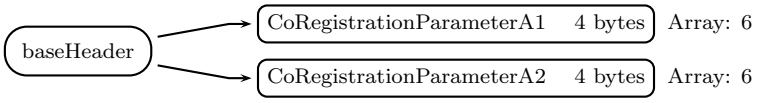


Figure 113: Data Format Structure for AMSR2BASE, baseHeader

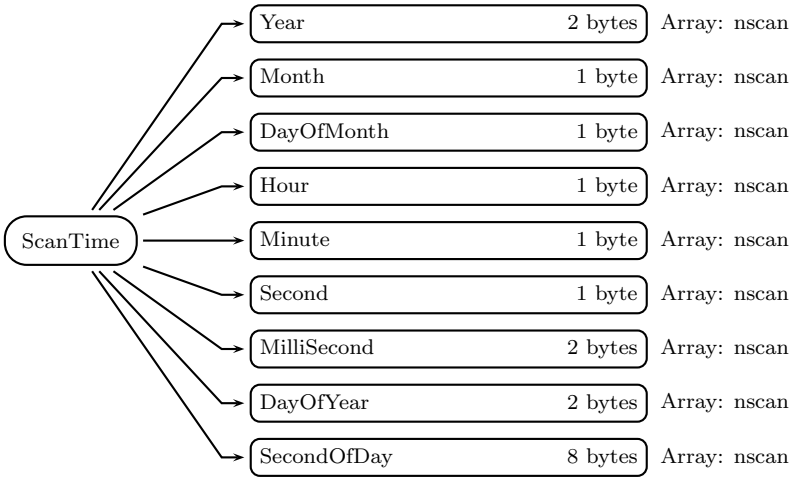


Figure 114: Data Format Structure for AMSR2BASE, ScanTime

baseHeader (Group)

CoRegistrationParameterA1 (4-byte float, array size: 6):
Co-registration parameter A1.

CoRegistrationParameterA2 (4-byte float, array size: 6):
Co-registration parameter A2.

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

isMissing (1-byte integer, array size: nscan):
Missing scan flag.

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -59.0 to 59.0 degrees. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow.

sclat (4-byte float, array size: nscan):
Spacecraft latitude. Values range from -90 to 90.0 degree. Special values are defined as:
-9999.9 Missing value

sclon (4-byte float, array size: nscan):
Spacecraft longitude. Values range from -180 to 180.0 degree. Special values are defined as:
-9999.9 Missing value

scalt (4-byte float, array size: nscan):
Spacecraft altitude. Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

Amsr2_Scan_Time (8-byte float, array size: nscan):
Total second (TAI) from 00:00 (UT) on January 1st, 1993.

Position_in_Orbit (8-byte float, array size: nscan):
fractional orbit number.

Navigation_Data (4-byte float, array size: 6 x nscan):
Satellite position and velocity.

Attitude_Data (4-byte float, array size: 3 x nscan):
Roll, Pitch and Yaw.

Tb_6GHz_V (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_6GHz_H (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_7GHz_V (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_7GHz_H (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_10GHz_V (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_10GHz_H (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_18GHz_V (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_18GHz_H (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_23GHz_V (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_23GHz_H (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_36GHz_V (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_36GHz_H (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_89GHz_V_A (4-byte float, array size: npixel2 x nscan):
Brightness temperature.

Tb_89GHz_H_A (4-byte float, array size: npixel2 x nscan):
Brightness temperature.

Tb_89GHz_V_B (4-byte float, array size: npixel2 x nscan):
Brightness temperature.

Tb_89GHz_H_B (4-byte float, array size: npixel2 x nscan):
Brightness temperature.

Hot_Load_Count_6_to_36 (2-byte integer, array size: count1 x freq1 x nscan):
The observed count of HTS and polarization.

Hot_Load_Count_89 (2-byte integer, array size: count2 x freq2 x nscan):
The observed count of HTS and polarization.

Cold_Sky_Mirror_Count_6_to_36 (2-byte integer, array size: count1 x freq1 x nscan):
The observed count of CSM and polarization.

Cold_Sky_Mirror_Count_89 (2-byte integer, array size: count2 x freq2 x nscan):
The observed count of CSM and polarization.

Rx_Offset_Gain_Count (2-byte unsigned integer, array size: 32 x nscan):
The gain and offset values for receiver (RX).

Latitude_6 (4-byte float, array size: npixel1 x nscan):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 6 GHz coregistration parameters to the 89A GHz location.

Longitude_6 (4-byte float, array size: npixel1 x nscan):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 6 GHz coregistration parameters to the 89A GHz location.

Latitude_7 (4-byte float, array size: npixel1 x nscan):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 7 GHz coregistration parameters to the 89A GHz location.

Longitude_7 (4-byte float, array size: npixel1 x nscan):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 7 GHz coregistration parameters to the 89A GHz location.

Latitude_10 (4-byte float, array size: npixel1 x nscan):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 10 GHz coregistration parameters to the 89A GHz location.

Longitude_10 (4-byte float, array size: npixel1 x nscan):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 10 GHz coregistration parameters to the 89A GHz location.

Latitude_18 (4-byte float, array size: npixel1 x nscan):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 18 GHz coregistration parameters to the 89A GHz location.

Longitude_18 (4-byte float, array size: npixel1 x nscan):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 18 GHz coregistration parameters to the 89A GHz location.

Latitude_23 (4-byte float, array size: npixel1 x nscan):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Longitude_23 (4-byte float, array size: npixel1 x nscan):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Latitude_36 (4-byte float, array size: npixel1 x nscan):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 36 GHz coregistration parameters to the 89A GHz location.

Longitude_36 (4-byte float, array size: npixel1 x nscan):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 36 GHz coregistration parameters to the 89A GHz location.

Latitude_89A (4-byte float, array size: npixel2 x nscan):
Latitude of the observation point on the earth surface at 89GHz A-horn.

Longitude_89A (4-byte float, array size: npixel2 x nscan):
Longitude of the observation point on the earth surface at 89GHz A-horn.

Latitude_89B (4-byte float, array size: npixel2 x nscan):
Latitude of the observation point on the earth surface at 89GHz B-horn.

Longitude_89B (4-byte float, array size: npixel2 x nscan):
Longitude of the observation point on the earth surface at 89GHz B-horn.

Sun_Azimuth (4-byte float, array size: npixel1 x nscan):
The sun azimuth angle on odd observation points (origin 1) of 89 GHz A-horn.

Sun_Elevation (4-byte float, array size: npixel1 x nscan):
The sun elevation angle on odd observation points (origin 1) of 89 GHz A-horn.

Earth_Incidence (4-byte float, array size: npixel1 x nscan):
The earth incidence angle on odd observation points (origin 1) of 89 GHz A-horn.

Sun_Glint_Angle (4-byte float, array size: npixel1 x nscan):
Sun glint angle calculated for 89A odd numbered pixels.

Earth_Azimuth (4-byte float, array size: npixel1 x nscan):
The earth azimuth angle on odd observation points (origin 1) of 89 GHz A-horn.

Land_Ocean_Flag_6_to_36 (1-byte char, array size: npixel1 x 6 x nscan):
The land coverage percentage of the observation footprint.

Land_Ocean_Flag_89 (1-byte char, array size: npixel2 x 2 x nscan):
The land coverage percentage of the observation footprint.

Observation_Supplement (1-byte char, array size: 248 x nscan):
Observation supplement raw data such as a H/W state.

SPC_Temperature_Count (2-byte unsigned integer, array size: 34 x nscan):
The temperature of SPC.

SPS_Temperature_Count (2-byte unsigned integer, array size: 46 x nscan):
The temperature of SPS.

PCD_Data (1-byte char, array size: 64 x nscan):
The PCD (Payload Correction Data) data ID. If the scan is missing, 1 is stored in all bits.

Scan_Data_Quality (1-byte char, array size: 512 x nscan):
Array of scan data quality information and supplementary information flags. These correspond to observation data and calculation result in each scan. See AMSR2 Level 1 Product Format Specification for details.

Pixel_Data_Quality_6_to_36 (1-byte char, array size: npixel2 x nscan):
Pixel quality bit flags for frequencies 6 GHz to 36GHz. See AMSR2 Level 1 Product Format Specification for details.

Pixel_Data_Quality_89 (1-byte char, array size: npixel2 x nscan):
Pixel quality bit flags for frequency 89GHz. See AMSR2 Level 1 Product Format Specification for details.

Interpolation_Flag_6_to_36 (1-byte char, array size: count1 x freq1 x nscan):
The interpolation flag for CSM data.

Interpolation_Flag_89 (1-byte char, array size: 32 x 4 x nscan):
The interpolation flag for CSM data.

C Structure Header file:

```
#ifndef _TK_AMSR2BASE_H_
#define _TK_AMSR2BASE_H_

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _LAMSR2BASE_S1_
#define _LAMSR2BASE_S1_

typedef struct {
    SCANTIME ScanTime;
    signed char isMissing;
    float solarBetaAngle;
    float timeSinceEclipseEntry;
    float sclat;
    float sclon;
    float scalt;
    double Amsr2_Scan_Time;
    double Position_in_Orbit;
    float Navigation_Data[6];
    float Attitude_Data[3];
    float Tb_6GHz_V[243];
```

```
float Tb_6GHz_H[243];
float Tb_7GHz_V[243];
float Tb_7GHz_H[243];
float Tb_10GHz_V[243];
float Tb_10GHz_H[243];
float Tb_18GHz_V[243];
float Tb_18GHz_H[243];
float Tb_23GHz_V[243];
float Tb_23GHz_H[243];
float Tb_36GHz_V[243];
float Tb_36GHz_H[243];
float Tb_89GHz_V_A[486];
float Tb_89GHz_H_A[486];
float Tb_89GHz_V_B[486];
float Tb_89GHz_H_B[486];
short Hot_Load_Count_6_to_36[12][16];
short Hot_Load_Count_89[4][32];
short Cold_Sky_Mirror_Count_6_to_36[12][16];
short Cold_Sky_Mirror_Count_89[4][32];
unsigned short Rx_Offset_Gain_Count[32];
float Latitude_6[243];
float Longitude_6[243];
float Latitude_7[243];
float Longitude_7[243];
float Latitude_10[243];
float Longitude_10[243];
float Latitude_18[243];
float Longitude_18[243];
float Latitude_23[243];
float Longitude_23[243];
float Latitude_36[243];
float Longitude_36[243];
float Latitude_89A[486];
float Longitude_89A[486];
float Latitude_89B[486];
float Longitude_89B[486];
float Sun_Azimuth[243];
float Sun_Elevation[243];
float Earth_Incidence[243];
float Sun_Glint_Angle[243];
float Earth_Azimuth[243];
unsigned char Land_Ocean_Flag_6_to_36[6][243];
unsigned char Land_Ocean_Flag_89[2][486];
```

```
    unsigned char Observation_Supplement[248];
    unsigned short SPC_Temperature_Count[34];
    unsigned short SPS_Temperature_Count[46];
    unsigned char PCD_Data[64];
    unsigned char Scan_Data_Quality[512];
    unsigned char Pixel_Data_Quality_6_to_36[486];
    unsigned char Pixel_Data_Quality_89[486];
    unsigned char Interpolation_Flag_6_to_36[12][16];
    unsigned char Interpolation_Flag_89[4][32];
} LAMSR2BASE_S1;

#endif

#ifndef _LAMSR2BASE_BASEHEADER_
#define _LAMSR2BASE_BASEHEADER_

typedef struct {
    float CoRegistrationParameterA1[6];
    float CoRegistrationParameterA2[6];
} LAMSR2BASE_BASEHEADER;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /LAMSR2BASE_S1/
    RECORD /SCANTIME/ ScanTime
    BYTE isMissing
    REAL*4 solarBetaAngle
```

```
REAL*4 timeSinceEclipseEntry
REAL*4 sclat
REAL*4 sclon
REAL*4 scalt
REAL*8 Amsr2_Scan_Time
REAL*8 Position_in_Orbit
REAL*4 Navigation_Data(6)
REAL*4 Attitude_Data(3)
REAL*4 Tb_6GHz_V(243)
REAL*4 Tb_6GHz_H(243)
REAL*4 Tb_7GHz_V(243)
REAL*4 Tb_7GHz_H(243)
REAL*4 Tb_10GHz_V(243)
REAL*4 Tb_10GHz_H(243)
REAL*4 Tb_18GHz_V(243)
REAL*4 Tb_18GHz_H(243)
REAL*4 Tb_23GHz_V(243)
REAL*4 Tb_23GHz_H(243)
REAL*4 Tb_36GHz_V(243)
REAL*4 Tb_36GHz_H(243)
REAL*4 Tb_89GHz_V_A(486)
REAL*4 Tb_89GHz_H_A(486)
REAL*4 Tb_89GHz_V_B(486)
REAL*4 Tb_89GHz_H_B(486)
INTEGER*2 Hot_Load_Count_6_to_36(16,12)
INTEGER*2 Hot_Load_Count_89(32,4)
INTEGER*2 Cold_Sky_Mirror_Count_6_to_36(16,12)
INTEGER*2 Cold_Sky_Mirror_Count_89(32,4)
INTEGER*2 Rx_Offset_Gain_Count(32)
REAL*4 Latitude_6(243)
REAL*4 Longitude_6(243)
REAL*4 Latitude_7(243)
REAL*4 Longitude_7(243)
REAL*4 Latitude_10(243)
REAL*4 Longitude_10(243)
REAL*4 Latitude_18(243)
REAL*4 Longitude_18(243)
REAL*4 Latitude_23(243)
REAL*4 Longitude_23(243)
REAL*4 Latitude_36(243)
REAL*4 Longitude_36(243)
REAL*4 Latitude_89A(486)
REAL*4 Longitude_89A(486)
```

```
    REAL*4 Latitude_89B(486)
    REAL*4 Longitude_89B(486)
    REAL*4 Sun_Azimuth(243)
    REAL*4 Sun_Elevation(243)
    REAL*4 Earth_Incidence(243)
    REAL*4 Sun_Glint_Angle(243)
    REAL*4 Earth_Azimuth(243)
    CHARACTER Land_Ocean_Flag_6_to_36(243,6)
    CHARACTER Land_Ocean_Flag_89(486,2)
    CHARACTER Observation_Supplement(248)
    INTEGER*2 SPC_Temperature_Count(34)
    INTEGER*2 SPS_Temperature_Count(46)
    CHARACTER PCD_Data(64)
    CHARACTER Scan_Data_Quality(512)
    CHARACTER Pixel_Data_Quality_6_to_36(486)
    CHARACTER Pixel_Data_Quality_89(486)
    CHARACTER Interpolation_Flag_6_to_36(16,12)
    CHARACTER Interpolation_Flag_89(32,4)
END STRUCTURE

STRUCTURE /LAMSR2BASE_BASEHEADER/
    REAL*4 CoRegistrationParameterA1(6)
    REAL*4 CoRegistrationParameterA2(6)
END STRUCTURE
```

5.7 MHSBASE - MHS base

MHSBASE contains antenna temperature from the MHS passive microwave instrument flown on the NOAA and METOPS satellites. Swath S1 is the only swath. Swath S1 contains 5 channels: 89.0GHzV, 157.0GHzV, 183.3GHz+/-250MHzH, 183.3GHz+/-500MHzH, 190.3 GHzV. MHS is very similar to AMSU-B. The scan period is 2.667s. The granule size is one half orbit. The input is Level-2 MHS Orbital products in HDF-EOS format archived at CLASS. All of the data of the input are included. See the Microwave Surface and Precipitation Products System (MSPPS) Users' Manual, which discussed AMSU-B. AMSU-B is the same format as MHS.

Dimension definitions:

nscan1	var	Number of Swath 1 scans in the granule.
nchannel1	5	Number of Swath 1 channels.
n270	270	Number of 270.
npixel1	90	Number of Swath 1 pixels in one scan.
nchUIA1	1	Number of Swath S1 unique incidence angles.
three	3	Number of spacial dimensions.

Figure 115 through Figure 118 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains metadata of general interest. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

baseHeader (Group)

TLE_date (4-byte integer, array size: 6):
TLE date time arrays.

TLE_time (8-byte float, array size: 1):
TLE time as in two line element.

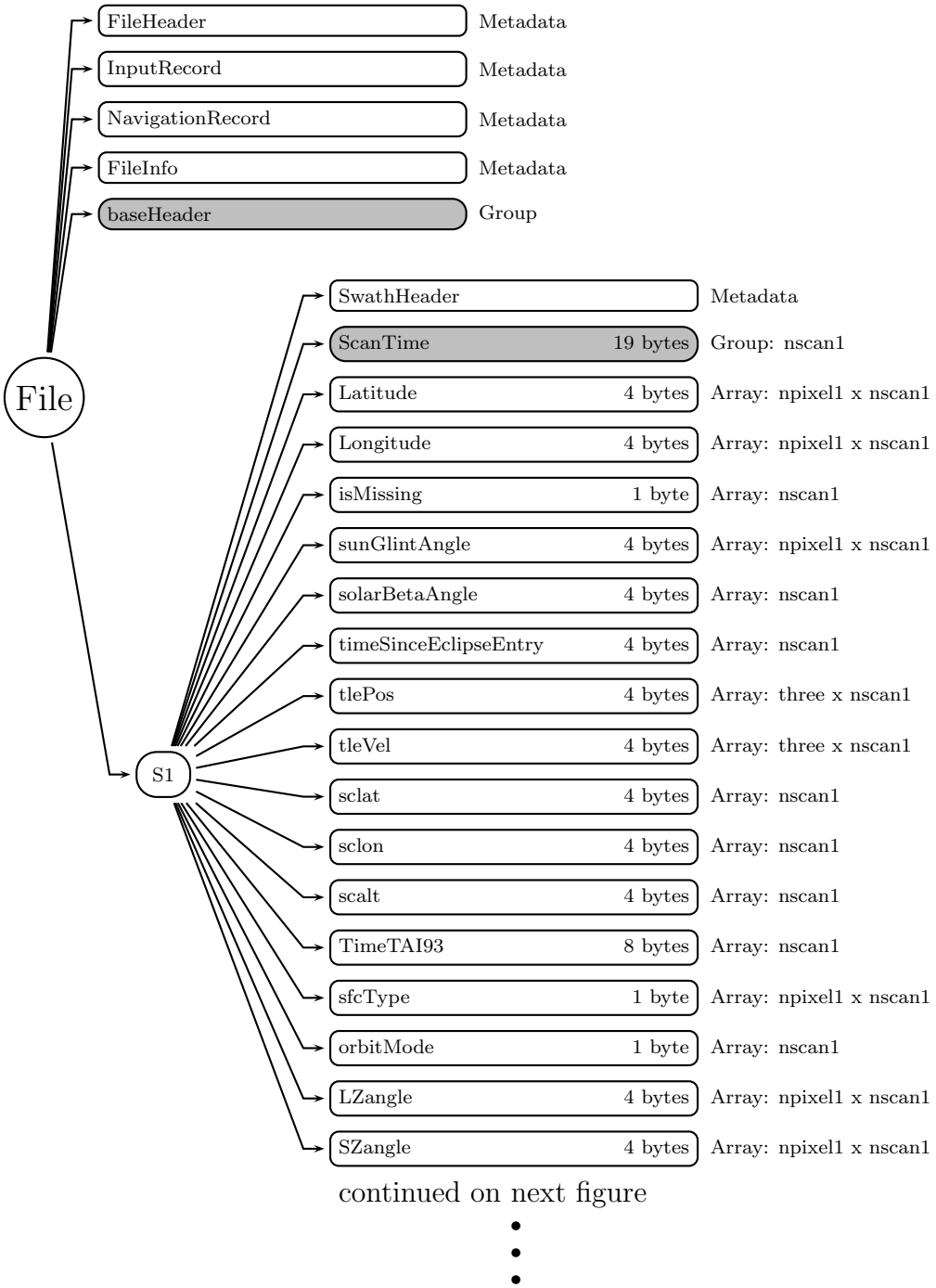
accf (8-byte float, array size: nchannel1 x n270):
The correction due to angular dependence of reflectivity.

Bspace (8-byte float, array size: nchannel1):
The channel offset derived from deep space calibration.

waveNumber (4-byte float, array size: nchannel1):
Wave number.

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.



continued on next figure

Figure 115: Data Format Structure for MHSBASE, MHS base

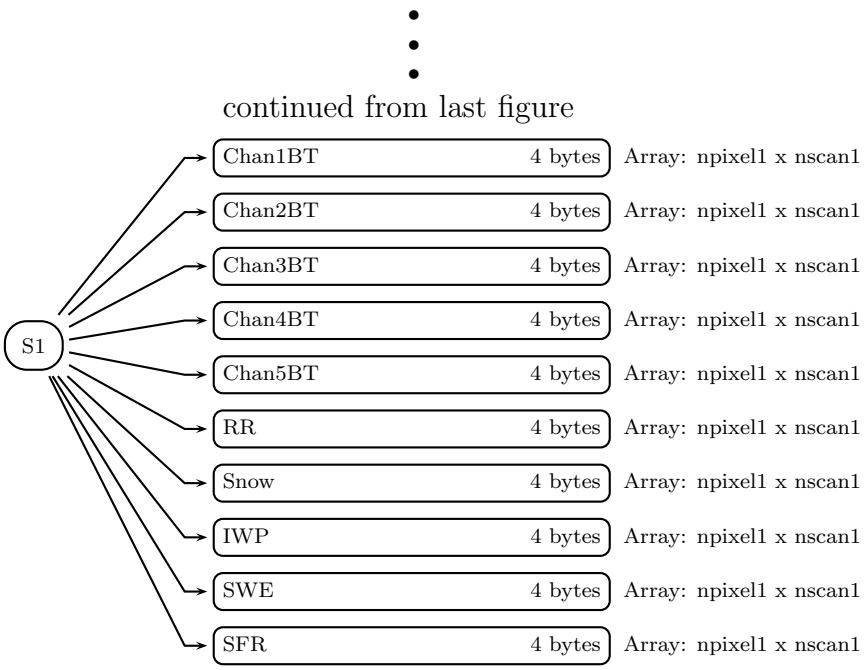


Figure 116: Data Format Structure for MHSBASE, MHS base

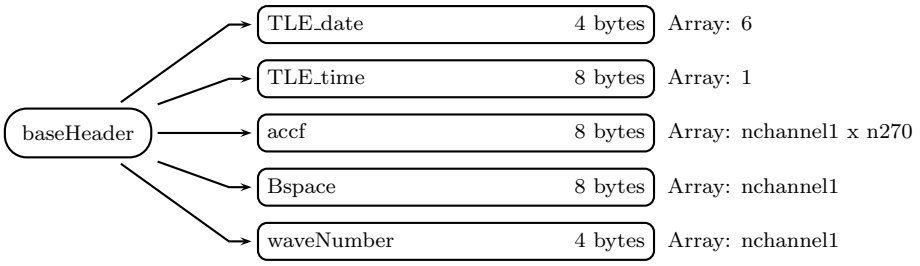


Figure 117: Data Format Structure for MHSBASE, baseHeader

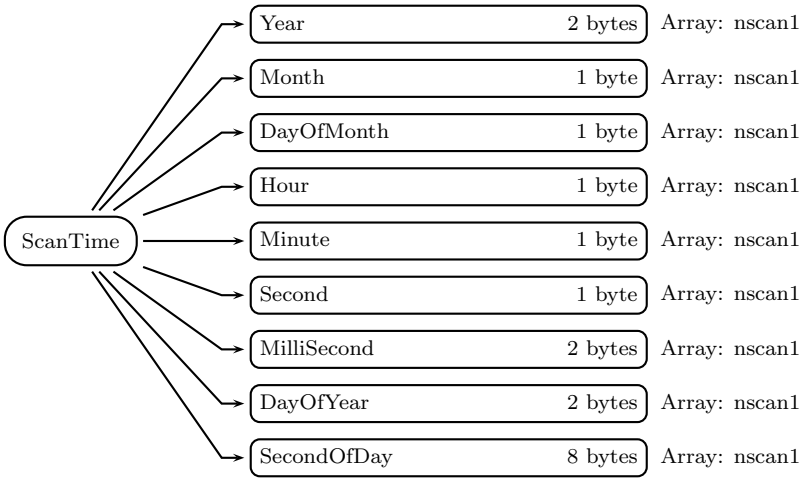


Figure 118: Data Format Structure for MHSBASE, ScanTime

ScanTime (Group)
A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel1 x nscan1):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel1 x nscan1):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod.

Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

isMissing (1-byte integer, array size: nscan1):
Missing scan flag.

sunGlintAngle (4-byte float, array size: npixel1 x nscan1):
Unpacked sun glint angle. Not sure about the range.

solarBetaAngle (4-byte float, array size: nscan1):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -59.0 to 59.0 degrees. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan1):
The estimated duration in seconds since the last entry into the Earth's shadow.

tlePos (4-byte float, array size: three x nscan1):
TLE satellite position. Values are in m. Special values are defined as:
-9999.9 Missing value

tleVel (4-byte float, array size: three x nscan1):
TLE satellite velocity. Values are in m/s. Special values are defined as:
-9999.9 Missing value

sclat (4-byte float, array size: nscan1):
Spacecraft latitude. Values range from -90 to 90.0 degree. Special values are defined as:
-9999.9 Missing value

sclon (4-byte float, array size: nscan1):
Spacecraft longitude. Values range from -180 to 180.0 degree. Special values are defined as:
-9999.9 Missing value

scalt (4-byte float, array size: nscan1):
Spacecraft altitude. Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

TimeTAI93 (8-byte float, array size: nscan1):
Number of seconds since 0000 Jan 1, 1993.

sfcType (1-byte integer, array size: npixel1 x nscan1):
Surface type: 0=ocean, 1=land, 2=coast

orbitMode (1-byte integer, array size: nscan1):
Orbit direction: 1=ascending 2=descending.

LZangle (4-byte float, array size: npixel1 x nscan1):
Local zenith angle. Not sure about the range and units.

SZangle (4-byte float, array size: npixel1 x nscan1):
Solar zenith angle. Not sure about the range and units.

Chan1BT (4-byte float, array size: npixel1 x nscan1):
Channel 1 Antenna Temperature.

Chan2BT (4-byte float, array size: npixel1 x nscan1):
Channel 1 Antenna Temperature.

Chan3BT (4-byte float, array size: npixel1 x nscan1):
Channel 1 Antenna Temperature.

Chan4BT (4-byte float, array size: npixel1 x nscan1):
Channel 1 Antenna Temperature.

Chan5BT (4-byte float, array size: npixel1 x nscan1):
Channel 1 Antenna Temperature.

RR (4-byte float, array size: npixel1 x nscan1):
Rain rate.

Snow (4-byte float, array size: npixel1 x nscan1):
Snow cover.

IWP (4-byte float, array size: npixel1 x nscan1):
Ice water path.

SWE (4-byte float, array size: npixel1 x nscan1):
Snow water equivalent.

SFR (4-byte float, array size: npixel1 x nscan1):
Snow fall rate.

C Structure Header file:

```
#ifndef _TK_MHSBASE_H_
#define _TK_MHSBASE_H_

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
```

```
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _LMHSBASE_S1_
#define _LMHSBASE_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[90];
    float Longitude[90];
    signed char isMissing;
    float sunGlintAngle[90];
    float solarBetaAngle;
    float timeSinceEclipseEntry;
    float tlePos[3];
    float tleVel[3];
    float sclat;
    float sclon;
    float scalt;
    double TimeTAI93;
    signed char sfcType[90];
    signed char orbitMode;
    float LZangle[90];
    float SZangle[90];
    float Chan1BT[90];
    float Chan2BT[90];
    float Chan3BT[90];
    float Chan4BT[90];
    float Chan5BT[90];
    float RR[90];
    float Snow[90];
    float IWP[90];
    float SWE[90];
    float SFR[90];
} LMHSBASE_S1;

#endif

#ifndef _LMHSBASE_BASEHEADER_
#define _LMHSBASE_BASEHEADER_
```

```
typedef struct {
    int TLE_date[6];
    double TLE_time[1];
    double accf[270][5];
    double Bspace[5];
    float waveNumber[5];
} LMHSBASE_BASEHEADER;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /LMHSBASE_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(90)
    REAL*4 Longitude(90)
    BYTE isMissing
    REAL*4 sunGlintAngle(90)
    REAL*4 solarBetaAngle
    REAL*4 timeSinceEclipseEntry
    REAL*4 tlePos(3)
    REAL*4 tleVel(3)
    REAL*4 sclat
    REAL*4 sclon
    REAL*4 scalt
    REAL*8 TimeTAI93
    BYTE sfcType(90)
    BYTE orbitMode
    REAL*4 LZangle(90)
```

```
    REAL*4 SZangle(90)
    REAL*4 Chan1BT(90)
    REAL*4 Chan2BT(90)
    REAL*4 Chan3BT(90)
    REAL*4 Chan4BT(90)
    REAL*4 Chan5BT(90)
    REAL*4 RR(90)
    REAL*4 Snow(90)
    REAL*4 IWP(90)
    REAL*4 SWE(90)
    REAL*4 SFR(90)
END STRUCTURE

STRUCTURE /LMHSBASE_BASEHEADER/
    INTEGER*4 TLE_date(6)
    REAL*8 TLE_time(1)
    REAL*8 accf(5,270)
    REAL*8 Bspace(5)
    REAL*4 waveNumber(5)
END STRUCTURE
```

5.8 SAPHIRBASE - SAPHIR base

SAPHIRBASE contains brightness temperature from the SAPHIR passive microwave instrument flown on the Megha-Tropiques satellite. The channels are 183.1 +/- delta GHz, where delta = 0.2, 1.1, 2.8, 4.2, 6.8, 11.0.

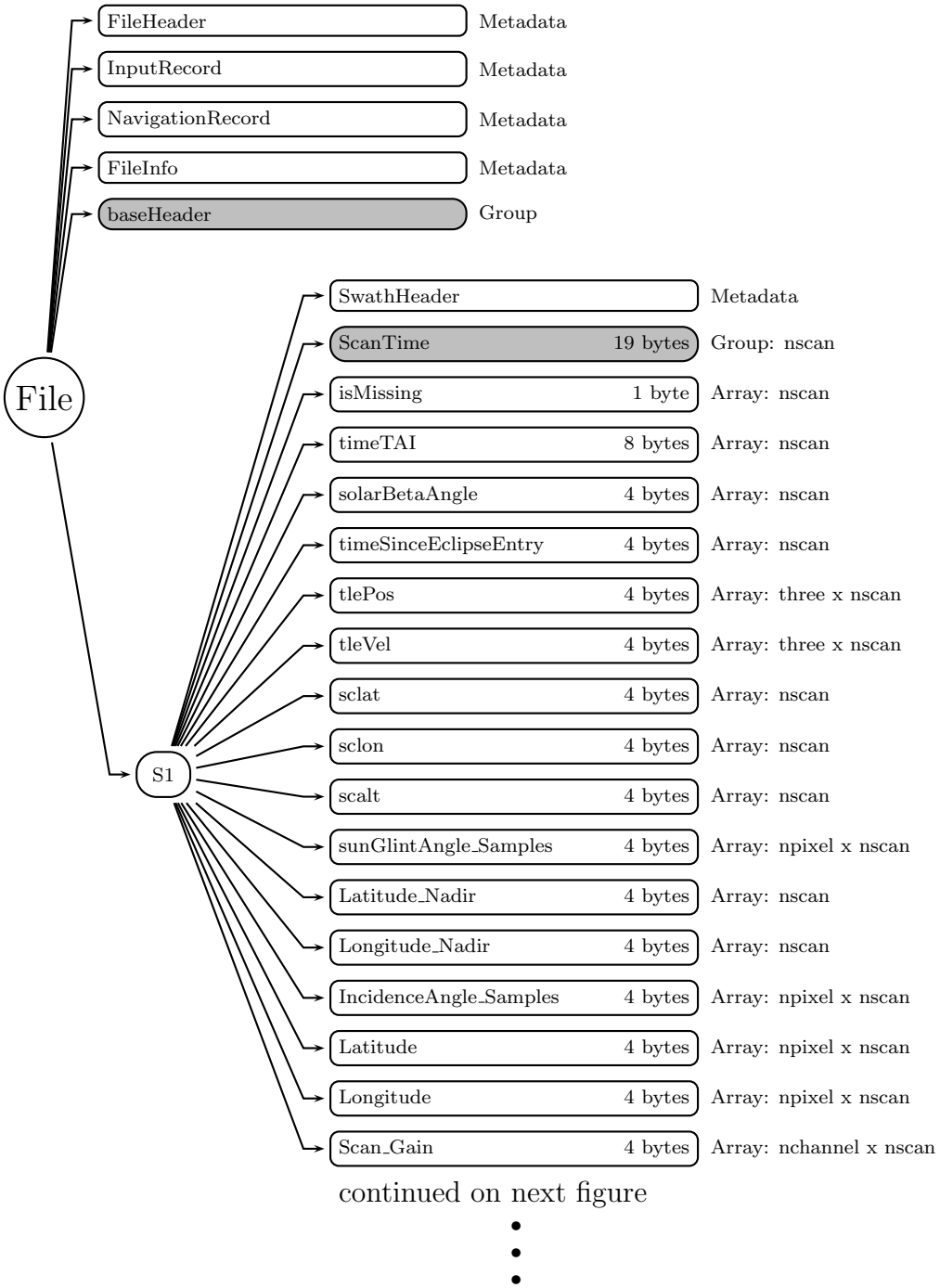
Dimension definitions:

nscan	var	Number of Swath 1 scans in the granule.
nchannel	6	Number of channels.
npixel	182	Number of pixels in one scan.
three	3	Number of vectors.

Figure 119 through Figure 122 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains metadata of general interest. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the



continued on next figure

Figure 119: Data Format Structure for SAPHIRBASE, SAPHIR base

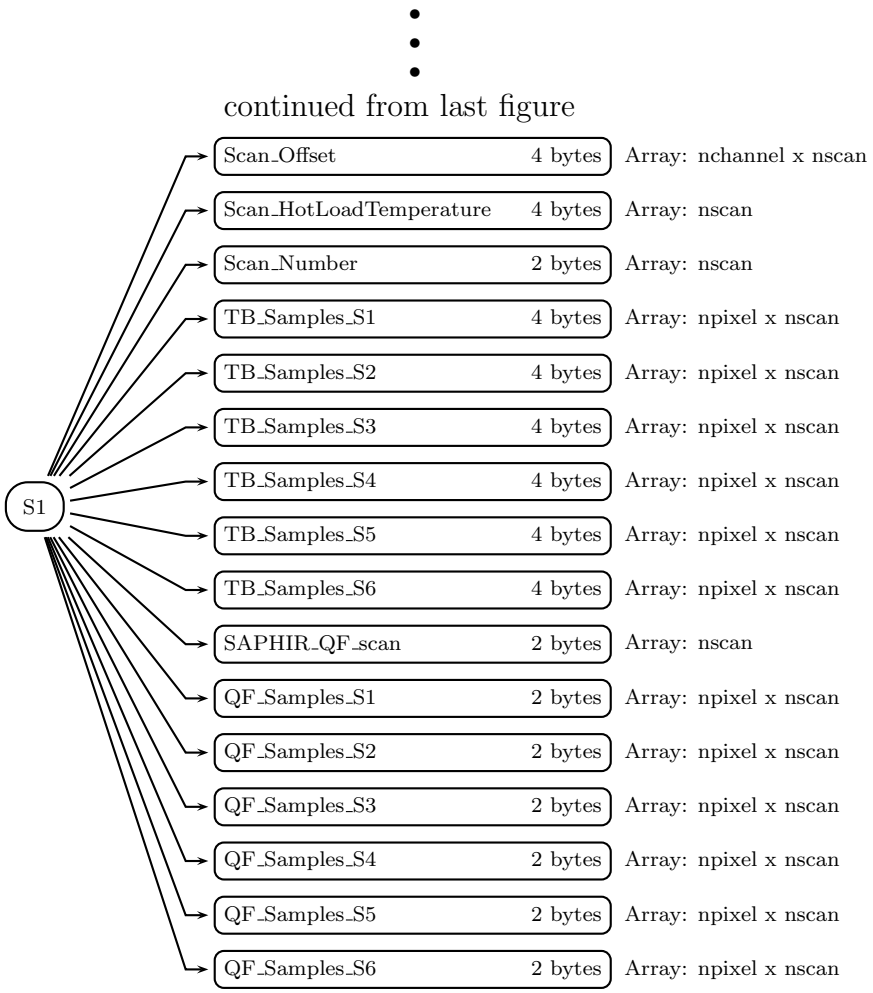


Figure 120: Data Format Structure for SAPHIRBASE, SAPHIR base

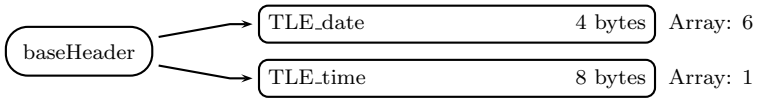


Figure 121: Data Format Structure for SAPHIRBASE, baseHeader

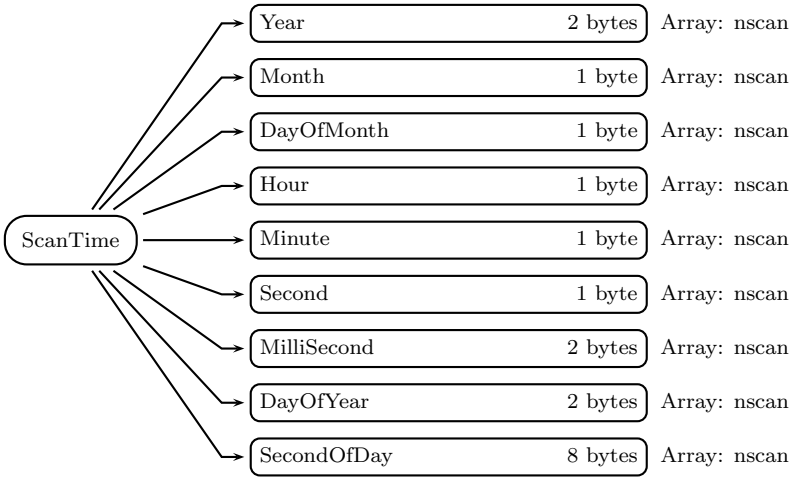


Figure 122: Data Format Structure for SAPHIRBASE, ScanTime

same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

baseHeader (Group)

TLE_date (4-byte integer, array size: 6):
TLE date time arrays.

TLE_time (8-byte float, array size: 1):
TLE time as in two line element.

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

isMissing (1-byte integer, array size: nscan):
Missing scan flag.

timeTAI (8-byte float, array size: nscan):
Number of seconds since epoch time.

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from

-59.0 to 59.0 degrees. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow.

tlePos (4-byte float, array size: three x nscan):
TLE satellite position. Values are in m. Special values are defined as:
-9999.9 Missing value

tleVel (4-byte float, array size: three x nscan):
TLE satellite velocity. Values are in m/s. Special values are defined as:
-9999.9 Missing value

sclat (4-byte float, array size: nscan):
Spacecraft latitude. Values range from -90 to 90.0 degree. Special values are defined as:
-9999.9 Missing value

sclon (4-byte float, array size: nscan):
Spacecraft longitude. Values range from -180 to 180.0 degree. Special values are defined as:
-9999.9 Missing value

scalt (4-byte float, array size: nscan):
Spacecraft altitude. Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

sunGlintAngle_Samples (4-byte float, array size: npixel x nscan):
sunGlint angle.

Latitude_Nadir (4-byte float, array size: nscan):
Spacecraft latitude. Values range from -90 to 90.0 degree. Special values are defined as:
-9999.9 Missing value

Longitude_Nadir (4-byte float, array size: nscan):
Spacecraft longitude. Values range from -180 to 180.0 degree. Special values are defined as:
-9999.9 Missing value

IncidenceAngle_Samples (4-byte float, array size: npixel x nscan):
Incidence angle.

Latitude (4-byte float, array size: npixel x nscan):
Latitude.

Longitude (4-byte float, array size: npixel x nscan):
Longitude.

Scan_Gain (4-byte float, array size: nchannel x nscan):
Gain.

Scan_Offset (4-byte float, array size: nchannel x nscan):
Gain.

Scan_HotLoadTemperature (4-byte float, array size: nscan):
HotLoadTemperature

Scan_Number (2-byte integer, array size: nscan):
Scan number.

TB_Samples_S1 (4-byte float, array size: npixel x nscan):
TB_Samples_S1.

TB_Samples_S2 (4-byte float, array size: npixel x nscan):
TB_Samples_S2.

TB_Samples_S3 (4-byte float, array size: npixel x nscan):
TB_Samples_S3.

TB_Samples_S4 (4-byte float, array size: npixel x nscan):
TB_Samples_S4.

TB_Samples_S5 (4-byte float, array size: npixel x nscan):
TB_Samples_S5.

TB_Samples_S6 (4-byte float, array size: npixel x nscan):
TB_Samples_S6.

SAPHIR_QF_scan (2-byte unsigned integer, array size: nscan):

QF_Samples_S1 (2-byte unsigned integer, array size: npixel x nscan):
QF_Samples

QF_Samples_S2 (2-byte unsigned integer, array size: npixel x nscan):
QF_Samples

QF_Samples_S3 (2-byte unsigned integer, array size: npixel x nscan):
QF_Samples

QF_Samples_S4 (2-byte unsigned integer, array size: npixel x nscan):
QF_Samples

QF_Samples_S5 (2-byte unsigned integer, array size: npixel x nscan):
QF_Samples

QF_Samples_S6 (2-byte unsigned integer, array size: npixel x nscan):
QF_Samples

C Structure Header file:

```
#ifndef _TK_SAPHIRBASE_H_
#define _TK_SAPHIRBASE_H_

#ifndef _SCANTIME_
#define _SCANTIME_
```

```
typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _LSAPHIRBASE_S1_
#define _LSAPHIRBASE_S1_

typedef struct {
    SCANTIME ScanTime;
    signed char isMissing;
    double timeTAI;
    float solarBetaAngle;
    float timeSinceEclipseEntry;
    float tlePos[3];
    float tleVel[3];
    float sclat;
    float sclon;
    float scalt;
    float sunGlintAngle_Samples[182];
    float Latitude_Nadir;
    float Longitude_Nadir;
    float IncidenceAngle_Samples[182];
    float Latitude[182];
    float Longitude[182];
    float Scan_Gain[6];
    float Scan_Offset[6];
    float Scan_HotLoadTemperature;
    short Scan_Number;
    float TB_Samples_S1[182];
    float TB_Samples_S2[182];
    float TB_Samples_S3[182];
    float TB_Samples_S4[182];
    float TB_Samples_S5[182];
```

```
    float TB_Samples_S6[182];
    unsigned short SAPHIR_QF_scan;
    unsigned short QF_Samples_S1[182];
    unsigned short QF_Samples_S2[182];
    unsigned short QF_Samples_S3[182];
    unsigned short QF_Samples_S4[182];
    unsigned short QF_Samples_S5[182];
    unsigned short QF_Samples_S6[182];
} LSAPHIRBASE_S1;

#endif

#ifndef _LSAPHIRBASE_BASEHEADER_
#define _LSAPHIRBASE_BASEHEADER_

typedef struct {
    int TLE_date[6];
    double TLE_time[1];
} LSAPHIRBASE_BASEHEADER;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /LSAPHIRBASE_S1/
    RECORD /SCANTIME/ ScanTime
    BYTE isMissing
    REAL*8 timeTAI
    REAL*4 solarBetaAngle
```

```
    REAL*4 timeSinceEclipseEntry
    REAL*4 tlePos(3)
    REAL*4 tleVel(3)
    REAL*4 sclat
    REAL*4 sclon
    REAL*4 scalt
    REAL*4 sunGlintAngle_Samples(182)
    REAL*4 Latitude_Nadir
    REAL*4 Longitude_Nadir
    REAL*4 IncidenceAngle_Samples(182)
    REAL*4 Latitude(182)
    REAL*4 Longitude(182)
    REAL*4 Scan_Gain(6)
    REAL*4 Scan_Offset(6)
    REAL*4 Scan_HotLoadTemperature
    INTEGER*2 Scan_Number
    REAL*4 TB_Samples_S1(182)
    REAL*4 TB_Samples_S2(182)
    REAL*4 TB_Samples_S3(182)
    REAL*4 TB_Samples_S4(182)
    REAL*4 TB_Samples_S5(182)
    REAL*4 TB_Samples_S6(182)
    INTEGER*2 SAPHIR_QF_scan
    INTEGER*2 QF_Samples_S1(182)
    INTEGER*2 QF_Samples_S2(182)
    INTEGER*2 QF_Samples_S3(182)
    INTEGER*2 QF_Samples_S4(182)
    INTEGER*2 QF_Samples_S5(182)
    INTEGER*2 QF_Samples_S6(182)
END STRUCTURE

STRUCTURE /LSAPHIRBASE_BASEHEADER/
    INTEGER*4 TLE_date(6)
    REAL*8 TLE_time(1)
END STRUCTURE
```

5.9 ATMSBASE - ATMS base

ATMSBASE contains brightness temperature from the ATMS passive microwave instrument flown on the Suomi NPP satellite and JPSS satellites. ATMS is approximately AMSU-A plus MHS. Rotates 3 scans per 8 seconds. Input is SDR. ATMSBASE = 1BATMS - PadBytes - BrightnessTemperatureFactors + isMissing + timeSinceEclipseEn-

try + solarBetaAngle + sunGlintAngle + 6 times + tlePos + tleVel Data that occurs in 1BATMS 1, 2, 4 per ATMS granule appears per scan in ATMSBASE, i.e., it is repeated. There is 1 swath with the following channels:

```
Ch  GHz                Pol
1   23.8               QV
2   31.4               QV
3   50.3               QH
4   51.76              QH
5   52.8               QH
6   53.596+-0.115      QH
7   54.4               QH
8   54.94              QH
9   55.5               QH
10  fo = 57.29         QH
11  fo+-0.3222+-0.217  QH
12  fo+-0.3222+-0.048  QH
13  fo+-0.3222+-0.022  QH
14  fo+-0.3222+-0.010  QH
15  fo+-0.3222+-0.0045 QH
16  88.2               QV
17  165.5              QH
18  183.31+-7          QH
19  183.31+-4.5        QH
20  183.31+-3          QH
21  183.31+-1.8        QH
22  183.31+-1          QH

Note on geolocation and 1C swaths:
The BeamLatitude and BeamLongitude in ATMSBASE
have a band dimension of 5.  Lat and lon is for channels
1,2,3,16,17.  Each 1C swath will contain one band:

1C swath   Band   IEEE GHz       Ch geo   Chs in band
1          K      18-26.5        1        1
2          A(Ka)  26.5-40        2        2
3          V      50-75          3        3-15
4          W      75-110         16       16
5          G      110-300        17       17-22
```

Dimension definitions:

nscan	var	Number of scans in the granule.
nchannel	22	Number of channels.
nbeam	96	Number of beams in one scan.
nband	5	Number of bands (K,A,V,W,G).
vecsize	3	Vector size.
three	3	Number of vectors.
seven	7	Number of dimensions in time array.

Figure 123 through Figure 126 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains metadata of general interest. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

S1 (Swath)

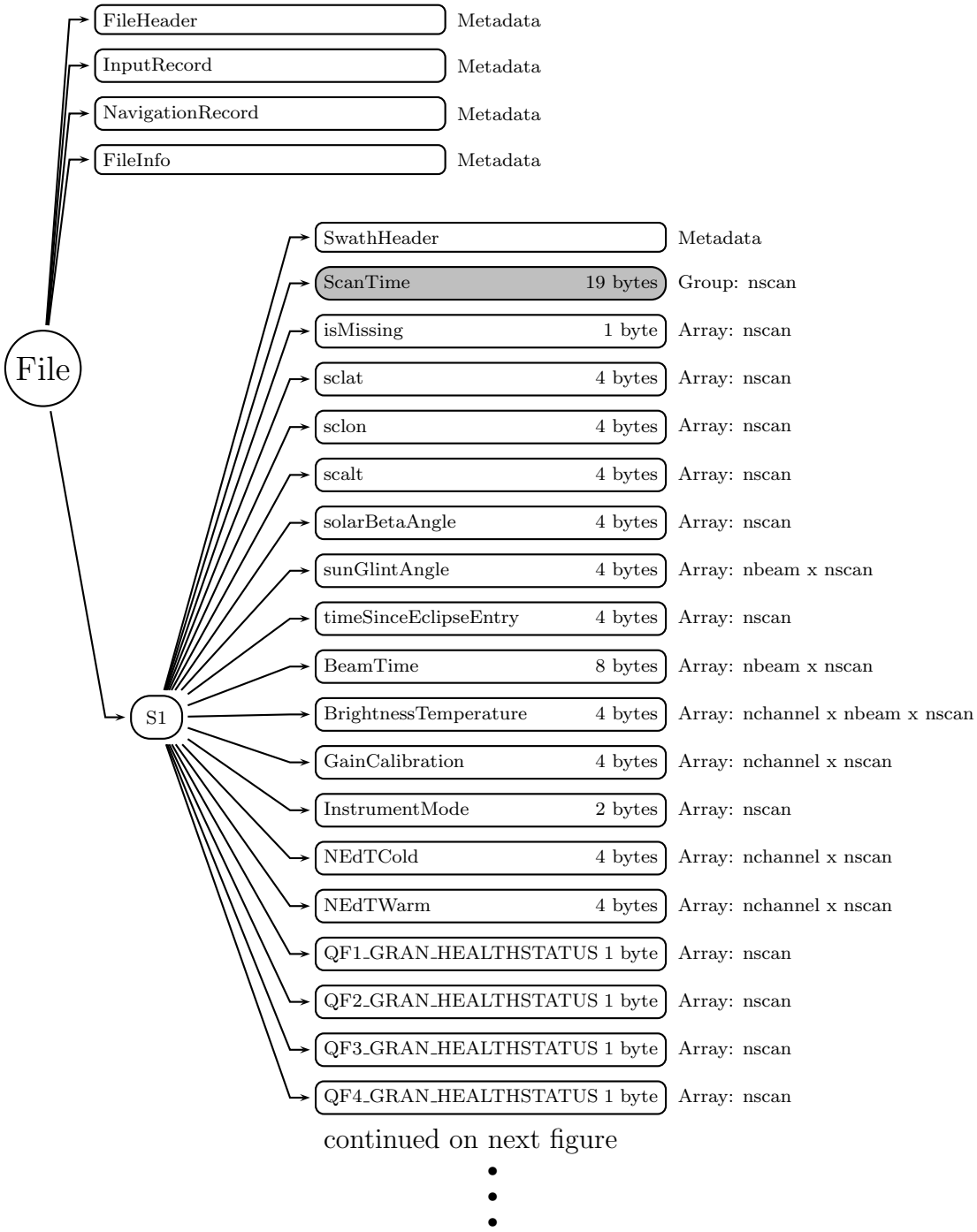
SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value



continued on next figure

Figure 123: Data Format Structure for ATMSBASE, ATMS base

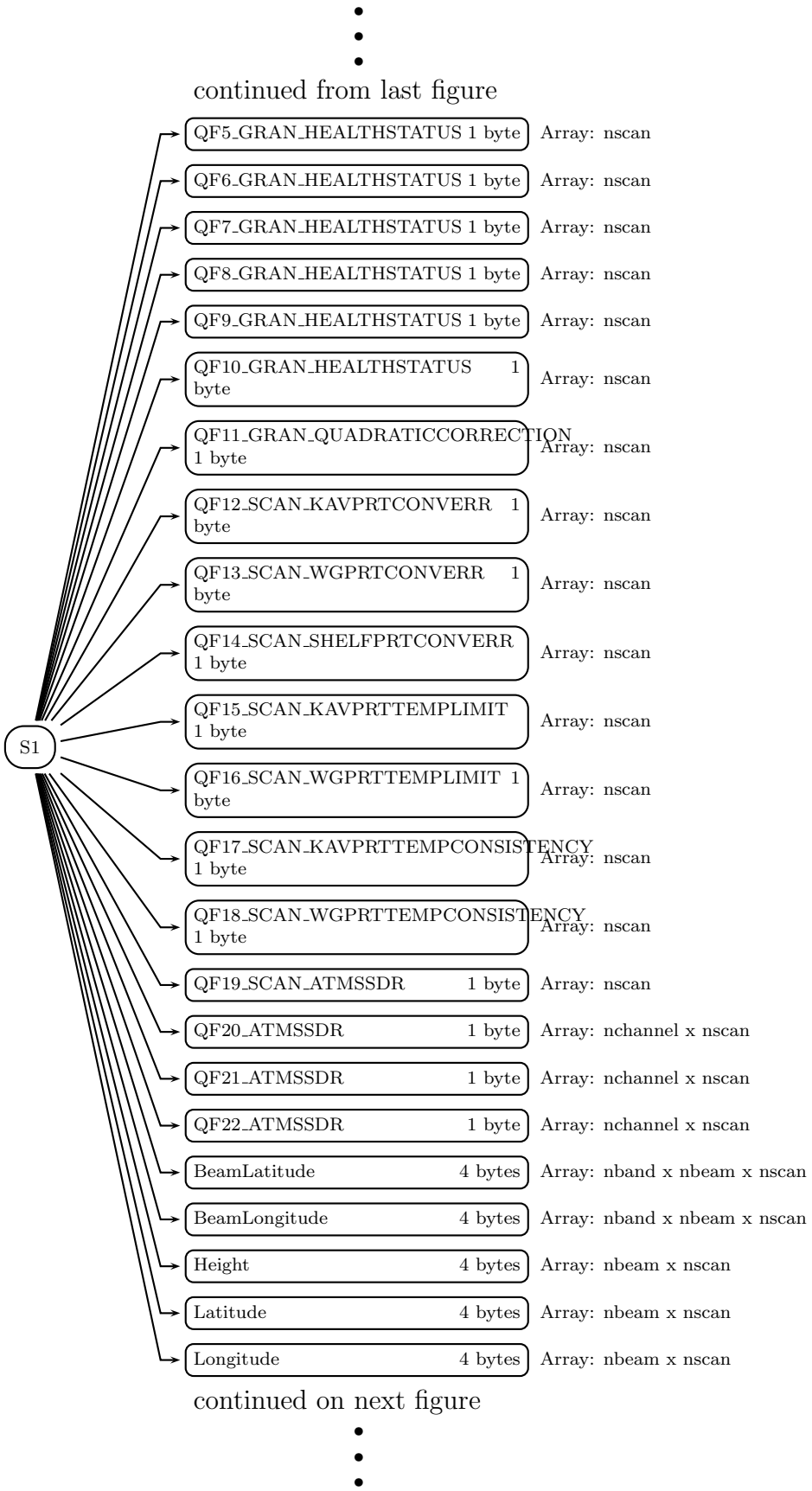


Figure 124: Data Format Structure for ATMSBASE, ATMS base

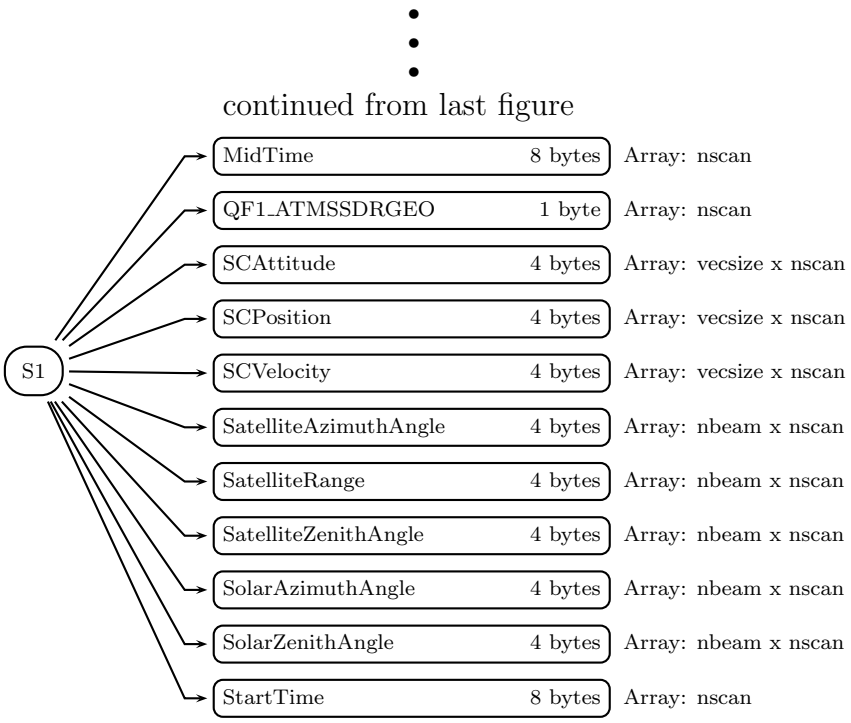


Figure 125: Data Format Structure for ATMSBASE, ATMS base

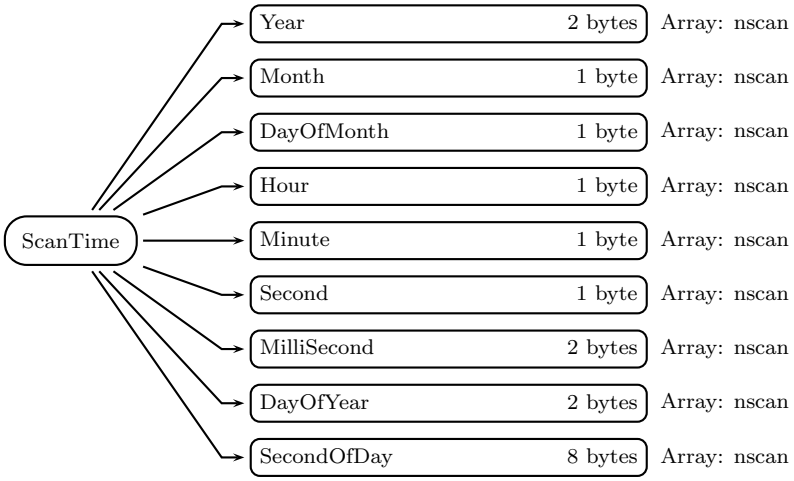


Figure 126: Data Format Structure for ATMSBASE, ScanTime

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

isMissing (1-byte integer, array size: nscan):
Missing scan flag.

sclat (4-byte float, array size: nscan):
Spacecraft latitude. Values range from -90 to 90.0 degree. Special values are defined as:
-9999.9 Missing value

sclon (4-byte float, array size: nscan):
Spacecraft longitude. Values range from -180 to 180.0 degree. Special values are defined as:
-9999.9 Missing value

scalt (4-byte float, array size: nscan):
Spacecraft altitude. Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from

-59.0 to 59.0 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: nbeam x nscan):
Sun glint angle. Not sure about the range.

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow.

BeamTime (8-byte float, array size: nbeam x nscan):

BrightnessTemperature (4-byte float, array size: nchannel x nbeam x nscan):

GainCalibration (4-byte float, array size: nchannel x nscan):

InstrumentMode (2-byte unsigned integer, array size: nscan):

NEdTCold (4-byte float, array size: nchannel x nscan):

NEdTWarm (4-byte float, array size: nchannel x nscan):

QF1_GRAN_HEALTHSTATUS (1-byte char, array size: nscan):

QF2_GRAN_HEALTHSTATUS (1-byte char, array size: nscan):

QF3_GRAN_HEALTHSTATUS (1-byte char, array size: nscan):

QF4_GRAN_HEALTHSTATUS (1-byte char, array size: nscan):

QF5_GRAN_HEALTHSTATUS (1-byte char, array size: nscan):

QF6_GRAN_HEALTHSTATUS (1-byte char, array size: nscan):

QF7_GRAN_HEALTHSTATUS (1-byte char, array size: nscan):

QF8_GRAN_HEALTHSTATUS (1-byte char, array size: nscan):

QF9_GRAN_HEALTHSTATUS (1-byte char, array size: nscan):

QF10_GRAN_HEALTHSTATUS (1-byte char, array size: nscan):

QF11_GRAN_QUADRATICCORRECTION (1-byte char, array size: nscan):

QF12_SCAN_KAVPRTCONVERR (1-byte char, array size: nscan):

QF13_SCAN_WGPRTCONVERR (1-byte char, array size: nscan):

QF14_SCAN_SHELFPRTCONVERR (1-byte char, array size: nscan):

QF15_SCAN_KAVPRTTEMPLIMIT (1-byte char, array size: nscan):

QF16_SCAN_WGPRTTEMPLIMIT (1-byte char, array size: nscan):

QF17_SCAN_KAVPRTTEMPCONSISTENCY (1-byte char, array size: nscan):

QF18_SCAN_WGPRTTEMPCONSISTENCY (1-byte char, array size: nscan):

QF19_SCAN_ATMSSDR (1-byte char, array size: nscan):

QF20_ATMSSDR (1-byte char, array size: nchannel x nscan):

QF21_ATMSSDR (1-byte char, array size: nchannel x nscan):

QF22_ATMSSDR (1-byte char, array size: nchannel x nscan):

BeamLatitude (4-byte float, array size: nband x nbeam x nscan):

BeamLongitude (4-byte float, array size: nband x nbeam x nscan):

Height (4-byte float, array size: nbeam x nscan):

Latitude (4-byte float, array size: nbeam x nscan):

Longitude (4-byte float, array size: nbeam x nscan):

MidTime (8-byte float, array size: nscan):

QF1_ATMSSDRGEO (1-byte char, array size: nscan):

SCAttitude (4-byte float, array size: vecsize x nscan):

SCPosition (4-byte float, array size: vecsize x nscan):

SCVelocity (4-byte float, array size: vecsize x nscan):

SatelliteAzimuthAngle (4-byte float, array size: nbeam x nscan):

SatelliteRange (4-byte float, array size: nbeam x nscan):

SatelliteZenithAngle (4-byte float, array size: nbeam x nscan):

SolarAzimuthAngle (4-byte float, array size: nbeam x nscan):

SolarZenithAngle (4-byte float, array size: nbeam x nscan):

StartTime (8-byte float, array size: nscan):

C Structure Header file:

```
#ifndef _TK_ATMSBASE_H_
#define _TK_ATMSBASE_H_

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif
```

```
#ifndef _LATMSBASE_S1_
#define _LATMSBASE_S1_

typedef struct {
    SCANTIME ScanTime;
    signed char isMissing;
    float sclat;
    float sclon;
    float scalt;
    float solarBetaAngle;
    float sunGlintAngle[96];
    float timeSinceEclipseEntry;
    double BeamTime[96];
    float BrightnessTemperature[96][22];
    float GainCalibration[22];
    unsigned short InstrumentMode;
    float NEdTCold[22];
    float NEdTWarm[22];
    unsigned char QF1_GRAN_HEALTHSTATUS;
    unsigned char QF2_GRAN_HEALTHSTATUS;
    unsigned char QF3_GRAN_HEALTHSTATUS;
    unsigned char QF4_GRAN_HEALTHSTATUS;
    unsigned char QF5_GRAN_HEALTHSTATUS;
    unsigned char QF6_GRAN_HEALTHSTATUS;
    unsigned char QF7_GRAN_HEALTHSTATUS;
    unsigned char QF8_GRAN_HEALTHSTATUS;
    unsigned char QF9_GRAN_HEALTHSTATUS;
    unsigned char QF10_GRAN_HEALTHSTATUS;
    unsigned char QF11_GRAN_QUADRATICCORRECTION;
    unsigned char QF12_SCAN_KAVPRTCONVERR;
    unsigned char QF13_SCAN_WGPRTCONVERR;
    unsigned char QF14_SCAN_SHELFPRTCONVERR;
    unsigned char QF15_SCAN_KAVPRTTEMPLIMIT;
    unsigned char QF16_SCAN_WGPRTTEMPLIMIT;
    unsigned char QF17_SCAN_KAVPRTTEMPCONSISTENCY;
    unsigned char QF18_SCAN_WGPRTTEMPCONSISTENCY;
    unsigned char QF19_SCAN_ATMSSDR;
    unsigned char QF20_ATMSSDR[22];
    unsigned char QF21_ATMSSDR[22];
    unsigned char QF22_ATMSSDR[22];
    float BeamLatitude[96][5];
    float BeamLongitude[96][5];
    float Height[96];
```

```
    float Latitude[96];
    float Longitude[96];
    double MidTime;
    unsigned char QF1_ATMSSDRGEO;
    float SCAttitude[3];
    float SCPosition[3];
    float SCVelocity[3];
    float SatelliteAzimuthAngle[96];
    float SatelliteRange[96];
    float SatelliteZenithAngle[96];
    float SolarAzimuthAngle[96];
    float SolarZenithAngle[96];
    double StartTime;
} LATMSBASE_S1;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /LATMSBASE_S1/
    RECORD /SCANTIME/ ScanTime
    BYTE isMissing
    REAL*4 sclat
    REAL*4 sclon
    REAL*4 scalt
    REAL*4 solarBetaAngle
    REAL*4 sunGlintAngle(96)
    REAL*4 timeSinceEclipseEntry
    REAL*8 BeamTime(96)
```

```
REAL*4 BrightnessTemperature(22,96)
REAL*4 GainCalibration(22)
INTEGER*2 InstrumentMode
REAL*4 NEdTCold(22)
REAL*4 NEdTWarm(22)
CHARACTER QF1_GRAN_HEALTHSTATUS
CHARACTER QF2_GRAN_HEALTHSTATUS
CHARACTER QF3_GRAN_HEALTHSTATUS
CHARACTER QF4_GRAN_HEALTHSTATUS
CHARACTER QF5_GRAN_HEALTHSTATUS
CHARACTER QF6_GRAN_HEALTHSTATUS
CHARACTER QF7_GRAN_HEALTHSTATUS
CHARACTER QF8_GRAN_HEALTHSTATUS
CHARACTER QF9_GRAN_HEALTHSTATUS
CHARACTER QF10_GRAN_HEALTHSTATUS
CHARACTER QF11_GRAN_QUADRATICCORRECTION
CHARACTER QF12_SCAN_KAVPRTCONVERR
CHARACTER QF13_SCAN_WGPRTCONVERR
CHARACTER QF14_SCAN_SHELFPRTCONVERR
CHARACTER QF15_SCAN_KAVPRTTEMPLIMIT
CHARACTER QF16_SCAN_WGPRTTEMPLIMIT
CHARACTER QF17_SCAN_KAVPRTTEMPCONSISTENCY
CHARACTER QF18_SCAN_WGPRTTEMPCONSISTENCY
CHARACTER QF19_SCAN_ATMSSDR
CHARACTER QF20_ATMSSDR(22)
CHARACTER QF21_ATMSSDR(22)
CHARACTER QF22_ATMSSDR(22)
REAL*4 BeamLatitude(5,96)
REAL*4 BeamLongitude(5,96)
REAL*4 Height(96)
REAL*4 Latitude(96)
REAL*4 Longitude(96)
REAL*8 MidTime
CHARACTER QF1_ATMSSDRGEO
REAL*4 SCAttitude(3)
REAL*4 SCPosition(3)
REAL*4 SCVelocity(3)
REAL*4 SatelliteAzimuthAngle(96)
REAL*4 SatelliteRange(96)
REAL*4 SatelliteZenithAngle(96)
REAL*4 SolarAzimuthAngle(96)
REAL*4 SolarZenithAngle(96)
REAL*8 StartTime
```

```
END STRUCTURE
```

5.10 1CTMI - GPM Common Calibrated Brightness Temperature

1CTMI contains common calibrated brightness temperatures from the TMI passive microwave instrument flown on the TRMM satellite. Since TMI is the reference for the intercalibration, the 1CTMI brightness temperatures are unchanged from the TRMM 1B11 product although the format is changed. Swath S1 has 7 low resolution channels (10V 10H 19V 19H 21V 37V 37H). Swath S2 has 2 high resolution channels (85V 85H). Data for both swaths is observed in the same revolution of the instrument.

Earth observations are taken during a segment of the rotation when TMI is looking in the +x direction of the TRMM satellite. Since the spacecraft turns around every few weeks, +x may be forward or aft. We define the spacecraft axis v, used in the definition of the variable SCorientation, at the center of this segment and the same as the +x direction.

RELATION BETWEEN THE SWATHS: Swath S2 has the same number of scans but twice as many pixels as Swath S1. Each S1 scan contains low frequency channels sampled 104 times along the scan. Each S2 scan contains high frequency channels sampled 208 times along the scan. S1 and S2 scans are repeated every 1.9s Along an S1 scan every other center of an S2 pixel coincides with the center of an S1 pixel.

The Figure below shows the locations of the pixels of scans 1 and 2 for both swaths. Each "+" represents centers of pixels from one or more swaths. For example, the label "S1:1,2 S2:1,3" means that both Swath S1, Scan 1, Pixel 2 and Swath S2, Scan 1, Pixel 3 are located at the "+".

```
S1:1,1 S2:1,1    S2:1,2   S1:1,2 S2:1,3         S1:1,104 S2:1,207  S2:1,208
      +            +            +       .......        +             +



S1:2,1 S2:2,1    S2:2,2   S1:2,2 S2:2,3         S1:2,104 S2:2,207  S2:2,208
      +            +            +       .......        +             +
```

Dimension definitions:

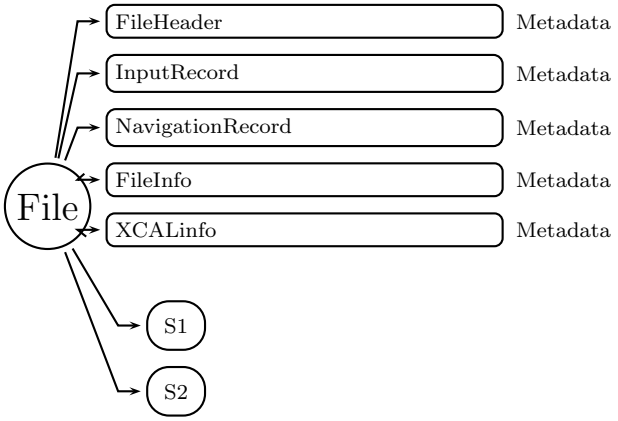


Figure 127: Data Format Structure for 1CTMI, GPM Common Calibrated Brightness Temperature

nscan1	var	Number of Swath S1 scans in the granule.
nchannel1	7	Number of Swath S1 channels (10V 10H 19V 19H 21V 37V 37H).
npixel1	104	Number of Swath S1 pixels in one scan.
nchUIA1	4	Number of Swath S1 unique incidence angles.
nscan2	var	Number of Swath S2 scans in the granule.
nchannel2	2	Number of Swath S2 channels (85V 85H).
npixel2	208	Number of Swath S2 pixels in one scan.
nchUIA2	1	Number of Swath S2 unique incidence angles.

Figure 127 through Figure 133 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

XCALinfo (Metadata):
XCALinfo contains metadata required by 1C intercalibrated files. See Metadata for GPM Products for details.

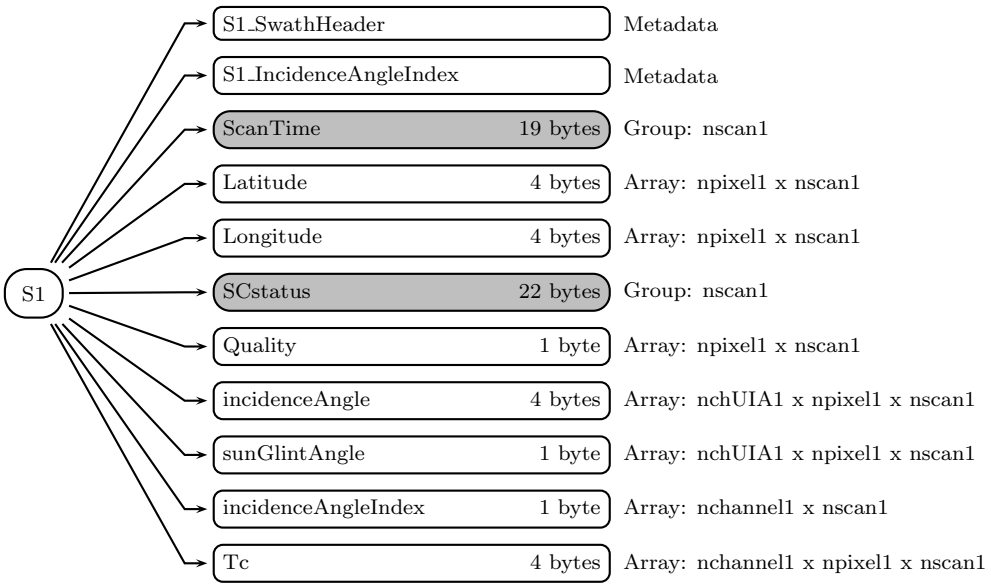


Figure 128: Data Format Structure for 1CTMI, S1

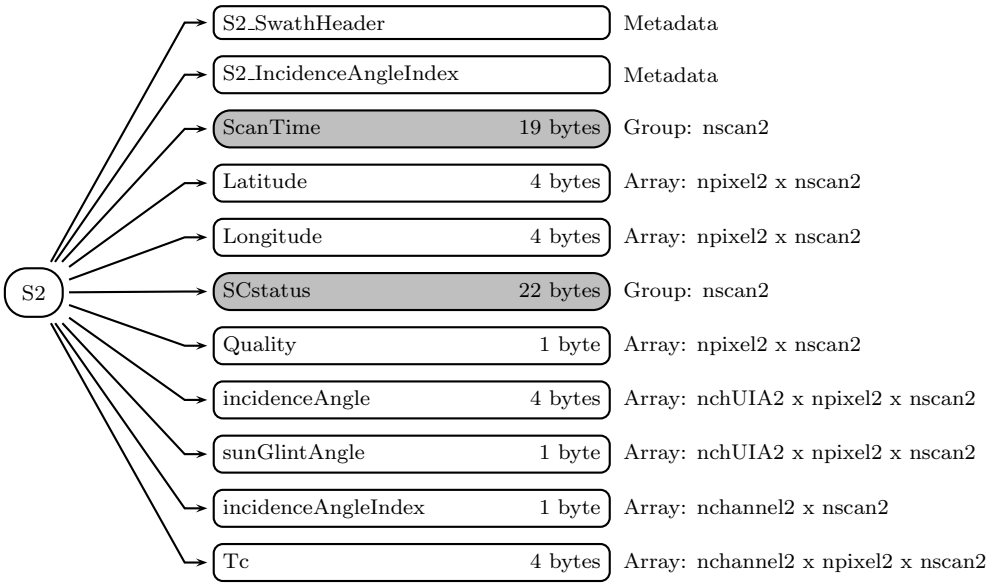


Figure 129: Data Format Structure for 1CTMI, S2

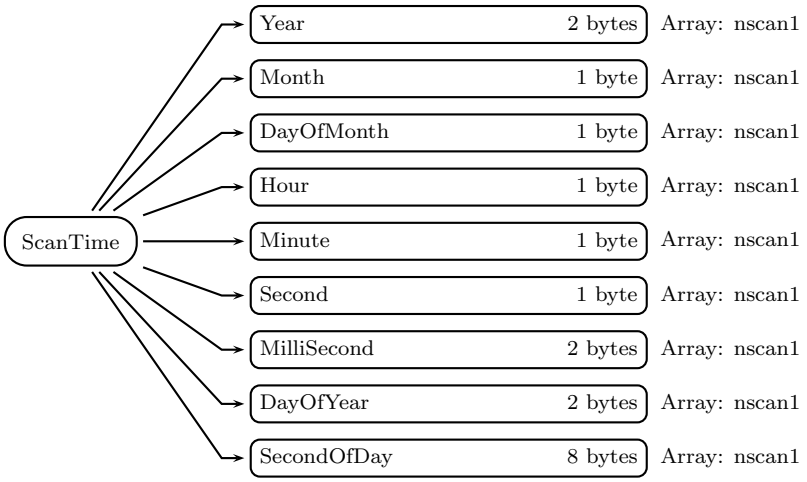


Figure 130: Data Format Structure for 1CTMI, S1, ScanTime

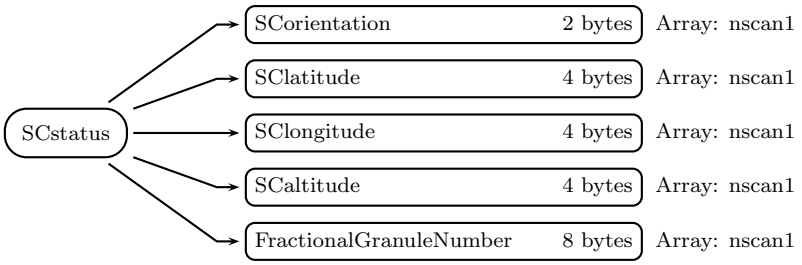


Figure 131: Data Format Structure for 1CTMI, S1, SCstatus

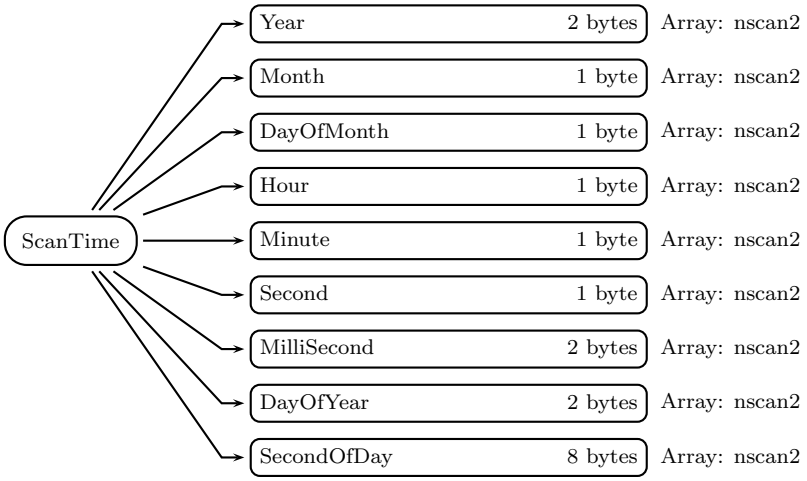


Figure 132: Data Format Structure for 1CTMI, S2, ScanTime

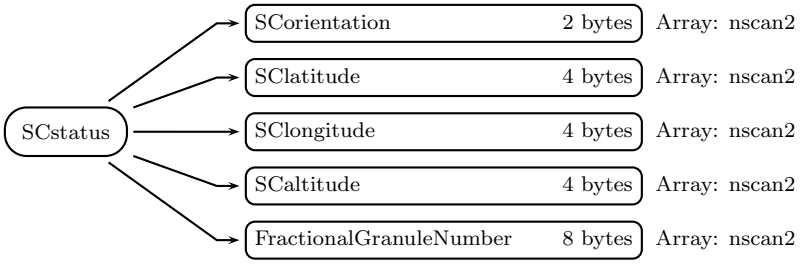


Figure 133: Data Format Structure for 1CTMI, S2, SCstatus

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S1_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel1 x nscan1):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel1 x nscan1):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S1)

SCorientation (2-byte integer, array size: nscan1):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan1):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel1 x nscan1):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
   0 = Good data
   1 = Possible sun glint
   2 = Possible radio frequency interference
   3 = Degraded geolocation data
   4 = Data corrected for warm load intrusion

  -1 = Data is missing from file or unreadable
  -2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
  -3 = Error in geolocation data
  -4 = Data missing in one channel
  -5 = Data missing in multiple channels
  -6 = Lat/lon values are out of range
  -7 = Non-normal status modes
 -10 = Distance to corresponding LF pixel > 7 km
       (Used in L1C-R product only)
 -99 = Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1):

Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1):

```
GPM Common Calibrated Brightness Temperature. The channels are:
10.7 GHz vertically-polarized TBs
10.7  GHz horizontally-polarized TBs
```

```
19.4  GHz vertically-polarized   TBs
19.4  GHz horizontally-polarized TBs
22.3  GHz vertically-polarized   TBs
37.0   GHz vertically-polarized   TBs
37.0   GHz horizontally-polarized TBs
```

Values range from 0 to 10000 K. Special values are defined as:
-9999.9 Missing value

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S2_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel2 x nscan2):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel2 x nscan2):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S2)

SCorientation (2-byte integer, array size: nscan2):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan2):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan2):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan2):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan2):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel2 x nscan2):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
   0 = Good data
   1 = Possible sun glint
   2 = Possible radio frequency interference
   3 = Degraded geolocation data
   4 = Data corrected for warm load intrusion

  -1 = Data is missing from file or unreadable
  -2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
  -3 = Error in geolocation data
  -4 = Data missing in one channel
  -5 = Data missing in multiple channels
  -6 = Lat/lon values are out of range
  -7 = Non-normal status modes
 -10 = Distance to corresponding LF pixel > 7 km
       (Used in L1C-R product only)
 -99 = Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA2 x npixel2 x nscan2):

Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA2 x npixel2 x nscan2):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel2 x nscan2):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel2 x npixel2 x nscan2):

```
GPM Common Calibrated Brightness Temperature. The channels are:
85.5  GHz vertically-polarized   TBs
85.5  GHz horizontally-polarized TBs
```

Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_1CTMI_H_
#define _TK_1CTMI_H_

#ifndef _L1CTMI_S2_
#define _L1CTMI_S2_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[208];
    float Longitude[208];
    SCSTATUS SCstatus;
    signed char Quality[208];
    float incidenceAngle[208][1];
    signed char sunGlintAngle[208][1];
    signed char incidenceAngleIndex[2];
    float Tc[208][2];
} L1CTMI_S2;

#endif

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
```

```
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1CTMI_S1_
#define _L1CTMI_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[104];
    float Longitude[104];
    SCSTATUS SCstatus;
    signed char Quality[104];
    float incidenceAngle[104][4];
    signed char sunGlintAngle[104][4];
    signed char incidenceAngleIndex[7];
    float Tc[104][7];
} L1CTMI_S1;

#endif

#ifndef _L1CTMI_SWATHS_
#define _L1CTMI_SWATHS_

typedef struct {
    L1CTMI_S1 S1;
    L1CTMI_S2 S2;
} L1CTMI_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1CTMI_S2/
```

```
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(208)
    REAL*4 Longitude(208)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(208)
    REAL*4 incidenceAngle(1,208)
    BYTE sunGlintAngle(1,208)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,208)
END STRUCTURE

STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1CTMI_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(104)
    REAL*4 Longitude(104)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(104)
    REAL*4 incidenceAngle(4,104)
    BYTE sunGlintAngle(4,104)
    BYTE incidenceAngleIndex(7)
    REAL*4 Tc(7,104)
END STRUCTURE
```

```
STRUCTURE /L1CTMI_SWATHS/
    RECORD /L1CTMI_S1/ S1
    RECORD /L1CTMI_S2/ S2
END STRUCTURE
```

5.11 1CGMI - GPM Common Calibrated Brightness Temperature

1CGMI contains common calibrated brightness temperatures from the GMI passive microwave instrument flown on the GPM satellite. 1C-R GMI is a remapped version of 1CGMI which is explained at the end of this section. Swath S1 has 9 channels which are similar to TRMM TMI (10V 10H 19V 19H 23V 37V 37H 89V 89H). Swath S2 has 4 channels similar to AMSU-B (166V 166H 183+/-3V 183+/-8V). Data for both swaths is observed in the same revolution of the instrument.

Earth observations are taken during a segment of the rotation when GMI is looking in the +x direction of the GPM satellite. Since the spacecraft turns around every few weeks, +x may be forward or aft. We define the spacecraft axis v, used in the definition of the variable SCorientation, at the center of this segment and the same as the +x direction.

32rpm * 1min/60s * 5538s/orbit = 2954 scans / orbit.

RELATION BETWEEN THE SWATHS: Swath S2 has the same number of scans and the same number of pixels as Swath S1. Each S1 scan contains 9 channels sampled 221 times along the scan. Each S2 scan contains 4 channels sampled 221 times along the scan. Since the incidence angle of Swath S1 is different than Swath S2, the geolocations of the pixel centers are different.

1C-R GMI is a remapped version of 1CGMI. 1C-R is the input for Gprof. The 1C-R Swath S1 is the same as the 1C Swath S1. However, the 1C-R Swath S2 consists of pixels selected from 1C Swath S2 to be as close as possible to the S1 pixels. The 1C-R S2 pixels will often be observed at a different scantime and sometimes from a different granule than the corresponding S1 pixel. Since 1C S2 is narrower than 1C S1, 1C-R S2 has missing pixels on both edges of the swath.

Dimension definitions:

nscan1	var	Typical number of Swath S1 scans in the granule.
nchannel1	9	Number of Swath S1 channels (10V 10H 19V 19H 23V 37V 37H 89V 89H).
npixel1	221	Number of Swath S1 pixels in one scan.
nchUIA1	1	Number of Swath S1 unique incidence angles.
nscan2	var	Typical number of Swath S2 scans in the granule.
nchannel2	4	Number of Swath S2 channels (165V 165H 183+/-3V 183+/-8V).
npixel2	221	Number of Swath S2 pixels in one scan.
nchUIA2	1	Number of Swath S2 unique incidence angles.

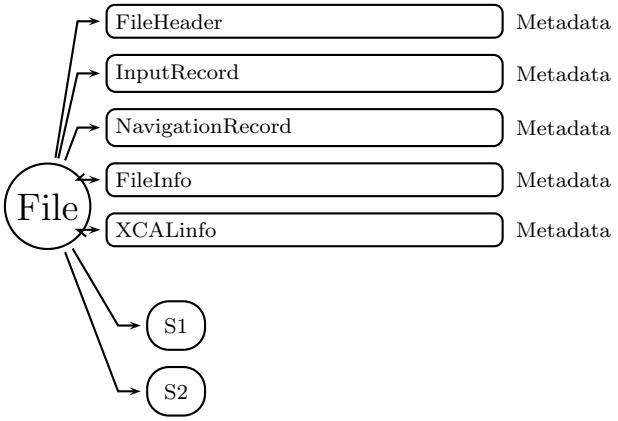


Figure 134: Data Format Structure for 1CGMI, GPM Common Calibrated Brightness Temperature

Figure 134 through Figure 140 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

XCALinfo (Metadata):
XCALinfo contains metadata required by 1C intercalibrated files. See Metadata for GPM Products for details.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

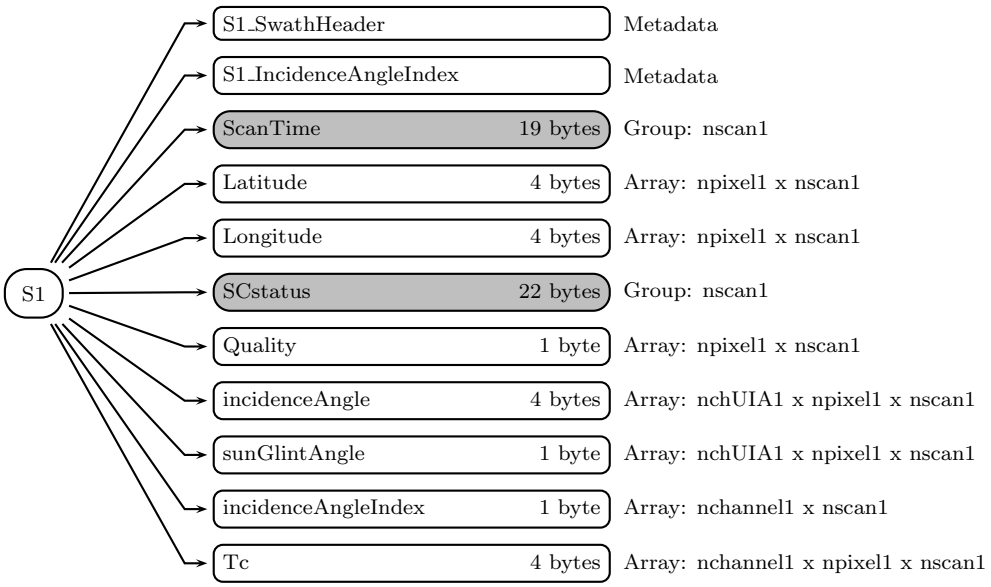


Figure 135: Data Format Structure for 1CGMI, S1

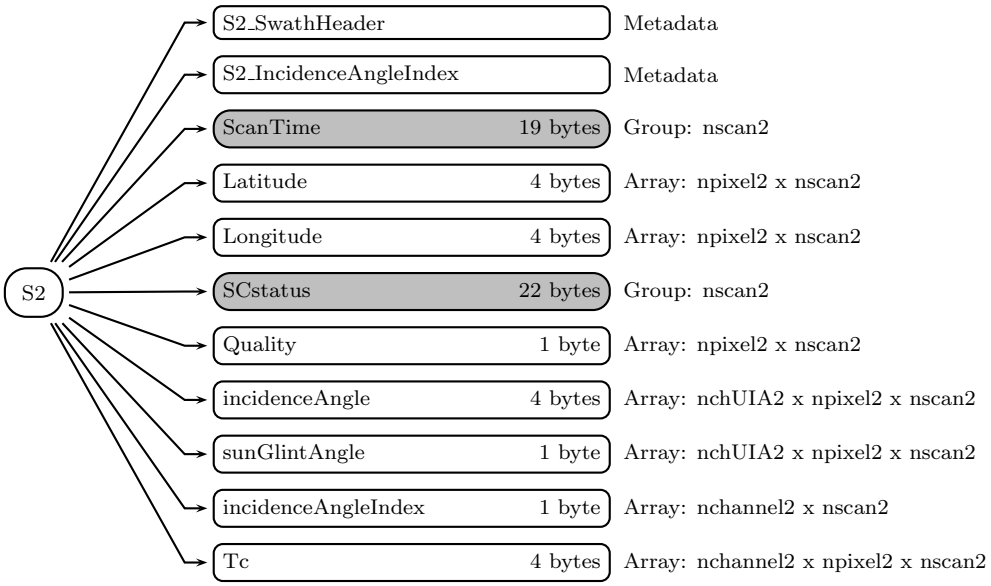


Figure 136: Data Format Structure for 1CGMI, S2

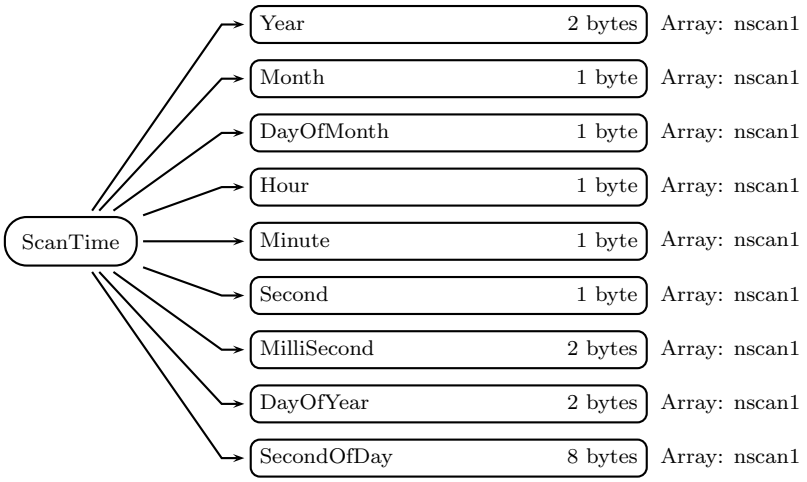


Figure 137: Data Format Structure for 1CGMI, S1, ScanTime

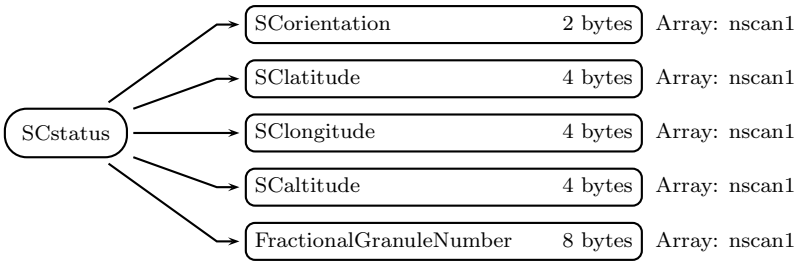


Figure 138: Data Format Structure for 1CGMI, S1, SCstatus

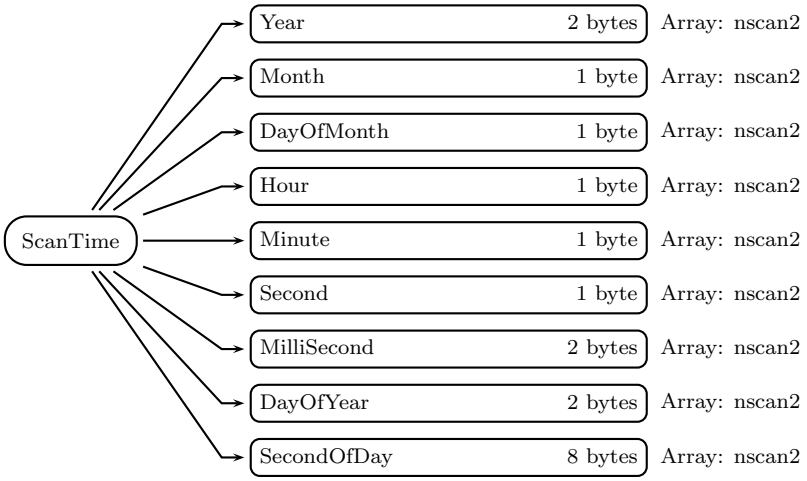


Figure 139: Data Format Structure for 1CGMI, S2, ScanTime

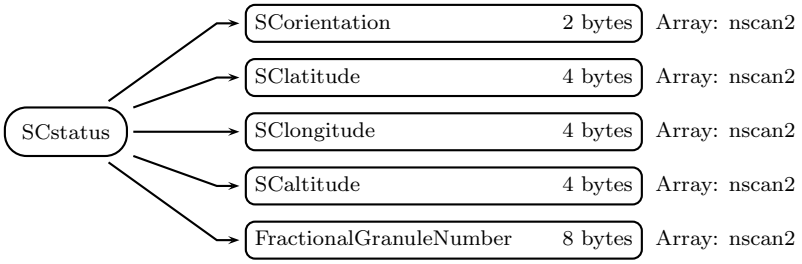


Figure 140: Data Format Structure for 1CGMI, S2, SCstatus

S1_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel1 x nscan1):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel1 x nscan1):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S1)

SCorientation (2-byte integer, array size: nscan1):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan1):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule.

Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel1 x nscan1):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
   0 = Good data
   1 = Possible sun glint
   2 = Possible radio frequency interference
   3 = Degraded geolocation data
   4 = Data corrected for warm load intrusion

 100 = Scan blanking on

  -1 = Data is missing from file or unreadable
  -2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
  -3 = Error in geolocation data
  -4 = Data missing in one channel
  -5 = Data missing in multiple channels
  -6 = Lat/lon values are out of range
  -7 = Non-normal status modes
 -10 = Distance to corresponding LF pixel > 7 km
       (Used in L1C-R product only)
 -99 = Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1):
Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1):

```
GPM Common Calibrated Brightness Temperature.
The channels are:

10.7  GHz vertically-polarized   TBs
10.7  GHz horizontally-polarized TBs
18.7  GHz vertically-polarized   TBs
18.7  GHz horizontally-polarized TBs
23.8  GHz vertically-polarized   TBs
36.5  GHz vertically-polarized   TBs
```

```
36.5  GHz horizontally-polarized TBs
89.0  GHz vertically-polarized   TBs
89.0  GHz horizontally-polarized TBs
```

Values range from 0 to 10000 K. Special values are defined as:
-9999.9 Missing value

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S2_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel2 x nscan2):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel2 x nscan2):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S2)

SCorientation (2-byte integer, array size: nscan2):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan2):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan2):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan2):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan2):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel2 x nscan2):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
   0 = Good data
   1 = Possible sun glint
   2 = Possible radio frequency interference
   3 = Degraded geolocation data
   4 = Data corrected for warm load intrusion

 100 = Scan blanking on

  -1 = Data is missing from file or unreadable
  -2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
  -3 = Error in geolocation data
  -4 = Data missing in one channel
  -5 = Data missing in multiple channels
  -6 = Lat/lon values are out of range
  -7 = Non-normal status modes
 -10 = Distance to corresponding LF pixel > 7 km
       (Used in L1C-R product only)
 -99 = Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA2 x npixel2 x nscan2):
Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA2 x npixel2 x nscan2):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel2 x nscan2):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel2 x npixel2 x nscan2):

```
GPM Common Calibrated Brightness Temperature.
The channels are:

166.0  GHz vertically-polarized        TBs
166.0  GHz horizontally-polarized      TBs
183.31+/-3  GHz vertically-polarized   TBs
```

```
183.31+/-8  GHz vertically-polarized   TBs
```

Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_1CGMI_H_
#define _TK_1CGMI_H_

#ifndef _L1CGMI_S2_
#define _L1CGMI_S2_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    SCSTATUS SCstatus;
    signed char Quality[221];
    float incidenceAngle[221][1];
    signed char sunGlintAngle[221][1];
    signed char incidenceAngleIndex[4];
    float Tc[221][4];
} L1CGMI_S2;

#endif

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_
```

```
typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1CGMI_S1_
#define _L1CGMI_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    SCSTATUS SCstatus;
    signed char Quality[221];
    float incidenceAngle[221][1];
    signed char sunGlintAngle[221][1];
    signed char incidenceAngleIndex[9];
    float Tc[221][9];
} L1CGMI_S1;

#endif

#ifndef _L1CGMI_SWATHS_
#define _L1CGMI_SWATHS_

typedef struct {
    L1CGMI_S1 S1;
    L1CGMI_S2 S2;
} L1CGMI_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1CGMI_S2/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(221)
    REAL*4 incidenceAngle(1,221)
    BYTE sunGlintAngle(1,221)
    BYTE incidenceAngleIndex(4)
    REAL*4 Tc(4,221)
END STRUCTURE

STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1CGMI_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(221)
    REAL*4 incidenceAngle(1,221)
    BYTE sunGlintAngle(1,221)
    BYTE incidenceAngleIndex(9)
    REAL*4 Tc(9,221)
```

```
END STRUCTURE

STRUCTURE /L1CGMI_SWATHS/
    RECORD /L1CGMI_S1/ S1
    RECORD /L1CGMI_S2/ S2
END STRUCTURE
```

5.12 1CSSMIS - Common Calibrated Brightness Temperature

1CSSMIS contains common calibrated brightness temperature from the SSMIS passive microwave instruments flown on the DMSP satellites. Swath S1 has 3 low frequency channels (19V 19H 22V). Swath S2 has 2 low frequency channels (37V 37H). Swath S3 has 4 high frequency channels (150H 183+/-1H 183+/-3H 183+/-7H). S4 has 2 high frequency channels (91V 91H). All the above frequencies are in GHz.

Earth observations for all four swaths are taken during a 144° segment of the instrument rotation when SSMIS scans in the direction of foreward satellite motion. We define the spacecraft vector (v) at the center of this segment. "v" is used in the definition of the variable SCorientation.

RELATION BETWEEN THE SWATHS: Each S1 and S2 scan contains low frequency channels sampled 90 times along the scan. Each S3 and S4 scan contains high frequency channels sampled 180 times along the scan. All four swaths have exactly the same number of scans. All four swaths repeat scans every 1.9s. The earth positions of S1 are very close to those of S2. The earth positions of S3 are very close to those of S4. The earth positions of S1 and S2 alternate with those of S3 and S4 along the satellite track. The positions of the S1 and S2 pixels do not match the positions of the S3 and S4 pixels.

The Figure below shows the locations of the samples of Swath S1 and Swath S2 scan 1 and Swath S3 and Swath S4 scan 1. Each "+" represents centers of samples from two swaths. For example, the label "S1S2:1,2" means that Swath S1 and Swath S2, scan 1, sample 2 is located approximately at the "+". The positions of S1 and S2 are slightly different from each other but close enough to be represented by the same "+" in the Figure. The positions of S3 and S4 are slightly different from each other but close enough to be represented by the same "+" in the Figure.

```
 S1S2:1,1                  S1S2:1,2                                  S1S2:1,90
     +                         +       .......                          +

  S3S4:1,1     S3S4:1,2     S3S4:1,3                 S3S4:1,179    S3S4:1,180
      +            +            +       .......         +             +
```

KNOWN PROBLEMS OR ISSUES WITH REVISION 2 DATA: None

Dimension definitions:

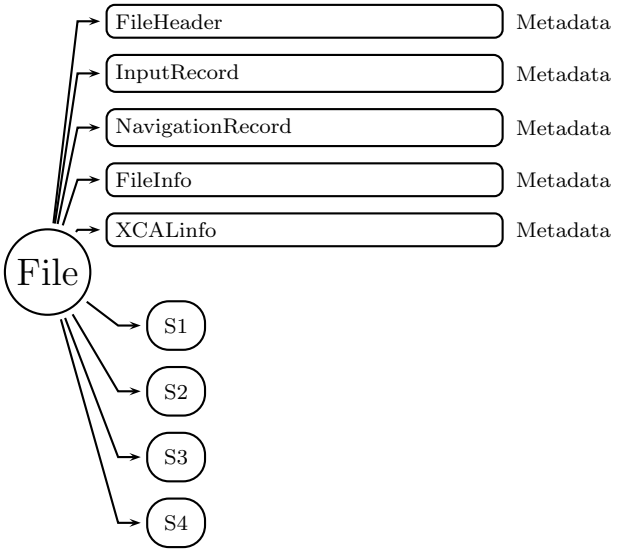


Figure 141: Data Format Structure for 1CSSMIS, Common Calibrated Brightness Temperature

nscan1	var	Number of Swath S1 scans in the granule.
nchannel1	3	Number of Swath S1 channels.
npixel1	90	Number of Swath S1 pixels in one scan.
nchUIA1	1	Number of Swath S1 unique incidence angles.
nscan2	var	Number of Swath S2 scans in the granule.
nchannel2	2	Number of Swath S2 channels.
npixel2	90	Number of Swath S2 pixels in one scan.
nchUIA2	1	Number of Swath S2 unique incidence angles.
nscan3	var	Number of Swath S3 scans in the granule.
nchannel3	4	Number of Swath S3 channels.
npixel3	180	Number of Swath S3 pixels in one scan.
nchUIA3	1	Number of Swath S3 unique incidence angles.
nscan4	var	Number of Swath S4 scans in the granule.
nchannel4	2	Number of Swath S4 channels.
npixel4	180	Number of Swath S4 pixels in one scan.
nchUIA4	1	Number of Swath S4 unique incidence angles.

Figure 141 through Figure 153 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information

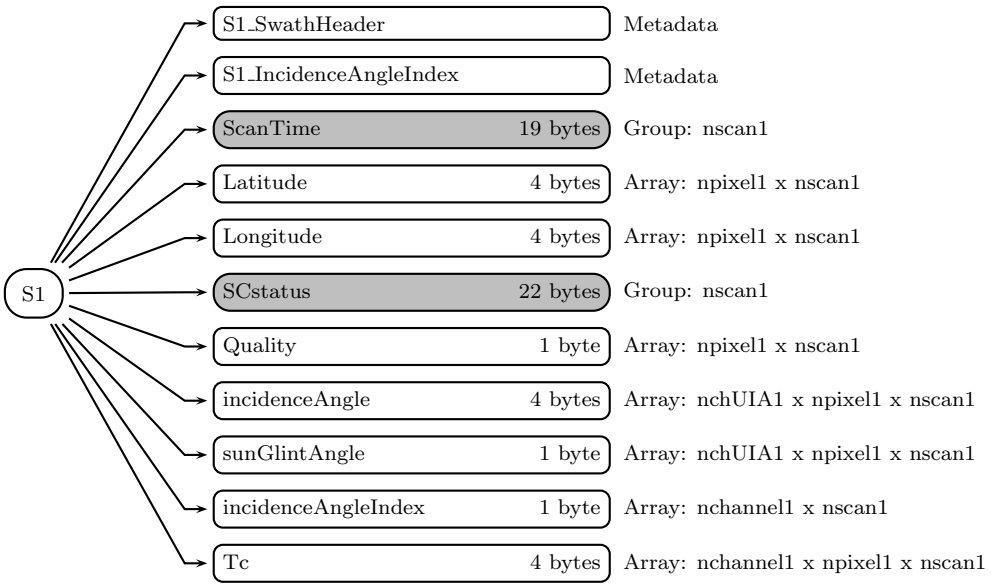


Figure 142: Data Format Structure for 1CSSMIS, S1

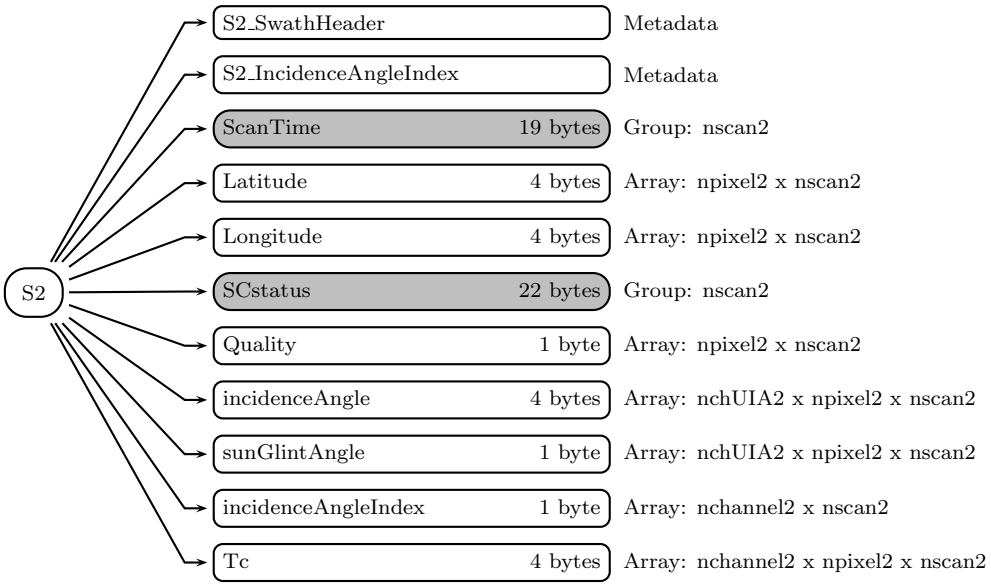


Figure 143: Data Format Structure for 1CSSMIS, S2

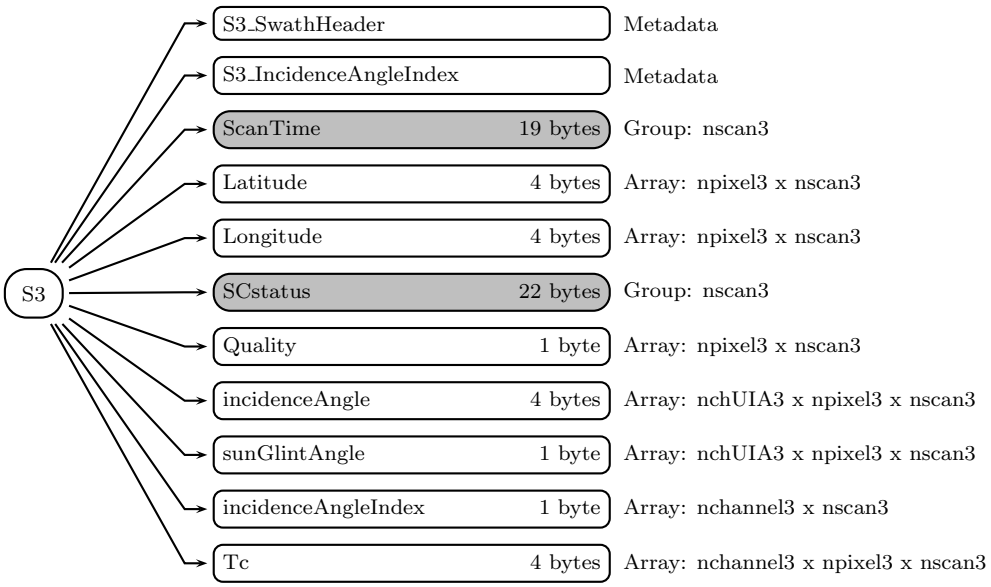


Figure 144: Data Format Structure for 1CSSMIS, S3

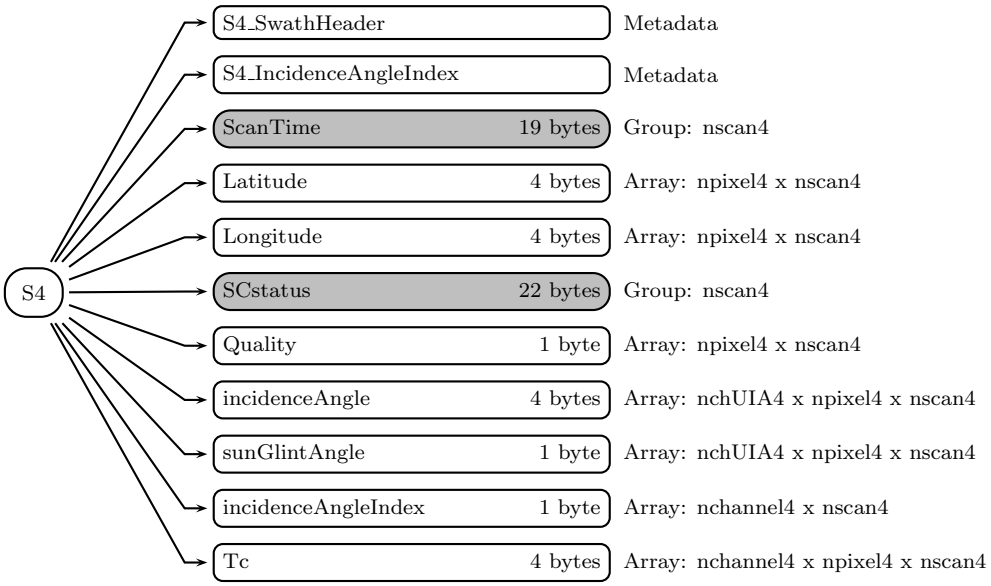


Figure 145: Data Format Structure for 1CSSMIS, S4

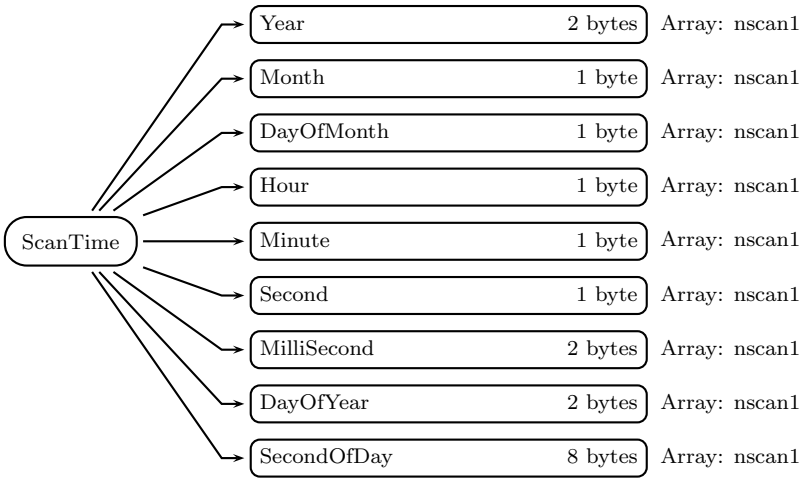


Figure 146: Data Format Structure for 1CSSMIS, S1, ScanTime

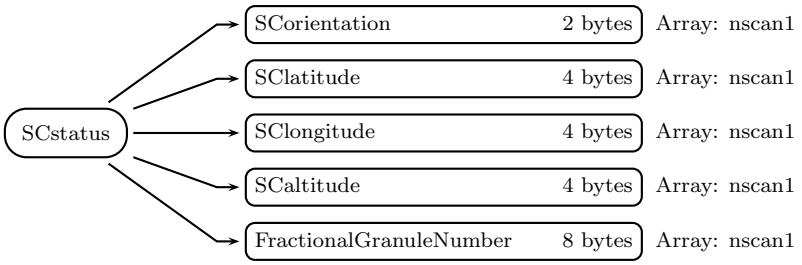


Figure 147: Data Format Structure for 1CSSMIS, S1, SCstatus

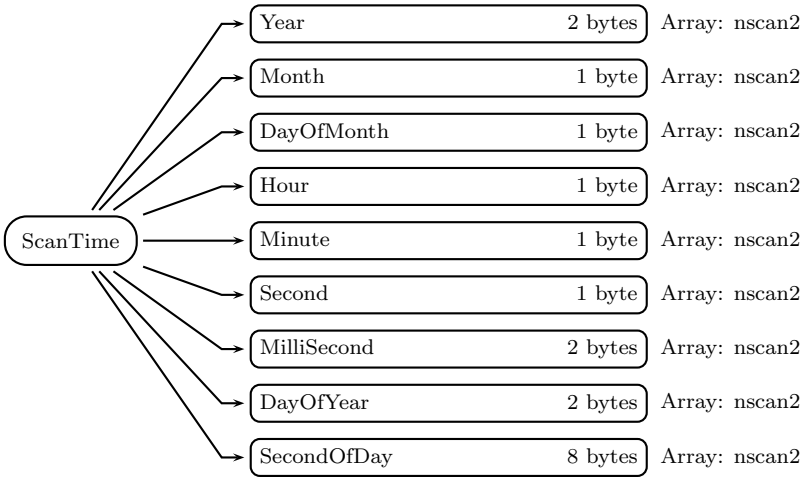


Figure 148: Data Format Structure for 1CSSMIS, S2, ScanTime

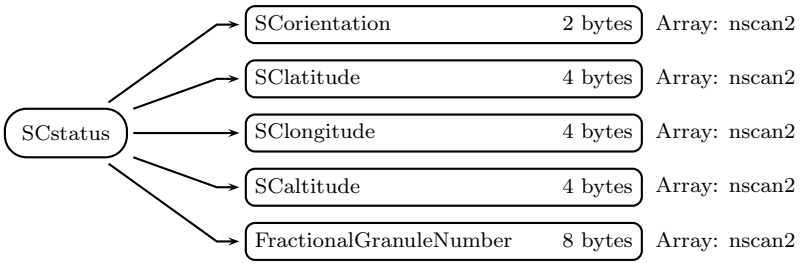


Figure 149: Data Format Structure for 1CSSMIS, S2, SCstatus

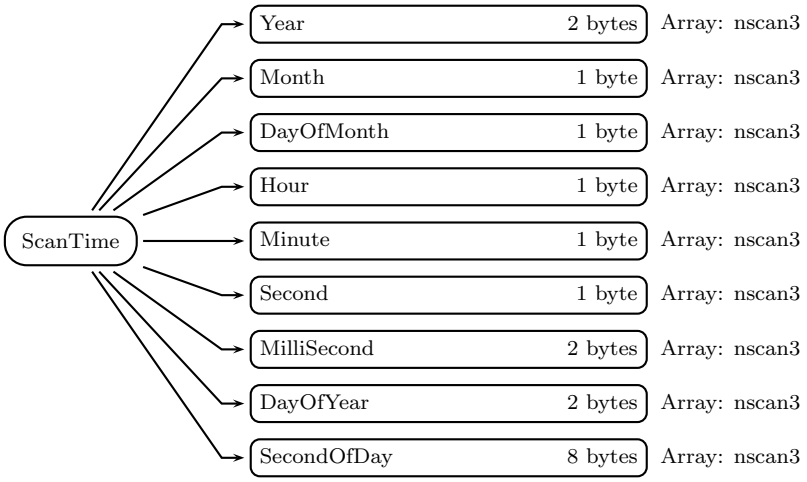


Figure 150: Data Format Structure for 1CSSMIS, S3, ScanTime

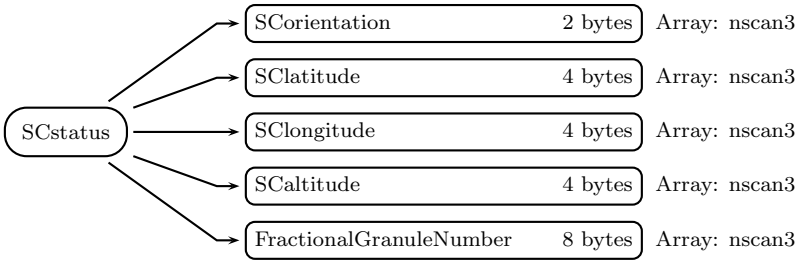


Figure 151: Data Format Structure for 1CSSMIS, S3, SCstatus

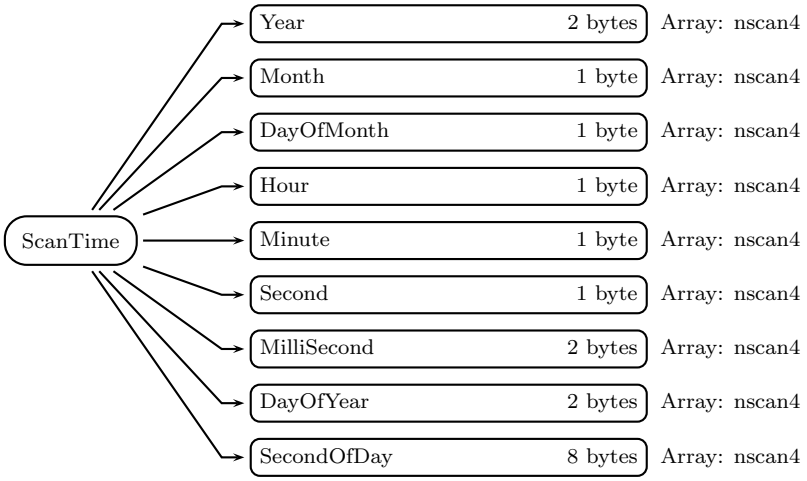


Figure 152: Data Format Structure for 1CSSMIS, S4, ScanTime

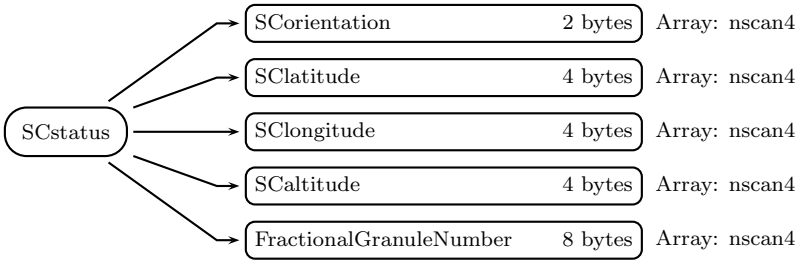


Figure 153: Data Format Structure for 1CSSMIS, S4, SCstatus

separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

XCALinfo (Metadata):
XCALinfo contains metadata required by 1C intercalibrated files. See Metadata for GPM Products for details.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S1_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel1 x nscan1):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel1 x nscan1):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S1)

SCorientation (2-byte integer, array size: nscan1):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan1):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel1 x nscan1):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
   0 = Good data
   1 = Possible sun glint
   2 = Possible radio frequency interference
   3 = Degraded geolocation data
   4 = Data corrected for warm load intrusion

 102 = Climatology check warning 19V channel
 103 = Climatology check warning 19H channel
 104 = Climatology check warning 22V channel
 105 = Climatology check warning 37V channel
 106 = Climatology check warning 37H channel
 107 = Climatology check warning 91V channel
 108 = Climatology check warning 91H channel
 109 = Climatology check warning 150H channel
 110 = Climatology check warning 183+/-1 channel
 111 = Climatology check warning 183+/-3 channel
```

```
 112 = Climatology check warning 183+/-7 channel
 113 = Climatology check warning Multiple enviro sensor channels
 114 = Climatology check warning Multiple imager sensor channels
 115 = Climatology check warning One or more LAS sensor channels
 116 = Climatology check warning One or more UAS sensor channels
 117 = Climatology check warning Correction for lunar intrusion into warm load
 118 = Climatology check warning Correction for solar intrusion into warm load

  -1 = Data is missing from file or unreadable
  -2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
  -3 = Error in geolocation data
  -4 = Data missing in one channel
  -5 = Data missing in multiple channels
  -6 = Lat/lon values are out of range
  -7 = Non-normal status modes
 -10 = Distance to corresponding LF pixel > 7 km
       (Used in L1C-R product only)
 -99 = Missing value (no quality information available)

-102 = Climatology check flagged in input BASE file
-110 = Climatology check failure 19V channel
-111 = Climatology check failure 19H channel
-112 = Climatology check failure 22V channel
-113 = Climatology check failure 37V channel
-114 = Climatology check failure 37H channel
-115 = Climatology check failure 91V channel
-116 = Climatology check failure 91H channel
-117 = Climatology check failure 150H channel
-118 = Climatology check failure 183+/-1 channel
-119 = Climatology check failure 183+/-3 channel
-120 = Climatology check failure 183+/-7 channel
-121 = Climatology check failure Multiple enviro sensor channels
-122 = Climatology check failure Multiple imager sensor channels
-123 = Climatology check failure One or more LAS sensor channels
-124 = Climatology check failure One or more UAS sensor channels
-125 = Failure of 150H channel on DMSP F18
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1):
Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1):
GPM Common Calibrated Brightness Temperature. The channels are:

```
19.35  GHz vertically-polarized   TBs
19.35  GHz horizontally-polarized TBs
22.235 GHz vertically-polarized   TBs
```

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S2_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel2 x nscan2):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel2 x nscan2):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S2)

SCorientation (2-byte integer, array size: nscan2):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan2):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan2):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan2):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan2):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel2 x nscan2):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
```

```
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
   0 = Good data
   1 = Possible sun glint
   2 = Possible radio frequency interference
   3 = Degraded geolocation data
   4 = Data corrected for warm load intrusion

 102 = Climatology check warning 19V channel
 103 = Climatology check warning 19H channel
 104 = Climatology check warning 22V channel
 105 = Climatology check warning 37V channel
 106 = Climatology check warning 37H channel
 107 = Climatology check warning 91V channel
 108 = Climatology check warning 91H channel
 109 = Climatology check warning 150H channel
 110 = Climatology check warning 183+/-1 channel
 111 = Climatology check warning 183+/-3 channel
 112 = Climatology check warning 183+/-7 channel
 113 = Climatology check warning Multiple enviro sensor channels
 114 = Climatology check warning Multiple imager sensor channels
 115 = Climatology check warning One or more LAS sensor channels
 116 = Climatology check warning One or more UAS sensor channels
 117 = Climatology check warning Correction for lunar intrusion into warm load
 118 = Climatology check warning Correction for solar intrusion into warm load

  -1 = Data is missing from file or unreadable
  -2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
  -3 = Error in geolocation data
  -4 = Data missing in one channel
  -5 = Data missing in multiple channels
  -6 = Lat/lon values are out of range
  -7 = Non-normal status modes
 -10 = Distance to corresponding LF pixel > 7 km
       (Used in L1C-R product only)
 -99 = Missing value (no quality information available)
```

```
-102 = Climatology check flagged in input BASE file
-110 = Climatology check failure 19V channel
-111 = Climatology check failure 19H channel
-112 = Climatology check failure 22V channel
-113 = Climatology check failure 37V channel
-114 = Climatology check failure 37H channel
-115 = Climatology check failure 91V channel
-116 = Climatology check failure 91H channel
-117 = Climatology check failure 150H channel
-118 = Climatology check failure 183+/-1 channel
-119 = Climatology check failure 183+/-3 channel
-120 = Climatology check failure 183+/-7 channel
-121 = Climatology check failure Multiple enviro sensor channels
-122 = Climatology check failure Multiple imager sensor channels
-123 = Climatology check failure One or more LAS sensor channels
-124 = Climatology check failure One or more UAS sensor channels
-125 = Failure of 150H channel on DMSP F18
```

incidenceAngle (4-byte float, array size: nchUIA2 x npixel2 x nscan2):
Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA2 x npixel2 x nscan2):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel2 x nscan2):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:
```

```
  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel2 x npixel2 x nscan2):
GPM Common Calibrated Brightness Temperature. The channels are:

```
37.0   GHz vertically-polarized   TBs
37.0   GHz horizontally-polarized TBs
```

S3 (Swath)

S3_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S3_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S3)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan3):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan3):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan3):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan3):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan3):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan3):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan3):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan3):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan3):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel3 x nscan3):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel3 x nscan3):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S3)

SCorientation (2-byte integer, array size: nscan3):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values

are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan3):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan3):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan3):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan3):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel3 x nscan3):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
   0 = Good data
   1 = Possible sun glint
   2 = Possible radio frequency interference
   3 = Degraded geolocation data
   4 = Data corrected for warm load intrusion

 102 = Climatology check warning 19V channel
 103 = Climatology check warning 19H channel
 104 = Climatology check warning 22V channel
 105 = Climatology check warning 37V channel
```

```
 106 = Climatology check warning 37H channel
 107 = Climatology check warning 91V channel
 108 = Climatology check warning 91H channel
 109 = Climatology check warning 150H channel
 110 = Climatology check warning 183+/-1 channel
 111 = Climatology check warning 183+/-3 channel
 112 = Climatology check warning 183+/-7 channel
 113 = Climatology check warning Multiple enviro sensor channels
 114 = Climatology check warning Multiple imager sensor channels
 115 = Climatology check warning One or more LAS sensor channels
 116 = Climatology check warning One or more UAS sensor channels
 117 = Climatology check warning Correction for lunar intrusion into warm load
 118 = Climatology check warning Correction for solar intrusion into warm load

  -1 = Data is missing from file or unreadable
  -2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
  -3 = Error in geolocation data
  -4 = Data missing in one channel
  -5 = Data missing in multiple channels
  -6 = Lat/lon values are out of range
  -7 = Non-normal status modes
 -10 = Distance to corresponding LF pixel > 7 km
       (Used in L1C-R product only)
 -99 = Missing value (no quality information available)

-102 = Climatology check flagged in input BASE file
-110 = Climatology check failure 19V channel
-111 = Climatology check failure 19H channel
-112 = Climatology check failure 22V channel
-113 = Climatology check failure 37V channel
-114 = Climatology check failure 37H channel
-115 = Climatology check failure 91V channel
-116 = Climatology check failure 91H channel
-117 = Climatology check failure 150H channel
-118 = Climatology check failure 183+/-1 channel
-119 = Climatology check failure 183+/-3 channel
-120 = Climatology check failure 183+/-7 channel
-121 = Climatology check failure Multiple enviro sensor channels
-122 = Climatology check failure Multiple imager sensor channels
-123 = Climatology check failure One or more LAS sensor channels
-124 = Climatology check failure One or more UAS sensor channels
-125 = Failure of 150H channel on DMSP F18
```

incidenceAngle (4-byte float, array size: nchUIA3 x npixel3 x nscan3):
Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA3 x npixel3 x nscan3):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel3 x nscan3):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel3 x npixel3 x nscan3):
GPM Common Calibrated Brightness Temperature. The channels are:

```
  150 GHz horizontally-polarized TBs
  183.31 +/- 1 GHz horizontally-polarized TBs
```

```
183.31 +/- 3 GHz horizontally-polarized TBs
183.31 +/- 7 GHz horizontally-polarized TBs
```

S4 (Swath)

S4_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S4_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S4)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan4):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan4):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan4):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan4):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan4):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan4):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan4):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan4):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan4):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel4 x nscan4):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel4 x nscan4):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S4)

SCorientation (2-byte integer, array size: nscan4):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan4):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan4):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan4):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan4):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule.

Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel4 x nscan4):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
   0 = Good data
   1 = Possible sun glint
   2 = Possible radio frequency interference
   3 = Degraded geolocation data
   4 = Data corrected for warm load intrusion

 102 = Climatology check warning 19V channel
 103 = Climatology check warning 19H channel
 104 = Climatology check warning 22V channel
 105 = Climatology check warning 37V channel
 106 = Climatology check warning 37H channel
 107 = Climatology check warning 91V channel
 108 = Climatology check warning 91H channel
 109 = Climatology check warning 150H channel
 110 = Climatology check warning 183+/-1 channel
 111 = Climatology check warning 183+/-3 channel
 112 = Climatology check warning 183+/-7 channel
 113 = Climatology check warning Multiple enviro sensor channels
 114 = Climatology check warning Multiple imager sensor channels
 115 = Climatology check warning One or more LAS sensor channels
 116 = Climatology check warning One or more UAS sensor channels
 117 = Climatology check warning Correction for lunar intrusion into warm load
 118 = Climatology check warning Correction for solar intrusion into warm load

  -1 = Data is missing from file or unreadable
  -2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
```

```
  -3 = Error in geolocation data
  -4 = Data missing in one channel
  -5 = Data missing in multiple channels
  -6 = Lat/lon values are out of range
  -7 = Non-normal status modes
 -10 = Distance to corresponding LF pixel > 7 km
       (Used in L1C-R product only)
 -99 = Missing value (no quality information available)

-102 = Climatology check flagged in input BASE file
-110 = Climatology check failure 19V channel
-111 = Climatology check failure 19H channel
-112 = Climatology check failure 22V channel
-113 = Climatology check failure 37V channel
-114 = Climatology check failure 37H channel
-115 = Climatology check failure 91V channel
-116 = Climatology check failure 91H channel
-117 = Climatology check failure 150H channel
-118 = Climatology check failure 183+/-1 channel
-119 = Climatology check failure 183+/-3 channel
-120 = Climatology check failure 183+/-7 channel
-121 = Climatology check failure Multiple enviro sensor channels
-122 = Climatology check failure Multiple imager sensor channels
-123 = Climatology check failure One or more LAS sensor channels
-124 = Climatology check failure One or more UAS sensor channels
-125 = Failure of 150H channel on DMSP F18
```

incidenceAngle (4-byte float, array size: nchUIA4 x npixel4 x nscan4):
Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA4 x npixel4 x nscan4):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel4 x nscan4):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:
```

```
        incidenceAngle(2,npixel,nscan)
        sunGlintAngle(2,npixel,nscan)
        incidenceAngleIndex(10,nscan)
        Tc(10,npixel,nscan)

      The user would do the following to retreive the angles
      for a given channel, pixel, and scan:

        i = incidenceAngleIndex(channel,scan)
        ia = incidenceAngle(i,pixel,scan)
        sga = sunGlintAngle(i,pixel,scan)

      The incidenceAngleIndex is the same for every scan,
      but is repeated each scan for the convenience of users
      reading the data scan by scan.  In addition,
      incidenceAngleIndex is located in metadata for the
      convenience of users wishing to read this information
      from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel4 x npixel4 x nscan4):
GPM Common Calibrated Brightness Temperature. The channels are:

```
        91.665 GHz vertically-polarized   TBs
        91.665 GHz horizontally-polarized TBs
```

C Structure Header file:

```
#ifndef _TK_1CSSMIS_H_
#define _TK_1CSSMIS_H_

#ifndef _L1CSSMIS_S4_
#define _L1CSSMIS_S4_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[180];
    float Longitude[180];
    SCSTATUS SCstatus;
    signed char Quality[180];
```

```
    float incidenceAngle[180][1];
    signed char sunGlintAngle[180][1];
    signed char incidenceAngleIndex[2];
    float Tc[180][2];
} L1CSSMIS_S4;

#endif

#ifndef _L1CSSMIS_S3_
#define _L1CSSMIS_S3_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[180];
    float Longitude[180];
    SCSTATUS SCstatus;
    signed char Quality[180];
    float incidenceAngle[180][1];
    signed char sunGlintAngle[180][1];
    signed char incidenceAngleIndex[4];
    float Tc[180][4];
} L1CSSMIS_S3;

#endif

#ifndef _L1CSSMIS_S2_
#define _L1CSSMIS_S2_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[90];
    float Longitude[90];
    SCSTATUS SCstatus;
    signed char Quality[90];
    float incidenceAngle[90][1];
    signed char sunGlintAngle[90][1];
    signed char incidenceAngleIndex[2];
    float Tc[90][2];
} L1CSSMIS_S2;

#endif

#ifndef _SCSTATUS_
```

```
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1CSSMIS_S1_
#define _L1CSSMIS_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[90];
    float Longitude[90];
    SCSTATUS SCstatus;
    signed char Quality[90];
    float incidenceAngle[90][1];
    signed char sunGlintAngle[90][1];
    signed char incidenceAngleIndex[3];
    float Tc[90][3];
} L1CSSMIS_S1;
```

```
#endif

#ifndef _L1CSSMIS_SWATHS_
#define _L1CSSMIS_SWATHS_

typedef struct {
    L1CSSMIS_S1 S1;
    L1CSSMIS_S2 S2;
    L1CSSMIS_S3 S3;
    L1CSSMIS_S4 S4;
} L1CSSMIS_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1CSSMIS_S4/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(180)
    REAL*4 Longitude(180)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(180)
    REAL*4 incidenceAngle(1,180)
    BYTE sunGlintAngle(1,180)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,180)
END STRUCTURE

STRUCTURE /L1CSSMIS_S3/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(180)
    REAL*4 Longitude(180)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(180)
    REAL*4 incidenceAngle(1,180)
    BYTE sunGlintAngle(1,180)
    BYTE incidenceAngleIndex(4)
    REAL*4 Tc(4,180)
END STRUCTURE
```

```
STRUCTURE /L1CSSMIS_S2/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(90)
    REAL*4 Longitude(90)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(90)
    REAL*4 incidenceAngle(1,90)
    BYTE sunGlintAngle(1,90)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,90)
END STRUCTURE

STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1CSSMIS_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(90)
    REAL*4 Longitude(90)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(90)
    REAL*4 incidenceAngle(1,90)
    BYTE sunGlintAngle(1,90)
    BYTE incidenceAngleIndex(3)
    REAL*4 Tc(3,90)
END STRUCTURE
```

```
STRUCTURE /L1CSSMIS_SWATHS/
    RECORD /L1CSSMIS_S1/ S1
    RECORD /L1CSSMIS_S2/ S2
    RECORD /L1CSSMIS_S3/ S3
    RECORD /L1CSSMIS_S4/ S4
END STRUCTURE
```

5.13 1CAMSR2 - Common Calibrated Brightness Temperature

1CAMSR2 contains common calibrated brightness temperature from the AMSR2 passive microwave instrument flown on the GCOMW1 satellite. This products contains 6 swaths. Swath 1 has channels 10.65V 10.65H. Swath 2 has channels 18.7V 18.7H. Swath 3 has channels 23.8V 23.8H. Swath 4 has channels 36.5V 36.5H. Swath S5 has 2 high frequency A-Scan channels (89V 89H). Swath S6 has 2 high frequency B-Scan channels (89V 89H). Data for all six swaths is observed in the same revolution of the instrument. High frequency A and high frequency B data are observed in separate feedhorns.

RELATION BETWEEN THE SWATHS: Each S1 scan contains 10 GHz channels sampled 243 times along the scan. S2, S3, and S4 are sampled nominally at the same position as the S1 samples, but differ by small distances. Each S5 scan contains high frequency A channels sampled 486 times along the scan. Each S6 scan contains high frequency B channels sampled 486 times along the scan. Both Swath S5 and Swath S6 have exactly twice as many pixels as Swath S1. S1 pixels 1, 2, 3, ... coincide with S5 pixels 1, 3, 5, ... Scans of all swaths are repeated every 1.5s and the scans of one swath are about 10km apart along the direction of the satellite track. Along an S1 scan every other center of an S5 pixel coincides with the center of an S1 pixel, but the S6 pixels are offset from S1 and S2 pixels by nominally 15km in the direction normal to the scan direction on the aft side, in other words S6 pixels are nominally 15km "behind" the S1 and S5 pixels for the same scan.

The Figure below shows the locations of the pixels of scans 1 and 2 for swaths S1, S5, and S6. Since swaths S2, S3 and S4 are close to S1, they are omitted from the figure. Each "+" represents centers of pixels from one or more swaths. For example, the label "S1:1,2 S5:1,3" means that both Swath S1, Scan 1, Pixel 2 and Swath S5, Scan 1, Pixel 3 are located at the "+".

```
    S6:1,1       S6:1,2       S6:1,3                 S6:1,391      S6:1,392
      +            +            +       .......        +             +


    S6:2,1       S6:2,2       S6:2,3                 S6:2,391      S6:2,392
      +            +            +       .......        +             +

S1:1,1 S5:1,1    S5:1,2   S1:1,2 S5:1,3         S1:1,196 S5:1,391  S5:1,392
      +            +            +       .......        +             +


S1:2,1 S5:2,1    S5:2,2   S1:2,2 S5:2,3         S1:2,196 S5:2,391  S5:2,392
      +            +            +       .......        +             +
```

KNOWN PROBLEMS OR ISSUES :

None

Dimension definitions:

nscan1	var	Number of scans in Swath S1 in the granule.
nscan2	var	Number of scans in Swath S2 in the granule.
nscan3	var	Number of scans in Swath S3 in the granule.
nscan4	var	Number of scans in Swath S4 in the granule.
nscan5	var	Number of scans in Swath S5 in the granule.
nscan6	var	Number of scans in Swath S6 in the granule.
npixel1	243	Number of Swath S1 pixels in one scan.
npixel2	243	Number of Swath S2 pixels in one scan.
npixel3	243	Number of Swath S3 pixels in one scan.
npixel4	243	Number of Swath S4 pixels in one scan.
npixel5	486	Number of Swath S5 pixels in one scan.
npixel6	486	Number of Swath S6 pixels in one scan.
nchannel1	2	Number of Swath S1 channels.
nchannel2	2	Number of Swath S2 channels.
nchannel3	2	Number of Swath S3 channels.
nchannel4	2	Number of Swath S4 channels.
nchannel5	2	Number of Swath S5 channels.
nchannel6	2	Number of Swath S6 channels.
nchUIA1	1	Number of Swath S1 unique incidence angles.
nchUIA2	1	Number of Swath S2 unique incidence angles.
nchUIA3	1	Number of Swath S3 unique incidence angles.
nchUIA4	1	Number of Swath S4 unique incidence angles.
nchUIA5	1	Number of Swath S5 unique incidence angles.
nchUIA6	1	Number of Swath S6 unique incidence angles.

Figure 154 through Figure 172 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

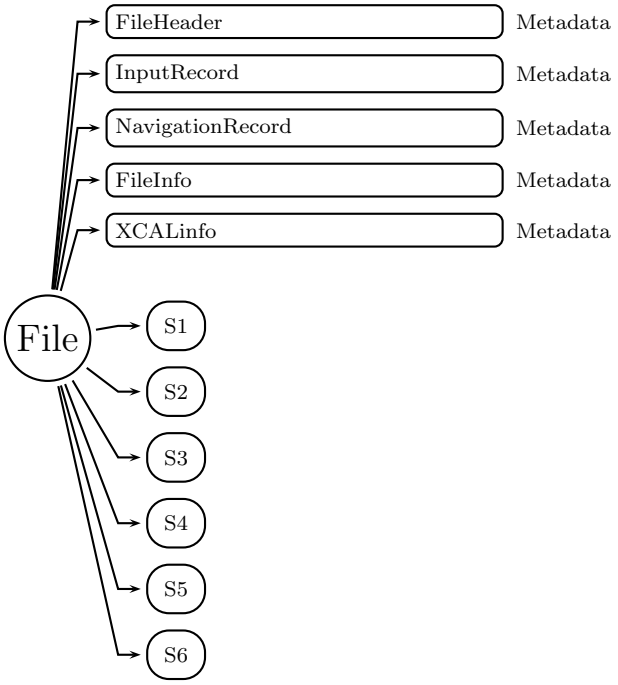


Figure 154: Data Format Structure for 1CAMSR2, Common Calibrated Brightness Temperature

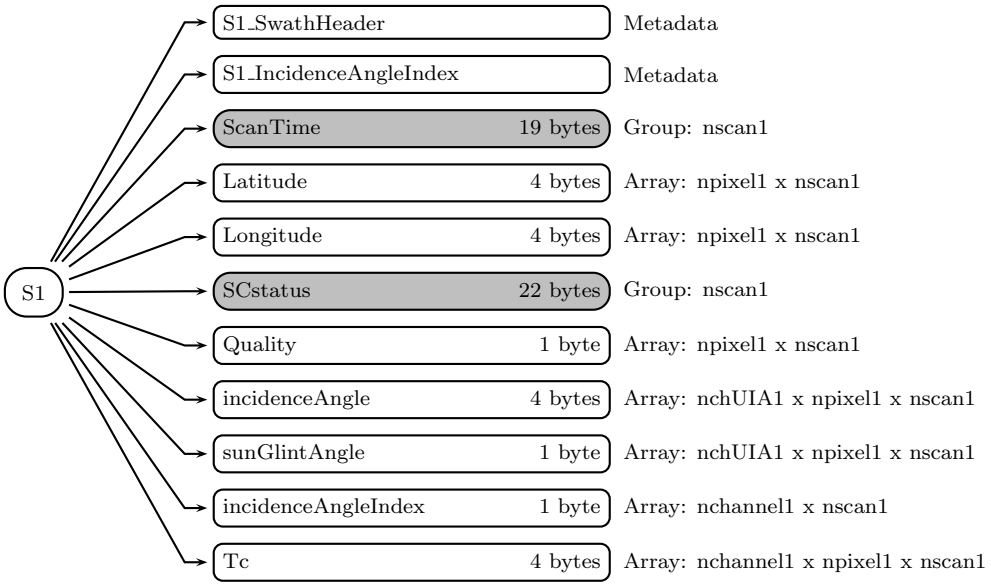


Figure 155: Data Format Structure for 1CAMSR2, S1

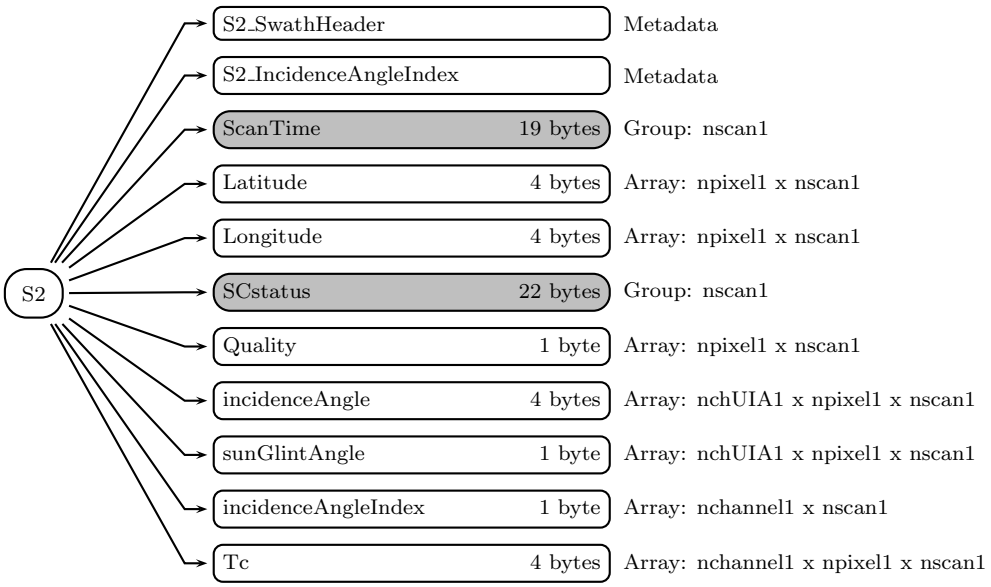


Figure 156: Data Format Structure for 1CAMSR2, S2

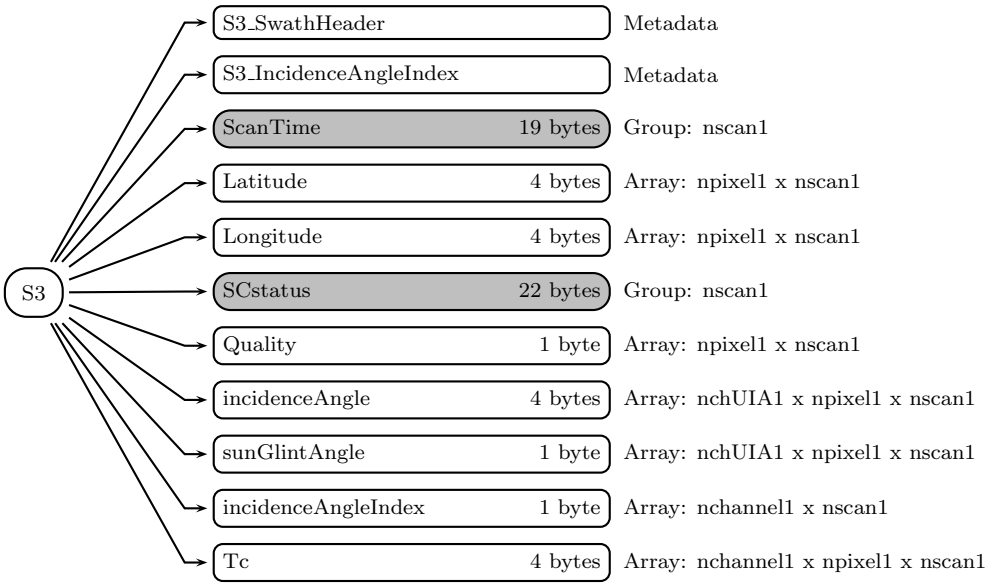


Figure 157: Data Format Structure for 1CAMSR2, S3

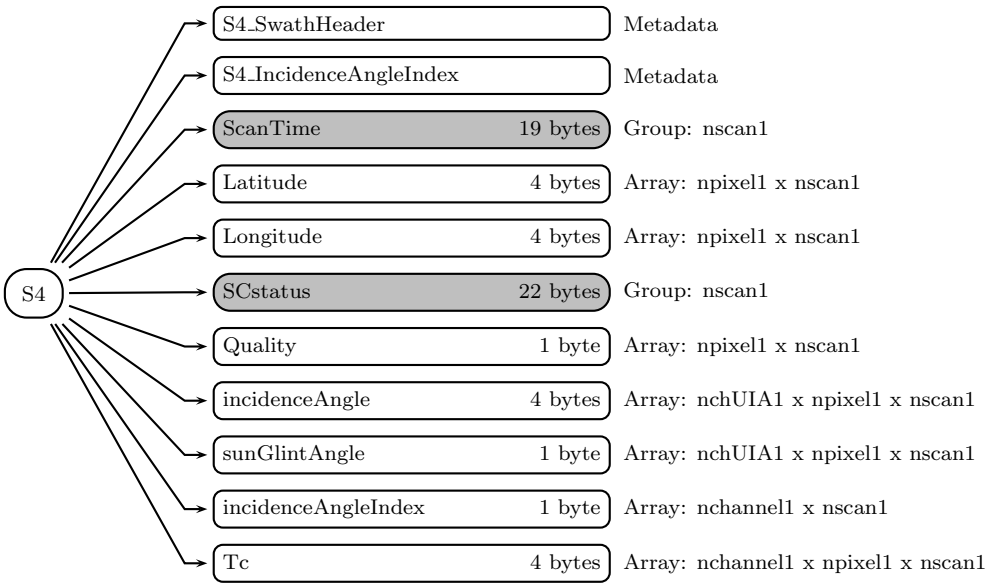


Figure 158: Data Format Structure for 1CAMSR2, S4

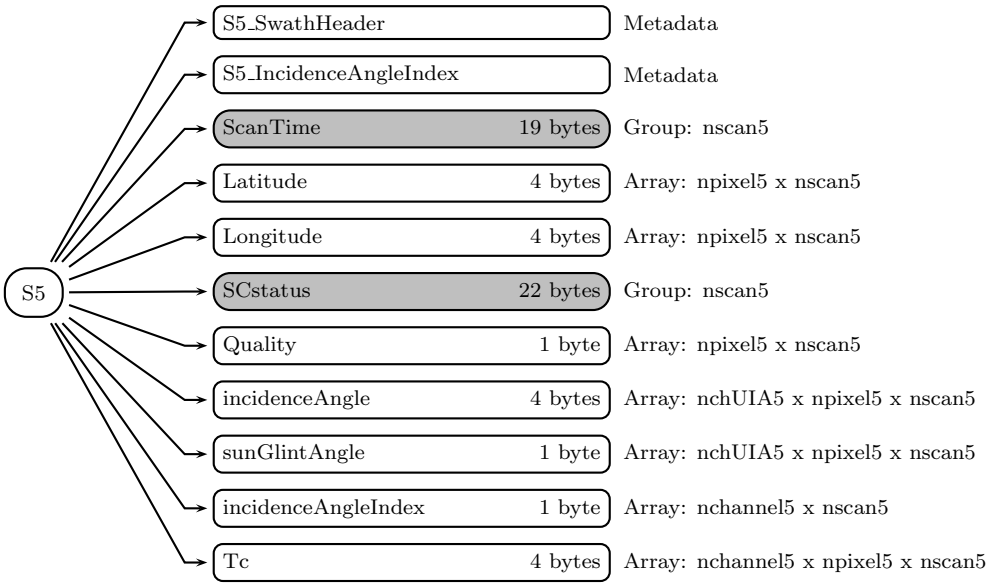


Figure 159: Data Format Structure for 1CAMSR2, S5

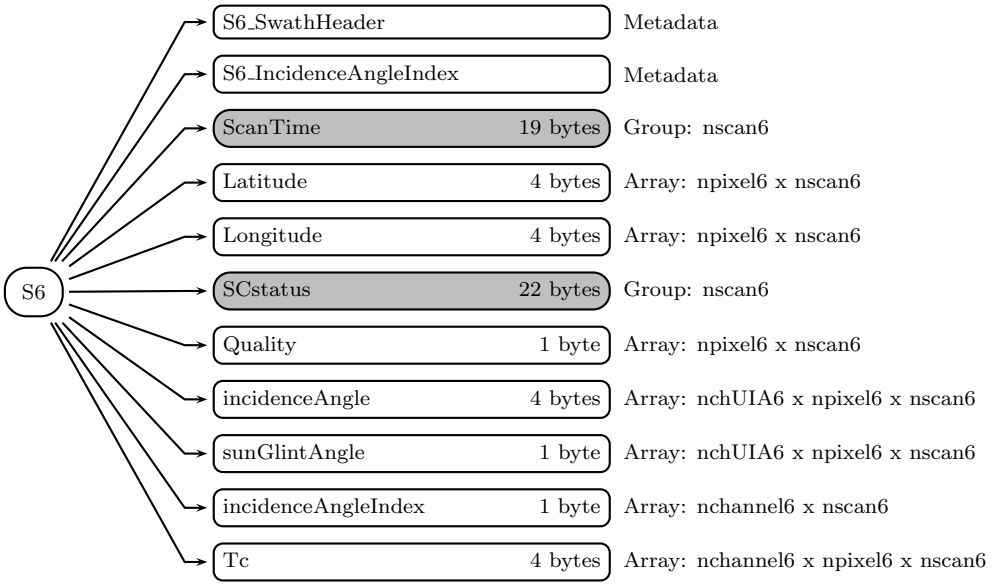


Figure 160: Data Format Structure for 1CAMSR2, S6

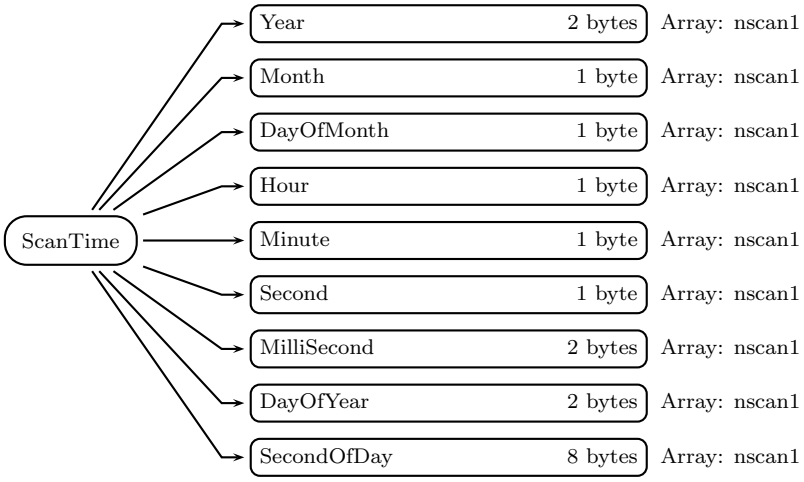


Figure 161: Data Format Structure for 1CAMSR2, S1, ScanTime

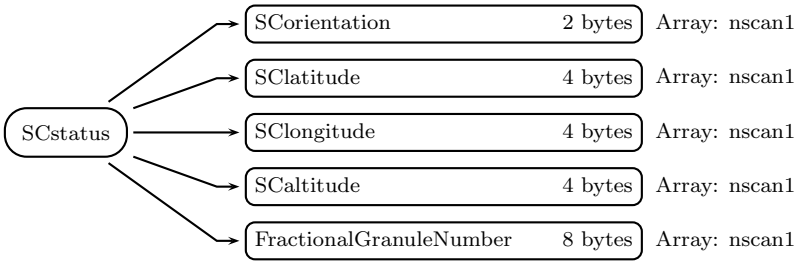


Figure 162: Data Format Structure for 1CAMSR2, S1, SCstatus

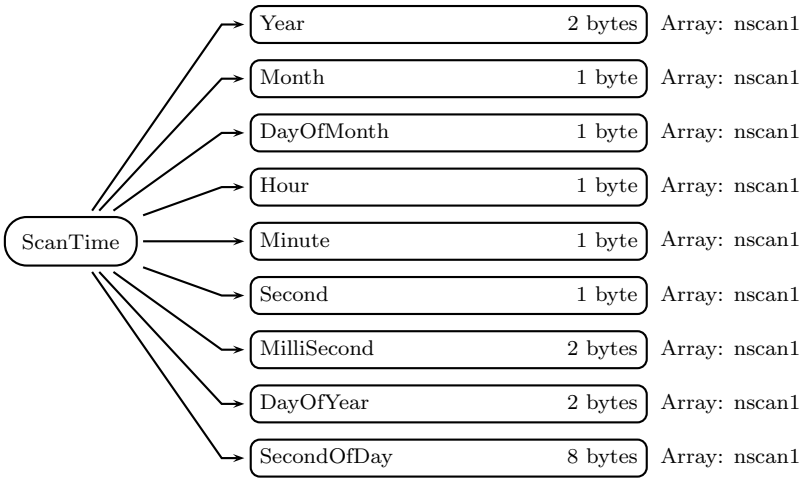


Figure 163: Data Format Structure for 1CAMSR2, S2, ScanTime

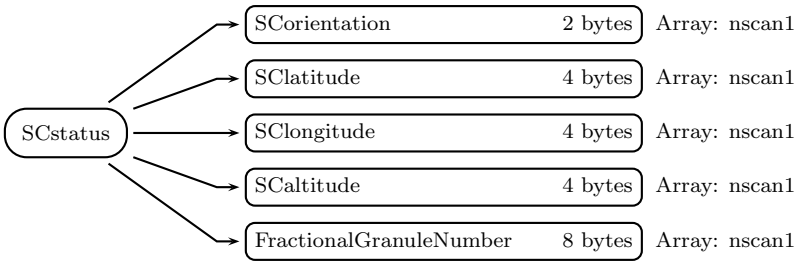


Figure 164: Data Format Structure for 1CAMSR2, S2, SCstatus

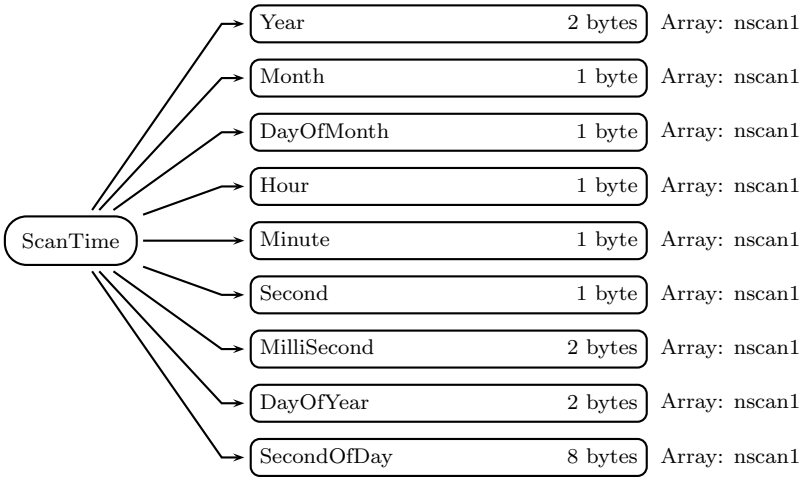


Figure 165: Data Format Structure for 1CAMSR2, S3, ScanTime

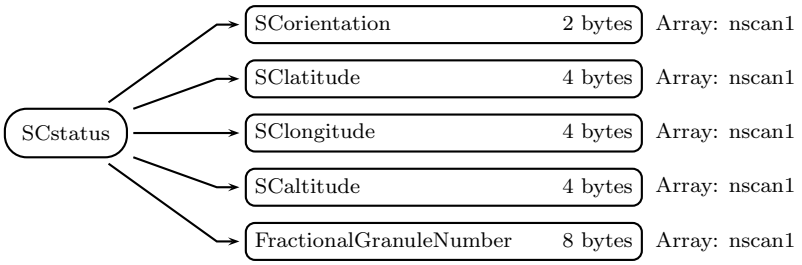


Figure 166: Data Format Structure for 1CAMSR2, S3, SCstatus

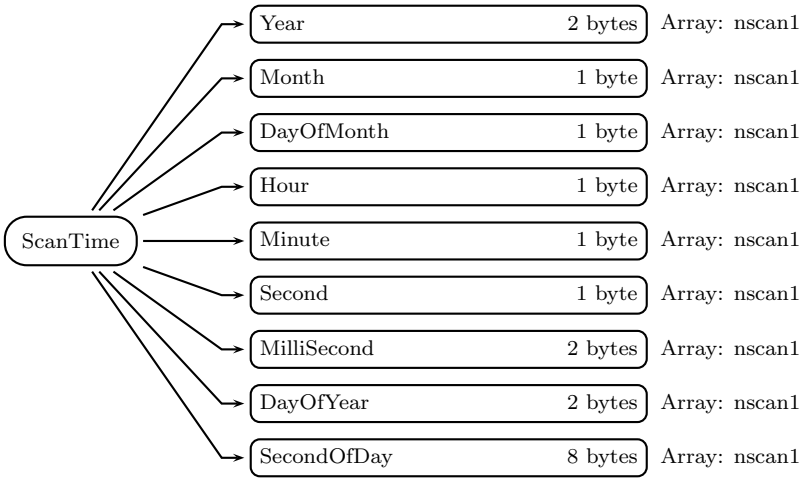


Figure 167: Data Format Structure for 1CAMSR2, S4, ScanTime

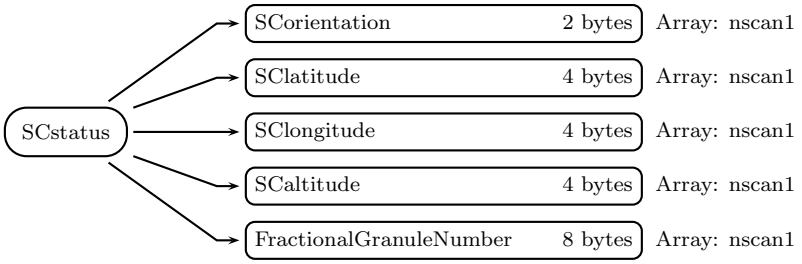


Figure 168: Data Format Structure for 1CAMSR2, S4, SCstatus

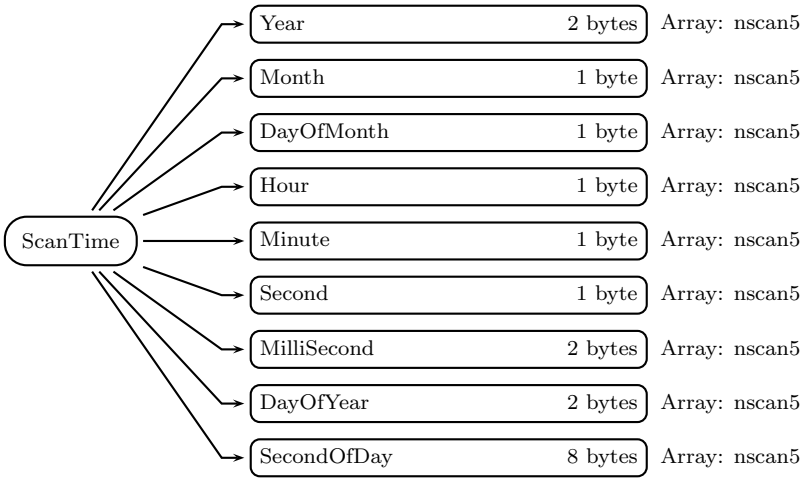


Figure 169: Data Format Structure for 1CAMSR2, S5, ScanTime

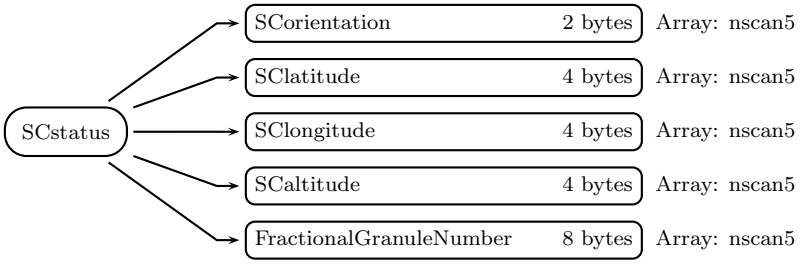


Figure 170: Data Format Structure for 1CAMSR2, S5, SCstatus

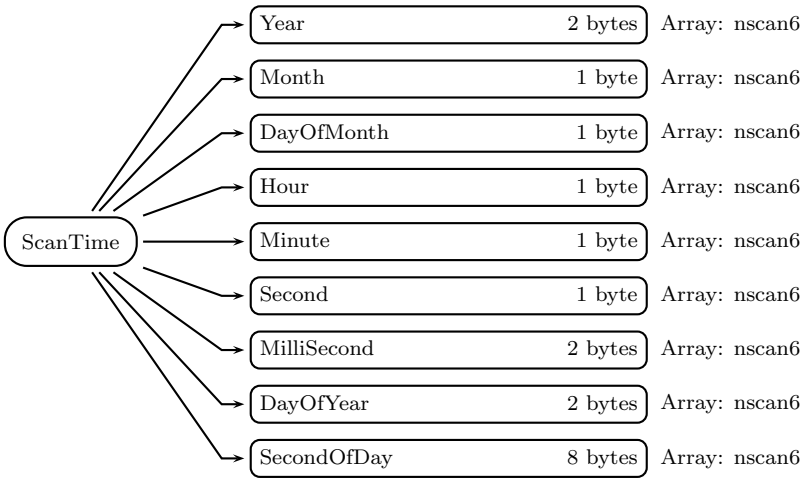


Figure 171: Data Format Structure for 1CAMSR2, S6, ScanTime

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

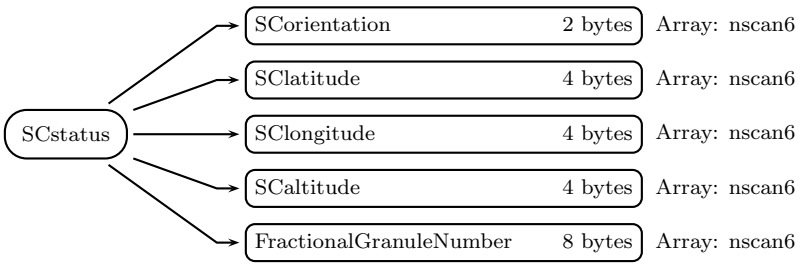


Figure 172: Data Format Structure for 1CAMSR2, S6, SCstatus

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

XCALinfo (Metadata):
XCALinfo contains metadata required by 1C intercalibrated files. See Metadata for GPM Products for details.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S1_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel1 x nscan1):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Longitude (4-byte float, array size: npixel1 x nscan1):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

SCstatus (Group in S1)

SCorientation (2-byte integer, array size: nscan1):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan1):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of

the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel1 x nscan1):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
   0 = Good data
   1 = Possible sun glint
   2 = Possible radio frequency interference
   3 = Degraded geolocation data
   4 = Data corrected for warm load intrusion

  -1 = Data is missing from file or unreadable
  -2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
  -3 = Error in geolocation data
  -4 = Data missing in one channel
  -5 = Data missing in multiple channels
  -6 = Lat/lon values are out of range
  -7 = Non-normal status modes
 -10 = Distance to corresponding LF pixel > 7 km
       (Used in L1C-R product only)
 -99 = Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1):
Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1):
GPM Common Calibrated Brightness Temperature. The channels are:

```
10.65    GHz vertically-polarized   TBs
10.65    GHz horizontally-polarized TBs
```

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S2_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel1 x nscan1):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Longitude (4-byte float, array size: npixel1 x nscan1):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

SCstatus (Group in S2)

SCorientation (2-byte integer, array size: nscan1):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan1):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel1 x nscan1):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
```

```
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
   0 = Good data
   1 = Possible sun glint
   2 = Possible radio frequency interference
   3 = Degraded geolocation data
   4 = Data corrected for warm load intrusion

  -1 = Data is missing from file or unreadable
  -2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
  -3 = Error in geolocation data
  -4 = Data missing in one channel
  -5 = Data missing in multiple channels
  -6 = Lat/lon values are out of range
  -7 = Non-normal status modes
 -10 = Distance to corresponding LF pixel > 7 km
       (Used in L1C-R product only)
 -99 = Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1):
Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)
```

```
The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1):
GPM Common Calibrated Brightness Temperature. The channels are:

```
18.7     GHz vertically-polarized   TBs
18.7     GHz horizontally-polarized TBs
```

S3 (Swath)

S3_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S3_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S3)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel1 x nscan1):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Longitude (4-byte float, array size: npixel1 x nscan1):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

SCstatus (Group in S3)

SCorientation (2-byte integer, array size: nscan1):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values

are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan1):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel1 x nscan1):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
   0 = Good data
   1 = Possible sun glint
   2 = Possible radio frequency interference
   3 = Degraded geolocation data
   4 = Data corrected for warm load intrusion

  -1 = Data is missing from file or unreadable
  -2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
  -3 = Error in geolocation data
  -4 = Data missing in one channel
```

```
  -5 = Data missing in multiple channels
  -6 = Lat/lon values are out of range
  -7 = Non-normal status modes
 -10 = Distance to corresponding LF pixel > 7 km
       (Used in L1C-R product only)
 -99 = Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1):
Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1):
GPM Common Calibrated Brightness Temperature. The channels are:

```
23.8     GHz vertically-polarized   TBs
23.8     GHz horizontally-polarized TBs
```

S4 (Swath)

S4_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S4_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S4)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel1 x nscan1):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Longitude (4-byte float, array size: npixel1 x nscan1):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

SCstatus (Group in S4)

SCorientation (2-byte integer, array size: nscan1):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan1):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of

the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel1 x nscan1):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
   0 = Good data
   1 = Possible sun glint
   2 = Possible radio frequency interference
   3 = Degraded geolocation data
   4 = Data corrected for warm load intrusion

  -1 = Data is missing from file or unreadable
  -2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
  -3 = Error in geolocation data
  -4 = Data missing in one channel
  -5 = Data missing in multiple channels
  -6 = Lat/lon values are out of range
  -7 = Non-normal status modes
 -10 = Distance to corresponding LF pixel > 7 km
       (Used in L1C-R product only)
 -99 = Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1):
Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1):
GPM Common Calibrated Brightness Temperature. The channels are:

```
36.5     GHz vertically-polarized   TBs
36.5     GHz horizontally-polarized TBs
```

S5 (Swath)

S5_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S5_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S5)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan5):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan5):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan5):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan5):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan5):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan5):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan5):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan5):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan5):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel5 x nscan5):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel5 x nscan5):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S5)

SCorientation (2-byte integer, array size: nscan5):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan5):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan5):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan5):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan5):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel5 x nscan5):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
```

```
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
   0 = Good data
   1 = Possible sun glint
   2 = Possible radio frequency interference
   3 = Degraded geolocation data
   4 = Data corrected for warm load intrusion

  -1 = Data is missing from file or unreadable
  -2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
  -3 = Error in geolocation data
  -4 = Data missing in one channel
  -5 = Data missing in multiple channels
  -6 = Lat/lon values are out of range
  -7 = Non-normal status modes
 -10 = Distance to corresponding LF pixel > 7 km
       (Used in L1C-R product only)
 -99 = Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA5 x npixel5 x nscan5):
Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA5 x npixel5 x nscan5):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel5 x nscan5):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
```

```
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel5 x npixel5 x nscan5):
GPM Common Calibrated Brightness Temperature. The channels are:

```
89 GHz vertically-polarized   TBs
89 GHz horizontally-polarized TBs
```

S6 (Swath)

S6_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S6_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S6)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan6):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan6):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan6):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan6):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan6):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan6):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan6):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan6):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan6):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel6 x nscan6):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel6 x nscan6):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S6)

SCorientation (2-byte integer, array size: nscan6):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan6):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan6):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan6):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan6):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel6 x nscan6):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
   0 = Good data
   1 = Possible sun glint
```

```
  2 = Possible radio frequency interference
  3 = Degraded geolocation data
  4 = Data corrected for warm load intrusion

 -1 = Data is missing from file or unreadable
 -2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
 -3 = Error in geolocation data
 -4 = Data missing in one channel
 -5 = Data missing in multiple channels
 -6 = Lat/lon values are out of range
 -7 = Non-normal status modes
-10 = Distance to corresponding LF pixel > 7 km
      (Used in L1C-R product only)
-99 = Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA6 x npixel6 x nscan6):
Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA6 x npixel6 x nscan6):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel6 x nscan6):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)
```

```
The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel6 x npixel6 x nscan6):
GPM Common Calibrated Brightness Temperature. The channels are:

```
89 GHz vertically-polarized TBs
89 GHz horizontally-polarized TBs
```

C Structure Header file:

```
#ifndef _TK_1CAMSR2_H_
#define _TK_1CAMSR2_H_

#ifndef _L1CAMSR2_S6_
#define _L1CAMSR2_S6_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[486];
    float Longitude[486];
    SCSTATUS SCstatus;
    signed char Quality[486];
    float incidenceAngle[486][1];
    signed char sunGlintAngle[486][1];
    signed char incidenceAngleIndex[2];
    float Tc[486][2];
} L1CAMSR2_S6;

#endif

#ifndef _L1CAMSR2_S5_
#define _L1CAMSR2_S5_

typedef struct {
```

```
    SCANTIME ScanTime;
    float Latitude[486];
    float Longitude[486];
    SCSTATUS SCstatus;
    signed char Quality[486];
    float incidenceAngle[486][1];
    signed char sunGlintAngle[486][1];
    signed char incidenceAngleIndex[2];
    float Tc[486][2];
} L1CAMSR2_S5;

#endif

#ifndef _L1CAMSR2_S4_
#define _L1CAMSR2_S4_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[243];
    float Longitude[243];
    SCSTATUS SCstatus;
    signed char Quality[243];
    float incidenceAngle[243][1];
    signed char sunGlintAngle[243][1];
    signed char incidenceAngleIndex[2];
    float Tc[243][2];
} L1CAMSR2_S4;

#endif

#ifndef _L1CAMSR2_S3_
#define _L1CAMSR2_S3_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[243];
    float Longitude[243];
    SCSTATUS SCstatus;
    signed char Quality[243];
    float incidenceAngle[243][1];
    signed char sunGlintAngle[243][1];
    signed char incidenceAngleIndex[2];
    float Tc[243][2];
```

```
} L1CAMSR2_S3;

#endif

#ifndef _L1CAMSR2_S2_
#define _L1CAMSR2_S2_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[243];
    float Longitude[243];
    SCSTATUS SCstatus;
    signed char Quality[243];
    float incidenceAngle[243][1];
    signed char sunGlintAngle[243][1];
    signed char incidenceAngleIndex[2];
    float Tc[243][2];
} L1CAMSR2_S2;

#endif

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
```

```
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1CAMSR2_S1_
#define _L1CAMSR2_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[243];
    float Longitude[243];
    SCSTATUS SCstatus;
    signed char Quality[243];
    float incidenceAngle[243][1];
    signed char sunGlintAngle[243][1];
    signed char incidenceAngleIndex[2];
    float Tc[243][2];
} L1CAMSR2_S1;

#endif

#ifndef _L1CAMSR2_SWATHS_
#define _L1CAMSR2_SWATHS_

typedef struct {
    L1CAMSR2_S1 S1;
    L1CAMSR2_S2 S2;
    L1CAMSR2_S3 S3;
    L1CAMSR2_S4 S4;
    L1CAMSR2_S5 S5;
    L1CAMSR2_S6 S6;
} L1CAMSR2_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1CAMSR2_S6/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(486)
    REAL*4 Longitude(486)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(486)
    REAL*4 incidenceAngle(1,486)
    BYTE sunGlintAngle(1,486)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,486)
END STRUCTURE

STRUCTURE /L1CAMSR2_S5/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(486)
    REAL*4 Longitude(486)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(486)
    REAL*4 incidenceAngle(1,486)
    BYTE sunGlintAngle(1,486)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,486)
END STRUCTURE

STRUCTURE /L1CAMSR2_S4/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(243)
    REAL*4 Longitude(243)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(243)
    REAL*4 incidenceAngle(1,243)
    BYTE sunGlintAngle(1,243)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,243)
END STRUCTURE

STRUCTURE /L1CAMSR2_S3/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(243)
    REAL*4 Longitude(243)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(243)
    REAL*4 incidenceAngle(1,243)
```

```
    BYTE sunGlintAngle(1,243)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,243)
END STRUCTURE

STRUCTURE /L1CAMSR2_S2/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(243)
    REAL*4 Longitude(243)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(243)
    REAL*4 incidenceAngle(1,243)
    BYTE sunGlintAngle(1,243)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,243)
END STRUCTURE

STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1CAMSR2_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(243)
    REAL*4 Longitude(243)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(243)
```

```
    REAL*4 incidenceAngle(1,243)
    BYTE sunGlintAngle(1,243)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,243)
END STRUCTURE

STRUCTURE /L1CAMSR2_SWATHS/
    RECORD /L1CAMSR2_S1/ S1
    RECORD /L1CAMSR2_S2/ S2
    RECORD /L1CAMSR2_S3/ S3
    RECORD /L1CAMSR2_S4/ S4
    RECORD /L1CAMSR2_S5/ S5
    RECORD /L1CAMSR2_S6/ S6
END STRUCTURE
```

5.14 1CMHS - Common Calibrated Brightness Temperature

1CMHS contains common calibrated brightness temperature from the MHS passive microwave instrument flown on the NOAA and METOPS satellites. Swath S1 is the only swath and has 5 channels (89.0GHzV, 157.0GHzV, 183.3GHz+/-250MHzH, 183.3GHz+/-500MHzH, and 190.3 GHzV). MHS is very similar to AMSU-B. The scan period is 2.667s.

RELATION BETWEEN THE SWATHS: S1 is the only swath, containing observations sampled 90 times along the scan.

KNOWN PROBLEMS OR ISSUES WITH REVISION 1 DATA: None.

Dimension definitions:

nscan1	var	Number of Swath 1 scans in the granule.
nchannel1	5	Number of Swath 1 channels.
npixel1	90	Number of Swath 1 pixels in one scan.
nchUIA1	1	Number of Swath S1 unique incidence angles.

Figure 173 through Figure 176 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

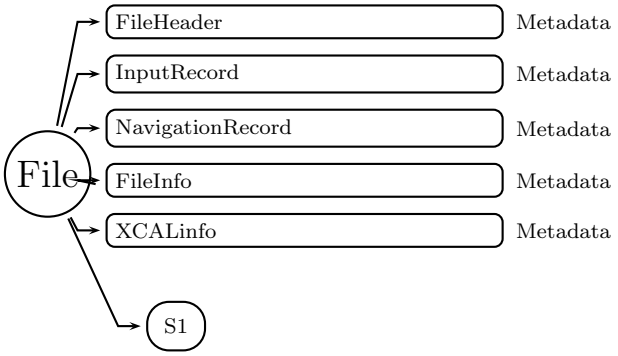


Figure 173: Data Format Structure for 1CMHS, Common Calibrated Brightness Temperature

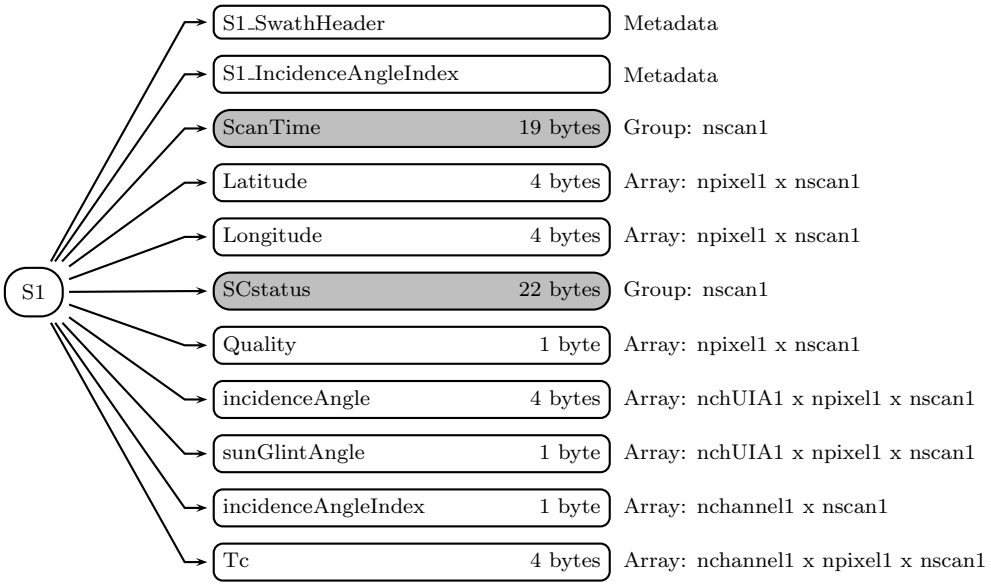


Figure 174: Data Format Structure for 1CMHS, S1

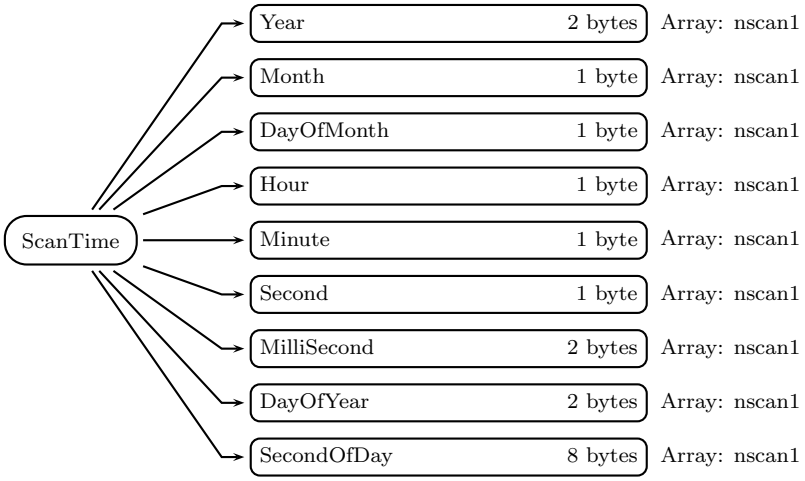


Figure 175: Data Format Structure for 1CMHS, ScanTime

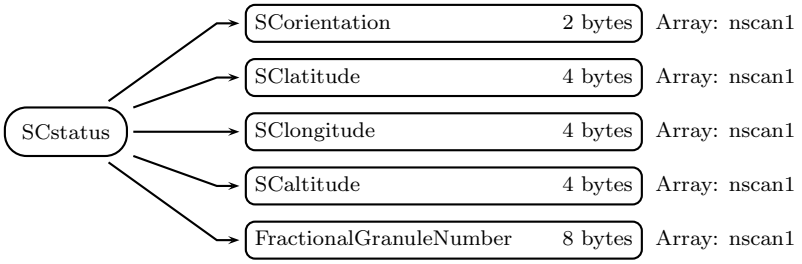


Figure 176: Data Format Structure for 1CMHS, SCstatus

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

XCALinfo (Metadata):
XCALinfo contains metadata required by 1C intercalibrated files. See Metadata for GPM Products for details.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S1_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel1 x nscan1):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel1 x nscan1):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCstatus (Group)

SCorientation (2-byte integer, array size: nscan1):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values

are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan1):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel1 x nscan1):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
   0 = Good data
   1 = Possible sun glint
   2 = Possible radio frequency interference
   3 = Degraded geolocation data
   4 = Data corrected for warm load intrusion

  -1 = Data is missing from file or unreadable
  -2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
  -3 = Error in geolocation data
  -4 = Data missing in one channel
```

```
  -5 = Data missing in multiple channels
  -6 = Lat/lon values are out of range
  -7 = Non-normal status modes
 -10 = Distance to corresponding LF pixel > 7 km
       (Used in L1C-R product only)
 -99 = Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1):
Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1):
GPM Common Calibrated Brightness Temperature. The channels are:

```
 89.0   GHz vertically-polarized   TBs
157.0   GHz vertically-polarized   TBs
183.3   GHz +/-250MHzH  horizontally-polarized   TBs
183.3   GHz +/-500MHzH  horizontally-polarized   TBs
190.3   GHz vertically-polarized   TBs
```

C Structure Header file:

```
#ifndef _TK_1CMHS_H_
#define _TK_1CMHS_H_

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;
```

```
#endif

#ifndef _L1CMHS_S1_
#define _L1CMHS_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[90];
    float Longitude[90];
    SCSTATUS SCstatus;
    signed char Quality[90];
    float incidenceAngle[90][1];
    signed char sunGlintAngle[90][1];
    signed char incidenceAngleIndex[5];
    float Tc[90][5];
} L1CMHS_S1;

#endif

#ifndef _L1CMHS_SWATHS_
#define _L1CMHS_SWATHS_

typedef struct {
    L1CMHS_S1 S1;
} L1CMHS_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
```

```
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1CMHS_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(90)
    REAL*4 Longitude(90)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(90)
    REAL*4 incidenceAngle(1,90)
    BYTE sunGlintAngle(1,90)
    BYTE incidenceAngleIndex(5)
    REAL*4 Tc(5,90)
END STRUCTURE

STRUCTURE /L1CMHS_SWATHS/
    RECORD /L1CMHS_S1/ S1
END STRUCTURE
```

5.15 1CSAPHIR - Common Calibrated Brightness Temperature

1CSAPHIR contains common calibrated brightness temperature from the SAPHIR passive microwave instrument flown on the Megha-Tropiques satellite. Swath S1 is the only swath and has 6 channels (S1 S2 S3 S4 S5 S6) The channels are 183.1 +/- delta GHz, where delta = 0.2, 1.1, 2.8, 4.2, 6.8, 11.0.

RELATION BETWEEN THE SWATHS: S1 is the only swath, containing observations sampled 182 times along the scan.

KNOWN PROBLEMS OR ISSUES WITH REVISION 1 DATA: None.

Dimension definitions:

nscan1	var	Number of Swath 1 scans in the granule.
nchannel1	6	Number of Swath 1 channels.
npixel1	182	Number of Swath 1 pixels in one scan.
nchUIA1	1	Number of Swath S1 unique incidence angles.

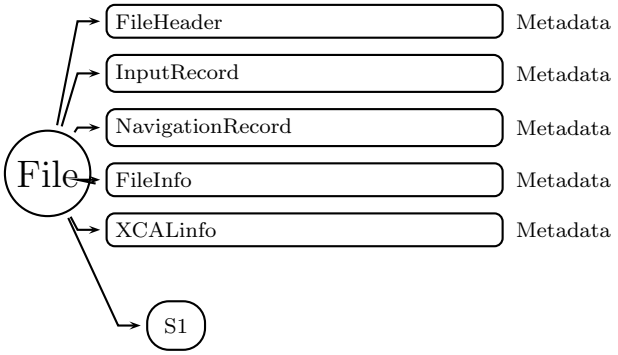


Figure 177: Data Format Structure for 1CSAPHIR, Common Calibrated Brightness Temperature

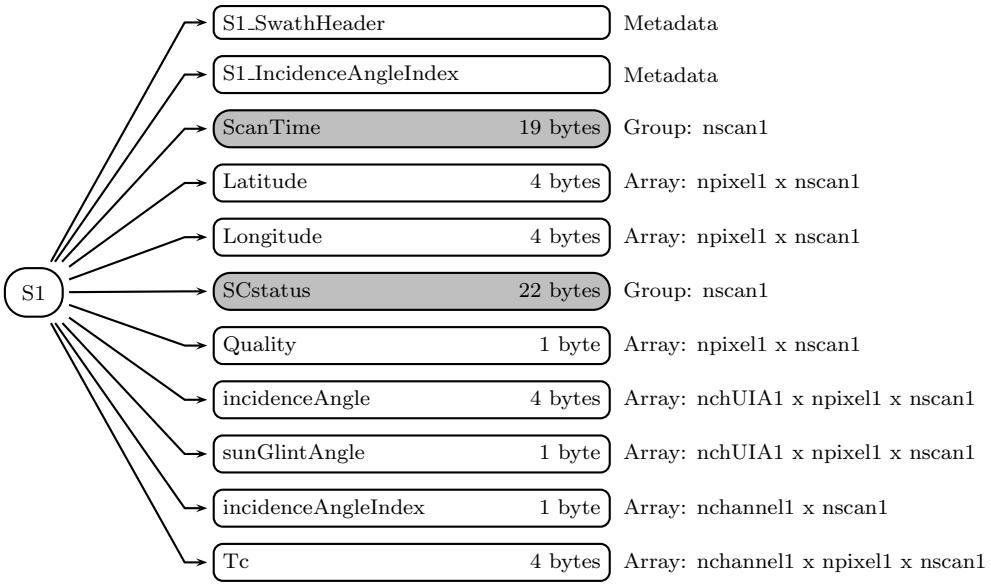


Figure 178: Data Format Structure for 1CSAPHIR, S1

Figure 177 through Figure 180 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in

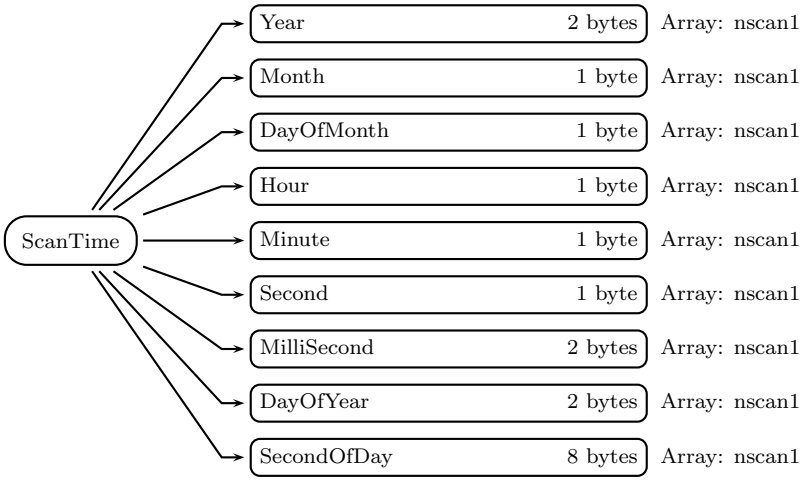


Figure 179: Data Format Structure for 1CSAPHIR, ScanTime

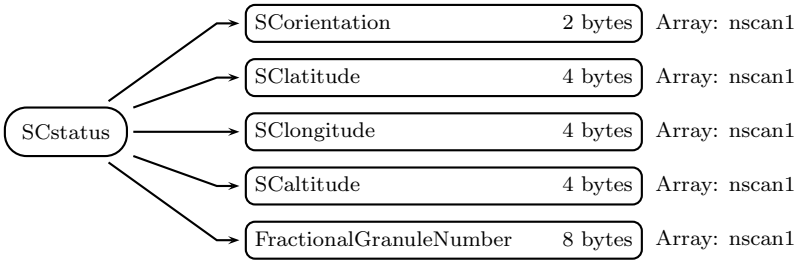


Figure 180: Data Format Structure for 1CSAPHIR, SCstatus

Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

XCALinfo (Metadata):
XCALinfo contains metadata required by 1C intercalibrated files. See Metadata for GPM Products for details.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S1_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel1 x nscan1):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel1 x nscan1):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCstatus (Group)

SCorientation (2-byte integer, array size: nscan1):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan1):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel1 x nscan1):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
   0 = Good data
   1 = Possible sun glint
   2 = Possible radio frequency interference
   3 = Degraded geolocation data
   4 = Data corrected for warm load intrusion

 101 = Backward scanning

  -1 = Data is missing from file or unreadable
  -2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
  -3 = Error in geolocation data
  -4 = Data missing in one channel
  -5 = Data missing in multiple channels
  -6 = Lat/lon values are out of range
  -7 = Non-normal status modes
 -10 = Distance to corresponding LF pixel > 7 km
       (Used in L1C-R product only)
 -99 = Missing value (no quality information available)
```

```
-100 = Invalid scan
-101 = Scan error
-102 = date/time error
-103 = PRT error
-104 = CRC error
-105 = Payload not nominal
-110 = Channel is off
-111 = L0 count saturated or has poor value
-112 = Hot/cold count not available
-113 = Calibration issue
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1):
Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
```

```
      convenience of users wishing to read this information
      from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1):
GPM Common Calibrated Brightness Temperature. The channels are:

```
(S1 S2 S3 S4 S5 S6)
      183.1 +/- delta GHz, where
      delta = 0.2, 1.1, 2.8, 4.2, 6.8, 11.0.
```

C Structure Header file:

```
#ifndef _TK_1CSAPHIR_H_
#define _TK_1CSAPHIR_H_

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
```

```
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1CSAPHIR_S1_
#define _L1CSAPHIR_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[182];
    float Longitude[182];
    SCSTATUS SCstatus;
    signed char Quality[182];
    float incidenceAngle[182][1];
    signed char sunGlintAngle[182][1];
    signed char incidenceAngleIndex[6];
    float Tc[182][6];
} L1CSAPHIR_S1;

#endif

#ifndef _L1CSAPHIR_SWATHS_
#define _L1CSAPHIR_SWATHS_

typedef struct {
    L1CSAPHIR_S1 S1;
} L1CSAPHIR_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE
```

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1CSAPHIR_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(182)
    REAL*4 Longitude(182)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(182)
    REAL*4 incidenceAngle(1,182)
    BYTE sunGlintAngle(1,182)
    BYTE incidenceAngleIndex(6)
    REAL*4 Tc(6,182)
END STRUCTURE

STRUCTURE /L1CSAPHIR_SWATHS/
    RECORD /L1CSAPHIR_S1/ S1
END STRUCTURE
```

5.16 1CATMS - Common Calibrated Brightness Temperature

1CATMS contains common calibrated brightness temperature from the ATMS passive microwave instrument flown on the Suomi NPP satellite and JPSS satellites. ATMS is approximatly a combination of the AMSU-A channels and the MHS channels. ATMS rotates 3 scans per 8 seconds. ATMS has the following 22 channels:

Ch	GHz	Pol
1	23.8	QV
2	31.4	QV
3	50.3	QH
4	51.76	QH
5	52.8	QH

```
6   53.596+-0.115      QH
7   54.4               QH
8   54.94              QH
9   55.5               QH
10  fo = 57.29         QH
11  fo+-0.3222+-0.217  QH
12  fo+-0.3222+-0.048  QH
13  fo+-0.3222+-0.022  QH
14  fo+-0.3222+-0.010  QH
15  fo+-0.3222+-0.0045 QH
16  88.2               QV
17  165.5              QH
18  183.31+-7          QH
19  183.31+-4.5        QH
20  183.31+-3          QH
21  183.31+-1.8        QH
22  183.31+-1          QH

QV means quasi-vertical;
the polarization vector is parallel
to the scan plane at nadir.
QH meansquasi-horizontal polarization.


Note on geolocation and 1C swaths:
The BeamLatitude and BeamLongitude in ATMSBASE
have a band dimension of 5.  Lat and lon is for channels
1,2,3,16,17.  Each 1C swath will contain one band:

1C swath   Band   IEEE GHz       Ch geo   Chs in band
1          K      18-26.5        1        1
2          A(Ka)  26.5-40        2        2
3          W      75-110         16       16
4          G      110-300        17       17-22

Note that channels 3-15 are NOT included
in the 1C product.
```

1CATMS contains 4 swaths, one for each band K, A(Ka), W, and G.

RELATION BETWEEN THE SWATHS: All 4 swaths contain observations sampled 96 times along the scan.

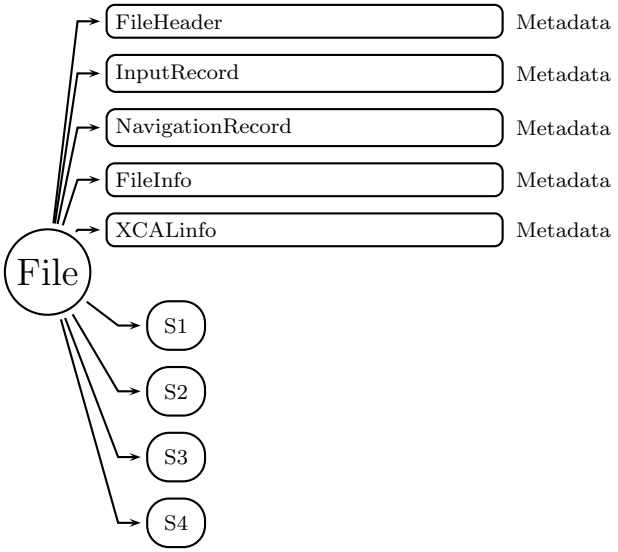


Figure 181: Data Format Structure for 1CATMS, Common Calibrated Brightness Temperature

KNOWN PROBLEMS OR ISSUES WITH REVISION 1 DATA: None.

Dimension definitions:

nscan1	var	Number of Swath 1 scans in the granule.
nchannel1	1	Number of Swath 1 channels.
npixel1	96	Number of Swath 1 pixels in one scan.
nchUIA1	1	Number of Swath S1 unique incidence angles.
nscan2	var	Number of Swath 2 scans in the granule.
nchannel2	1	Number of Swath 2 channels.
npixel2	96	Number of Swath 2 pixels in one scan.
nchUIA2	1	Number of Swath S2 unique incidence angles.
nscan3	var	Number of Swath 3 scans in the granule.
nchannel3	1	Number of Swath 3 channels.
npixel3	96	Number of Swath 3 pixels in one scan.
nchUIA3	1	Number of Swath S3 unique incidence angles.
nscan4	var	Number of Swath 4 scans in the granule.
nchannel4	6	Number of Swath 4 channels.
npixel4	96	Number of Swath 4 pixels in one scan.
nchUIA4	1	Number of Swath S4 unique incidence angles.

Figure 181 through Figure 193 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

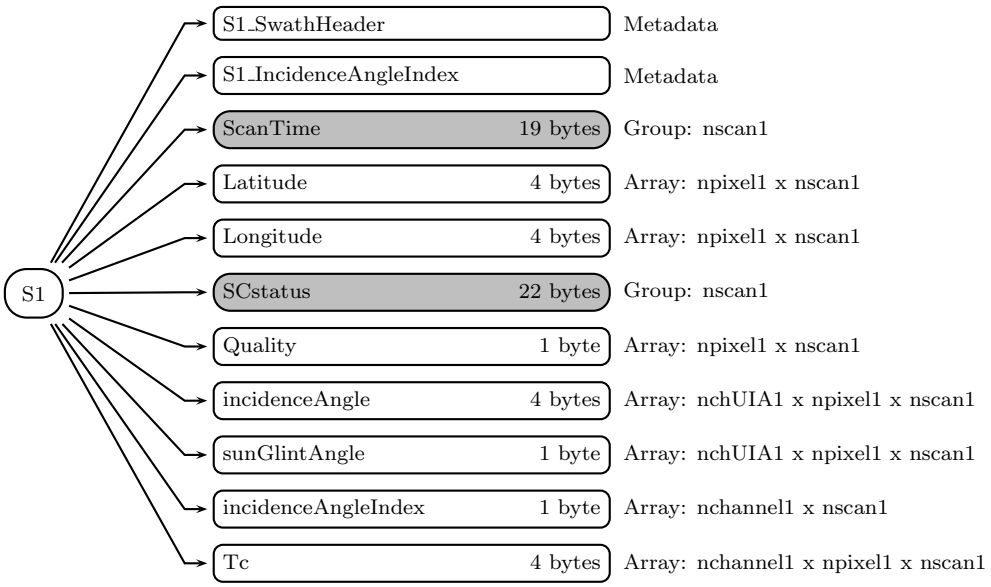


Figure 182: Data Format Structure for 1CATMS, S1

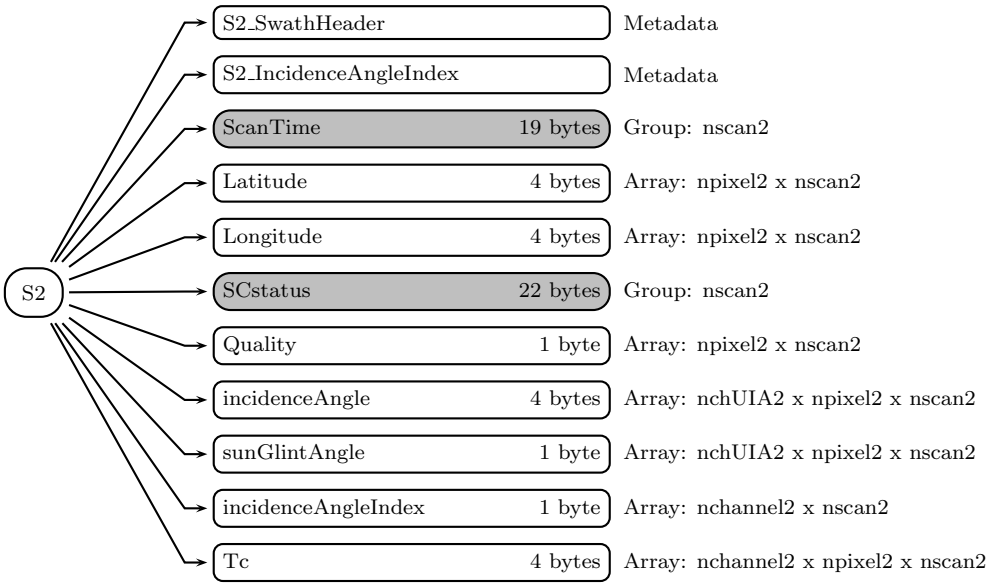


Figure 183: Data Format Structure for 1CATMS, S2

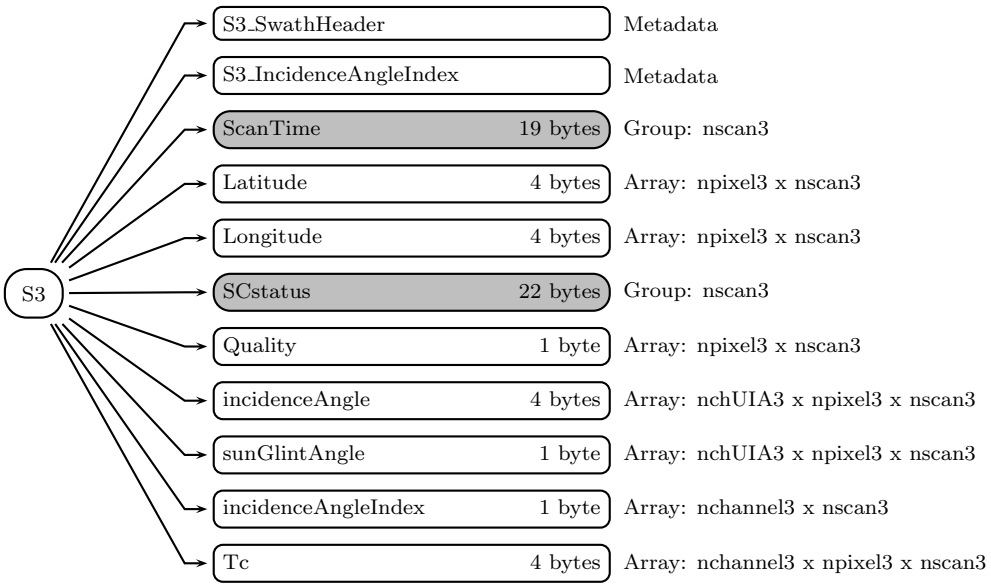


Figure 184: Data Format Structure for 1CATMS, S3

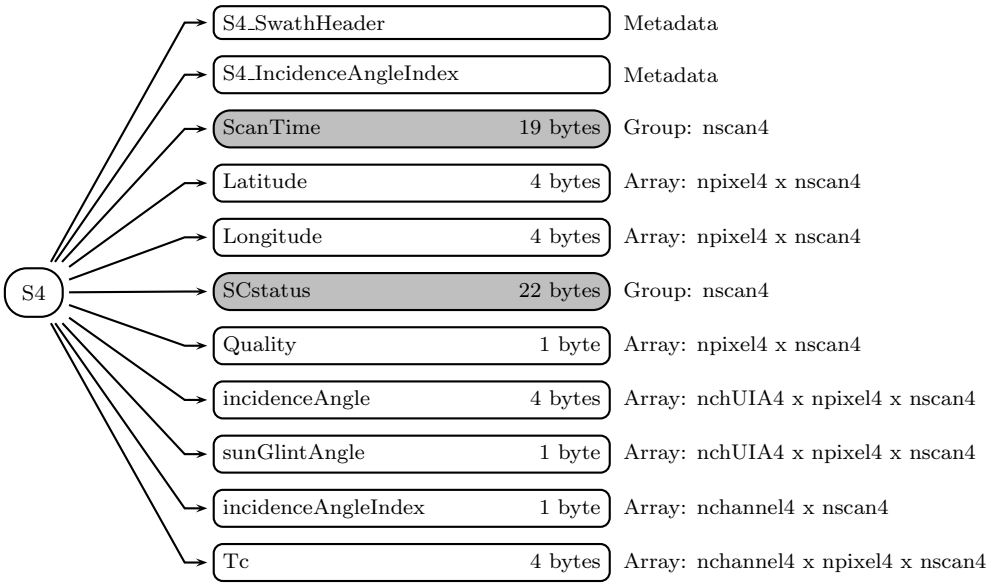


Figure 185: Data Format Structure for 1CATMS, S4

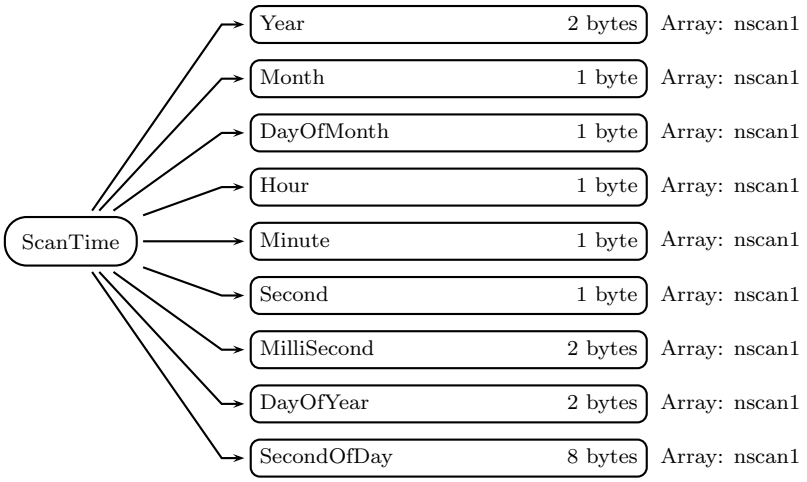


Figure 186: Data Format Structure for 1CATMS, S1, ScanTime

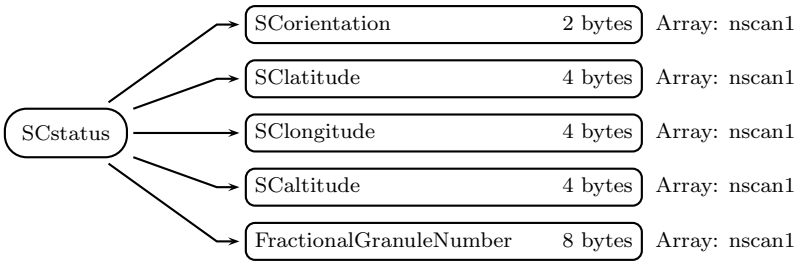


Figure 187: Data Format Structure for 1CATMS, S1, SCstatus

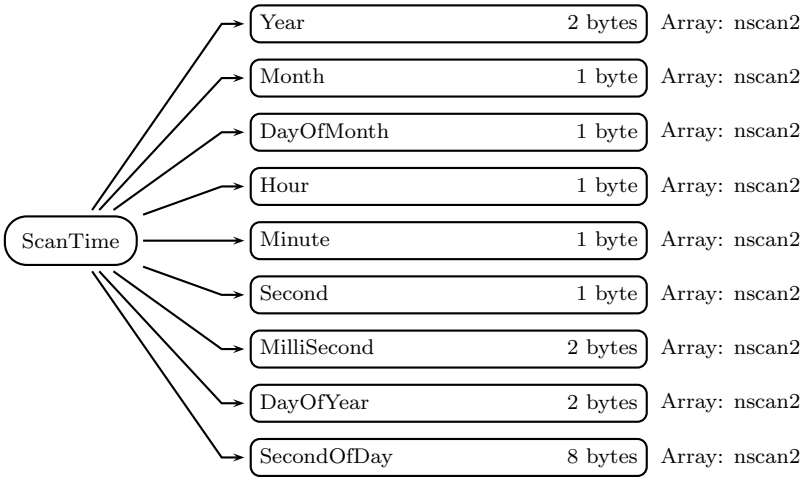


Figure 188: Data Format Structure for 1CATMS, S2, ScanTime

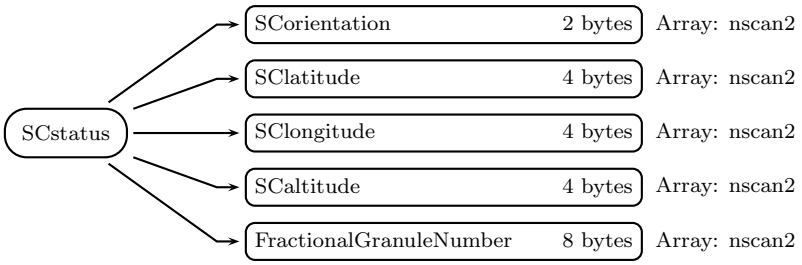


Figure 189: Data Format Structure for 1CATMS, S2, SCstatus

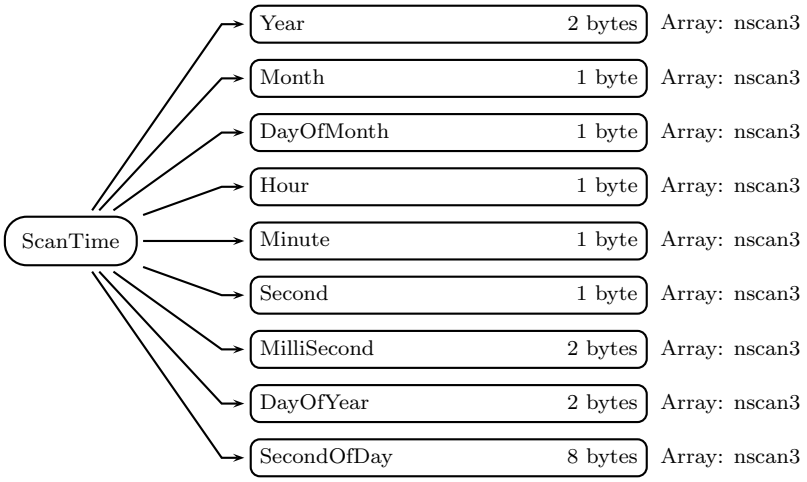


Figure 190: Data Format Structure for 1CATMS, S3, ScanTime

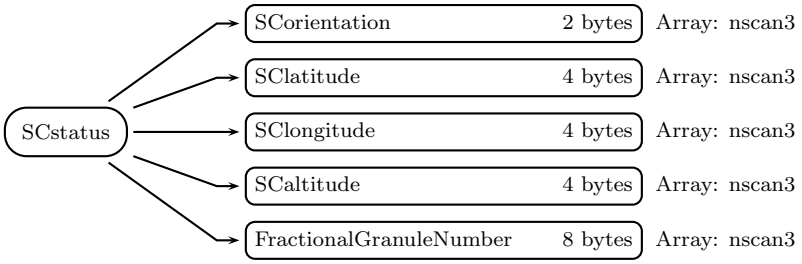


Figure 191: Data Format Structure for 1CATMS, S3, SCstatus

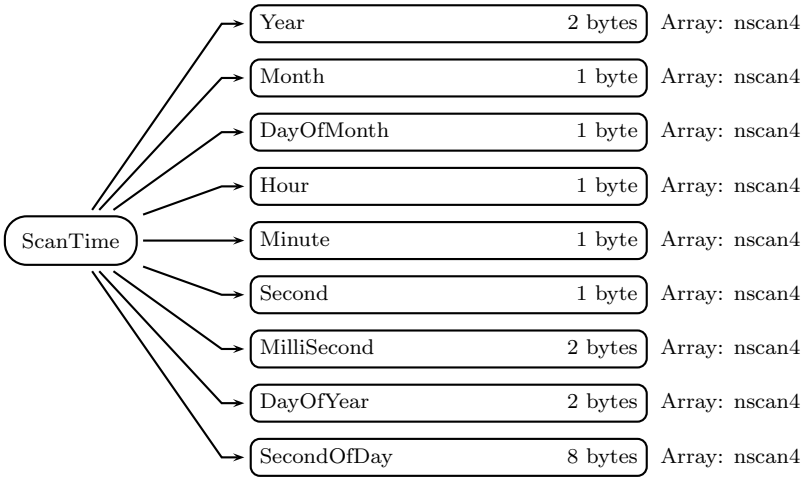


Figure 192: Data Format Structure for 1CATMS, S4, ScanTime

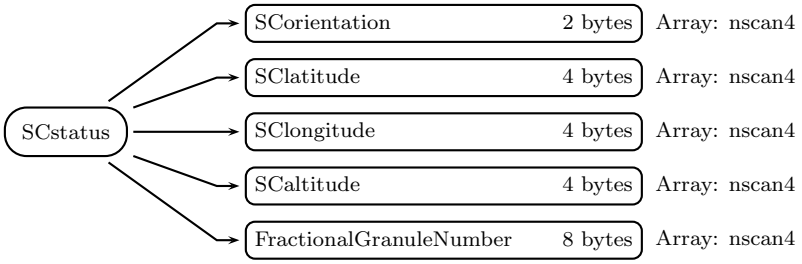


Figure 193: Data Format Structure for 1CATMS, S4, SCstatus

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

XCALinfo (Metadata):
XCALinfo contains metadata required by 1C intercalibrated files. See Metadata for GPM Products for details.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S1_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel1 x nscan1):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel1 x nscan1):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S1)

SCorientation (2-byte integer, array size: nscan1):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan1):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel1 x nscan1):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
   0 = Good data
   1 = Possible sun glint
   2 = Possible radio frequency interference
   3 = Degraded geolocation data
   4 = Data corrected for warm load intrusion

  -1 = Data is missing from file or unreadable
  -2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
  -3 = Error in geolocation data
  -4 = Data missing in one channel
  -5 = Data missing in multiple channels
  -6 = Lat/lon values are out of range
```

```
  -7 = Non-normal status modes
 -10 = Distance to corresponding LF pixel > 7 km
       (Used in L1C-R product only)
 -99 = Missing value (no quality information available)

-100 = Missing scan indicated by QF19\_SCAN\_ATMSSDR
-101 = Time sequence error
-102 = Insufficient KAV PRT data
-103 = Insufficient WG PRT data
-104 = Space view antenna position error
-105 = Blackbody view antenna position error
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1):
Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
```

```
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1):
GPM Common Calibrated Brightness Temperature. The channels are:

```
23.8   GHz quasi vertically-polarized   TBs
```

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S2_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel2 x nscan2):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel2 x nscan2):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S2)

SCorientation (2-byte integer, array size: nscan2):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan2):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan2):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan2):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan2):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel2 x nscan2):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
   0 = Good data
   1 = Possible sun glint
   2 = Possible radio frequency interference
   3 = Degraded geolocation data
   4 = Data corrected for warm load intrusion

  -1 = Data is missing from file or unreadable
  -2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
  -3 = Error in geolocation data
  -4 = Data missing in one channel
  -5 = Data missing in multiple channels
  -6 = Lat/lon values are out of range
  -7 = Non-normal status modes
 -10 = Distance to corresponding LF pixel > 7 km
       (Used in L1C-R product only)
 -99 = Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA2 x npixel2 x nscan2):
Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA2 x npixel2 x nscan2):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel2 x nscan2):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel2 x npixel2 x nscan2):
GPM Common Calibrated Brightness Temperature. The channels are:

```
31.4   GHz quasi-vertically-polarized   TBs
```

S3 (Swath)

S3_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S3_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S3)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan3):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan3):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan3):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan3):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan3):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan3):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan3):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan3):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan3):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel3 x nscan3):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel3 x nscan3):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S3)

SCorientation (2-byte integer, array size: nscan3):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan3):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan3):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan3):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan3):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule.

Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel3 x nscan3):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
   0 = Good data
   1 = Possible sun glint
   2 = Possible radio frequency interference
   3 = Degraded geolocation data
   4 = Data corrected for warm load intrusion

  -1 = Data is missing from file or unreadable
  -2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
  -3 = Error in geolocation data
  -4 = Data missing in one channel
  -5 = Data missing in multiple channels
  -6 = Lat/lon values are out of range
  -7 = Non-normal status modes
 -10 = Distance to corresponding LF pixel > 7 km
       (Used in L1C-R product only)
 -99 = Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA3 x npixel3 x nscan3):
Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA3 x npixel3 x nscan3):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel3 x nscan3):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel3 x npixel3 x nscan3):
GPM Common Calibrated Brightness Temperature. The channels are:

```
88.2   GHz quasi-vertically-polarized   TBs
```

S4 (Swath)

S4_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S4_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S4)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan4):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan4):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan4):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan4):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan4):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan4):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan4):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan4):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan4):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel4 x nscan4):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are

defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel4 x nscan4):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S4)

SCorientation (2-byte integer, array size: nscan4):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan4):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan4):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan4):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan4):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel4 x nscan4):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
```

```
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
   0 = Good data
   1 = Possible sun glint
   2 = Possible radio frequency interference
   3 = Degraded geolocation data
   4 = Data corrected for warm load intrusion

  -1 = Data is missing from file or unreadable
  -2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
  -3 = Error in geolocation data
  -4 = Data missing in one channel
  -5 = Data missing in multiple channels
  -6 = Lat/lon values are out of range
  -7 = Non-normal status modes
 -10 = Distance to corresponding LF pixel > 7 km
       (Used in L1C-R product only)
 -99 = Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA4 x npixel4 x nscan4):
Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA4 x npixel4 x nscan4):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel4 x nscan4):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)
```

```
The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel4 x npixel4 x nscan4):
GPM Common Calibrated Brightness Temperature. The channels are:

```
165.5         GHz   quasi-horizontally-polarized   TBs
183.31+-7     GHz   quasi-horizontally-polarized   TBs
183.31+-4.5   GHz   quasi-horizontally-polarized   TBs
183.31+-3     GHz   quasi-horizontally-polarized   TBs
183.31+-1.8   GHz   quasi-horizontally-polarized   TBs
183.31+-1     GHz   quasi-horizontally-polarized   TBs
```

C Structure Header file:

```
#ifndef _TK_1CATMS_H_
#define _TK_1CATMS_H_

#ifndef _L1CATMS_S4_
#define _L1CATMS_S4_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[96];
    float Longitude[96];
    SCSTATUS SCstatus;
    signed char Quality[96];
```

```
    float incidenceAngle[96][1];
    signed char sunGlintAngle[96][1];
    signed char incidenceAngleIndex[6];
    float Tc[96][6];
} L1CATMS_S4;

#endif

#ifndef _L1CATMS_S3_
#define _L1CATMS_S3_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[96];
    float Longitude[96];
    SCSTATUS SCstatus;
    signed char Quality[96];
    float incidenceAngle[96][1];
    signed char sunGlintAngle[96][1];
    signed char incidenceAngleIndex[1];
    float Tc[96][1];
} L1CATMS_S3;

#endif

#ifndef _L1CATMS_S2_
#define _L1CATMS_S2_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[96];
    float Longitude[96];
    SCSTATUS SCstatus;
    signed char Quality[96];
    float incidenceAngle[96][1];
    signed char sunGlintAngle[96][1];
    signed char incidenceAngleIndex[1];
    float Tc[96][1];
} L1CATMS_S2;

#endif

#ifndef _SCSTATUS_
```

```
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1CATMS_S1_
#define _L1CATMS_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[96];
    float Longitude[96];
    SCSTATUS SCstatus;
    signed char Quality[96];
    float incidenceAngle[96][1];
    signed char sunGlintAngle[96][1];
    signed char incidenceAngleIndex[1];
    float Tc[96][1];
} L1CATMS_S1;
```

```
#endif

#ifndef _L1CATMS_SWATHS_
#define _L1CATMS_SWATHS_

typedef struct {
    L1CATMS_S1 S1;
    L1CATMS_S2 S2;
    L1CATMS_S3 S3;
    L1CATMS_S4 S4;
} L1CATMS_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1CATMS_S4/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(96)
    REAL*4 Longitude(96)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(96)
    REAL*4 incidenceAngle(1,96)
    BYTE sunGlintAngle(1,96)
    BYTE incidenceAngleIndex(6)
    REAL*4 Tc(6,96)
END STRUCTURE

STRUCTURE /L1CATMS_S3/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(96)
    REAL*4 Longitude(96)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(96)
    REAL*4 incidenceAngle(1,96)
    BYTE sunGlintAngle(1,96)
    BYTE incidenceAngleIndex(1)
    REAL*4 Tc(1,96)
END STRUCTURE
```

```
STRUCTURE /L1CATMS_S2/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(96)
    REAL*4 Longitude(96)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(96)
    REAL*4 incidenceAngle(1,96)
    BYTE sunGlintAngle(1,96)
    BYTE incidenceAngleIndex(1)
    REAL*4 Tc(1,96)
END STRUCTURE

STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1CATMS_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(96)
    REAL*4 Longitude(96)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(96)
    REAL*4 incidenceAngle(1,96)
    BYTE sunGlintAngle(1,96)
    BYTE incidenceAngleIndex(1)
    REAL*4 Tc(1,96)
END STRUCTURE
```

```
STRUCTURE /L1CATMS_SWATHS/
    RECORD /L1CATMS_S1/ S1
    RECORD /L1CATMS_S2/ S2
    RECORD /L1CATMS_S3/ S3
    RECORD /L1CATMS_S4/ S4
END STRUCTURE
```

5.17 1AGMI - GMI unpacked packet data

1AGMI contains unpacked packet data from GMI science data from the GMI passive microwave instrument flown on the GPM satellite. Swath S1 has 9 channels which are similar to TRMM TMI (10V 10H 19V 19H 23V 37V 37H 89V 89H). Swath S2 has 4 channels similar to AMSU-B (166V 166H 183+/-3V 183+/-8V). Data for both swaths is observed in the same revolution of the instrument. Swath S3 has ScienceDataHeader. Swath S4 has full rotation for low freq channels (S1). Swath S5 has full rotation for high freq channels (S2).

```
GMI sample counts.
                                        The S1 channels are:
10.7  GHz vertically-polarized
10.7  GHz horizontally-polarized
18.7  GHz vertically-polarized
18.7  GHz horizontally-polarized
23.8  GHz vertically-polarized
36.5  GHz vertically-polarized
36.5  GHz horizontally-polarized
        89.0  GHz vertically-polarized
        89.0  GHz horizontally-polarized


GMI sample counts.
                                        The S2 channels are:
166.0  GHz vertically-polarized
166.0  GHz horizontally-polarized
        183.31+/-3  GHz vertically-polarized
        183.31+/-8  GHz vertically-polarized
```

Earth observations are taken during a segment of the rotation when GMI is looking in the +x direction of the GPM satellite. Since the spacecraft turns around every few weeks, +x may be forward or aft. We define the spacecraft axis v, used in the definition of the variable SCorientation, at the center of this segment and the same as the +x direction.

32rpm * 1min/60s * 5538s/orbit = 2954 scans / orbit.

RELATION BETWEEN THE SWATHS: Swath S2 has the same number of scans and the same number of pixels as Swath S1. Each S1 scan contains 9 channels sampled 221 times along the scan. Each S2 scan contains 4 channels sampled 221 times along the scan. Since the incidence angle of Swath S1 is different than Swath S2, the geolocations of the pixel centers are different.

Dimension definitions:

VH	2	Number of polarizations.
nscan1	var	Typical number of Swath S1 scans in the granule.
nchannel1	9	Number of Swath S1 channels (10V 10H 19V 19H 23V 37V 37H 89V 89H).
npixelev	221	Number of earth view pixels in one scan.
npixelht	221	Number of hot load pixels in one scan.
npixelcs	221	Number of cold sky pixels in one scan.
nscan2	var	Typical number of Swath S2 scans in the granule.
nchannel2	4	Number of Swath S2 channels (166V 166H 183+/-3V 183+/-8V).
npixel3	1	Number of "pixels" in one scan in S3.
npixelfr	500	Number of full rotation earth view pixels in one scan.
nchannel12	13	Number of Swath S1 and S2 channels.
dim2	2	Number.
dim3	3	Number.
dim4	4	Number.
dim5	5	Number.
dim6	6	Number.
dim7	7	Number.
dim8	8	Number.
dim9	9	Number.
dim10	10	Number.
dim11	11	Number.
dim12	12	Number.
GMIxyz	3	x, y, z components in GMI instrument coordinate system.

Figure 194 through Figure 239 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

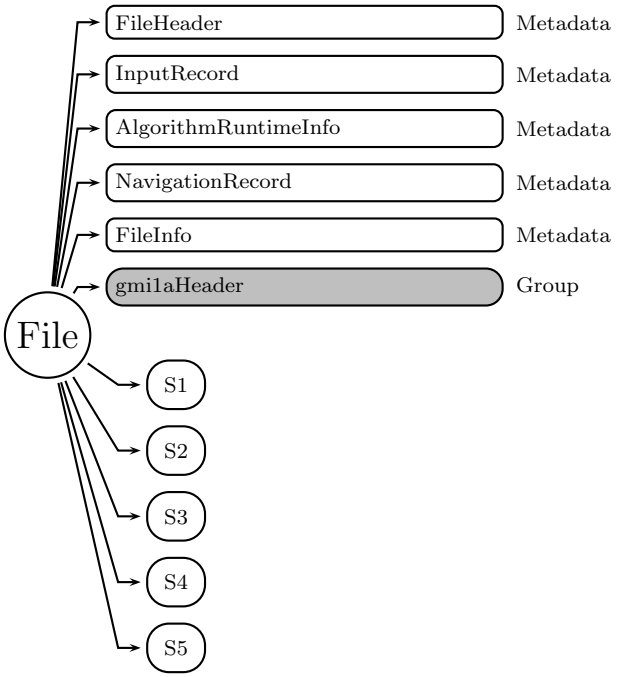


Figure 194: Data Format Structure for 1AGMI, GMI unpacked packet data

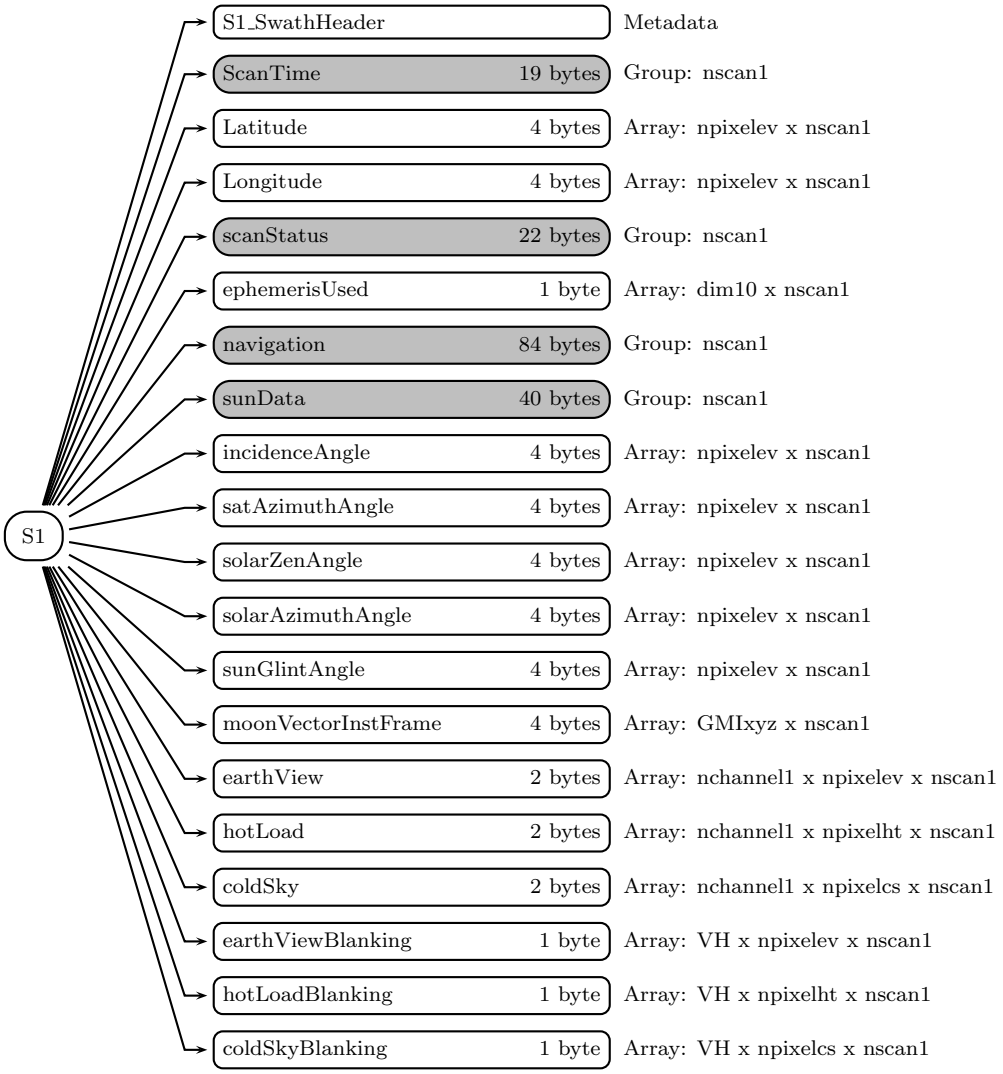


Figure 195: Data Format Structure for 1AGMI, S1

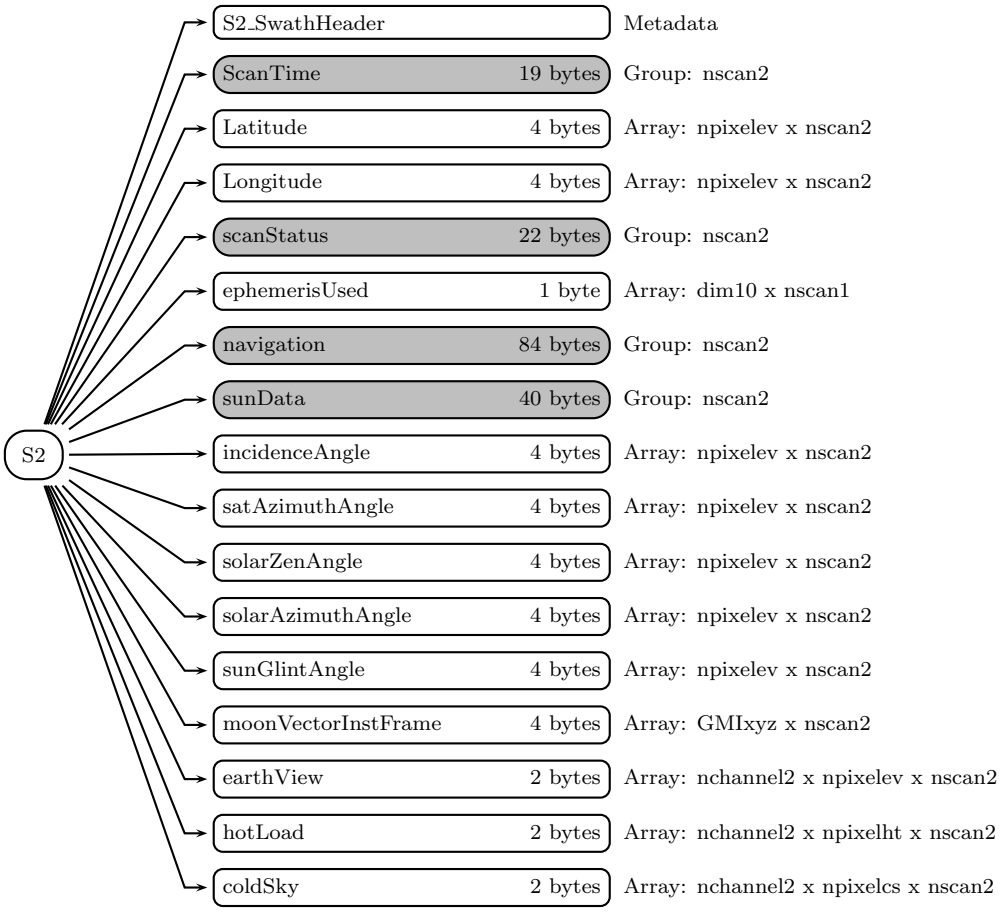


Figure 196: Data Format Structure for 1AGMI, S2

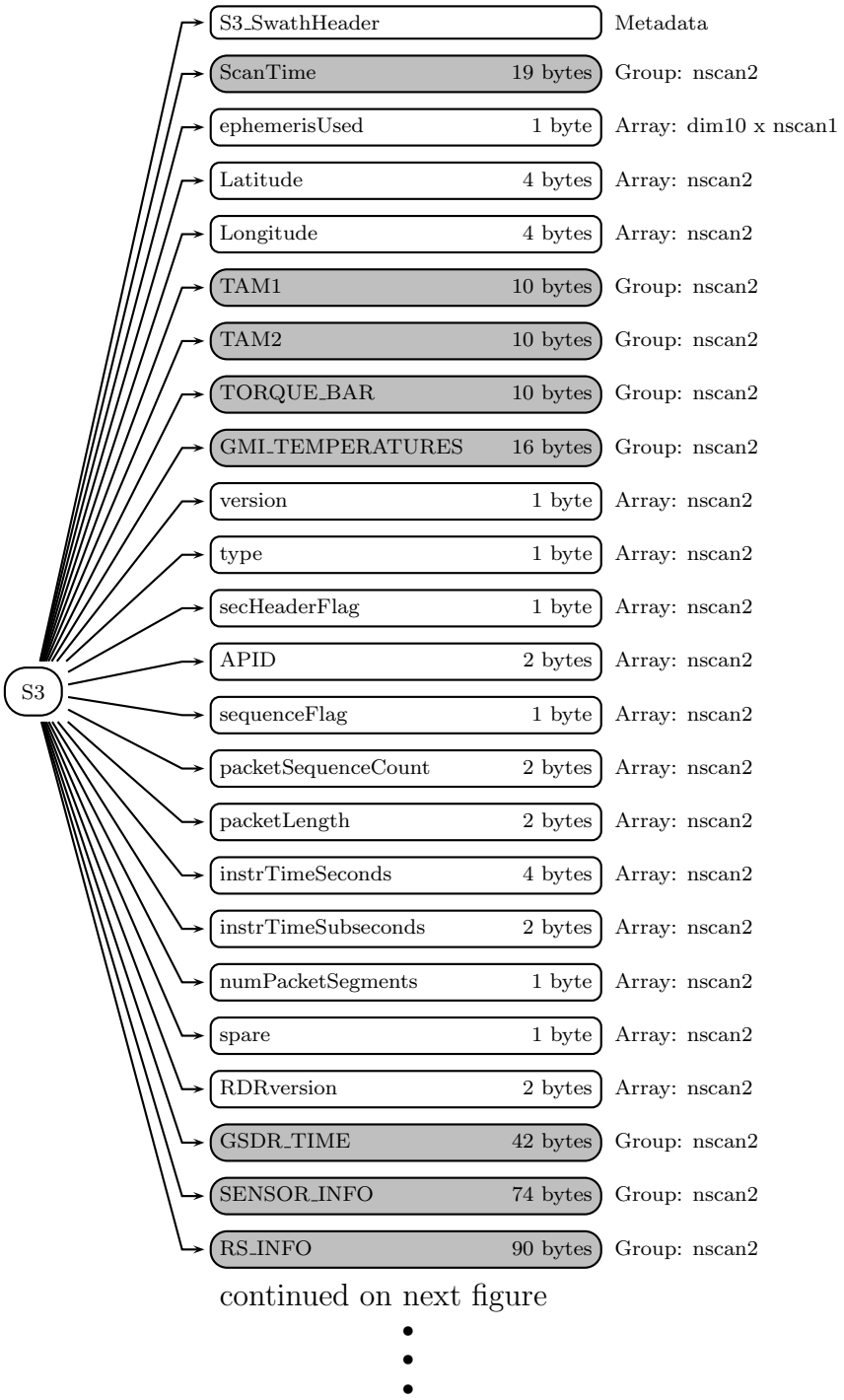


Figure 197: Data Format Structure for 1AGMI, S3, S3

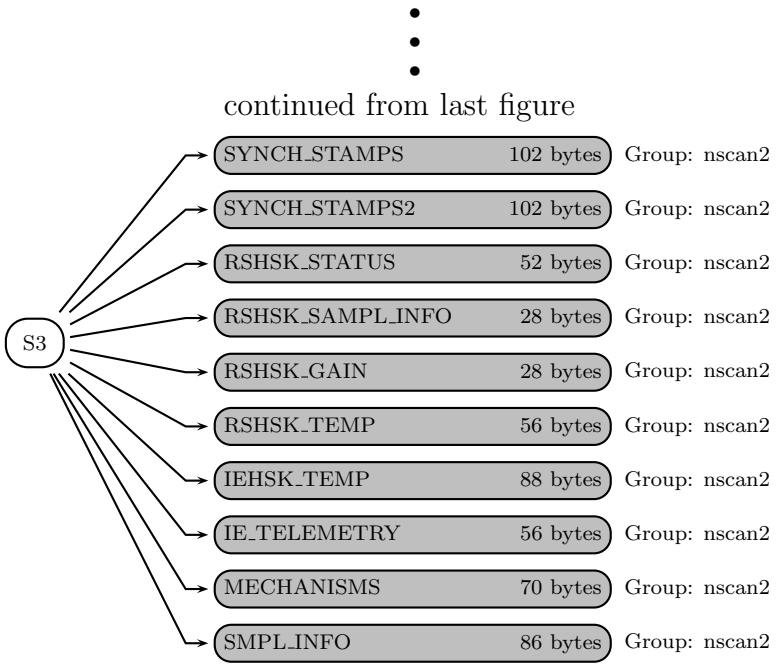


Figure 198: Data Format Structure for 1AGMI, S3

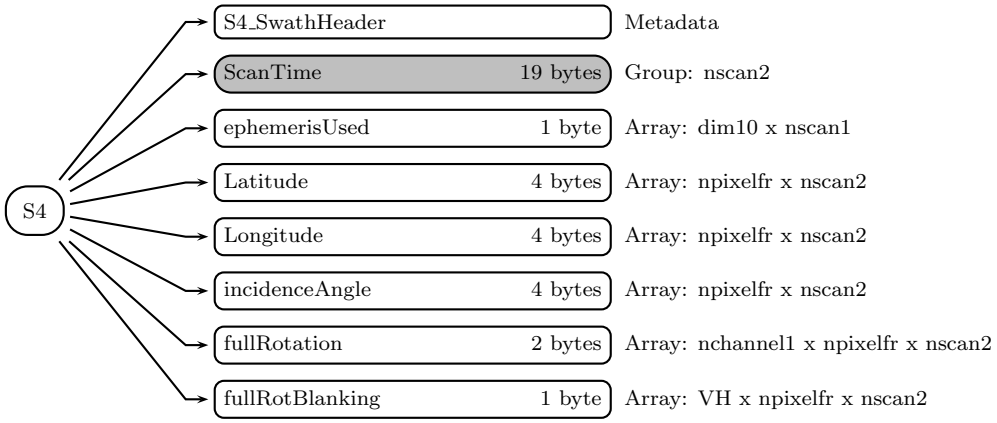


Figure 199: Data Format Structure for 1AGMI, S4

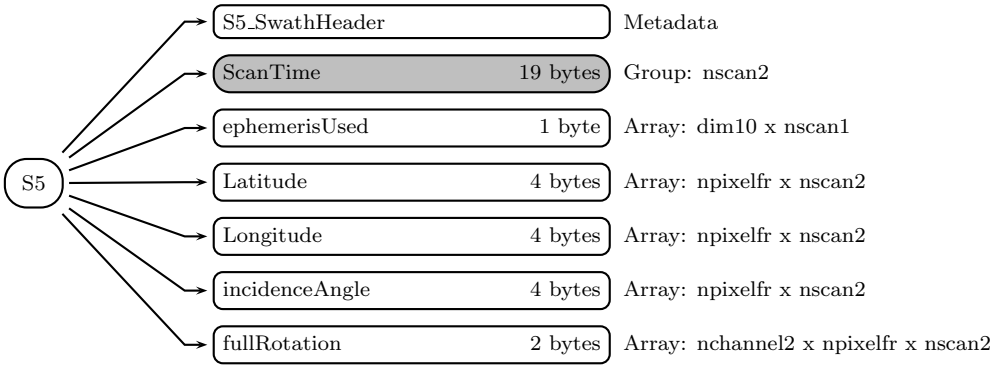


Figure 200: Data Format Structure for 1AGMI, S5

Figure 201: Data Format Structure for 1AGMI, gmi1aHeader

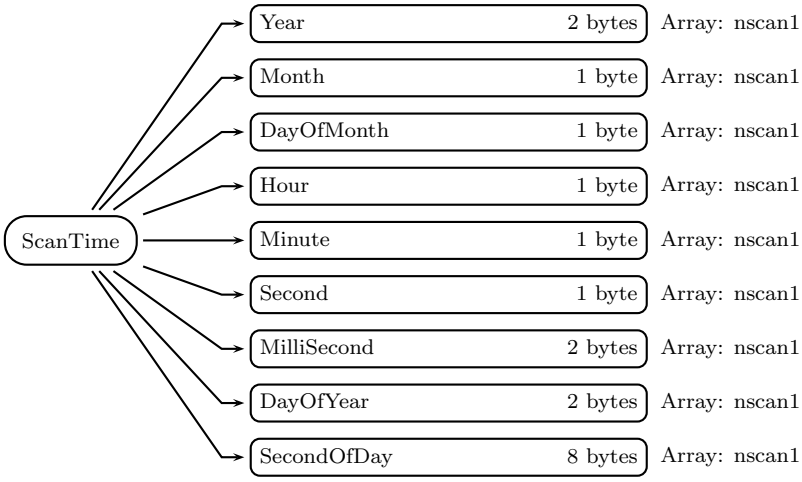


Figure 202: Data Format Structure for 1AGMI, S1, ScanTime

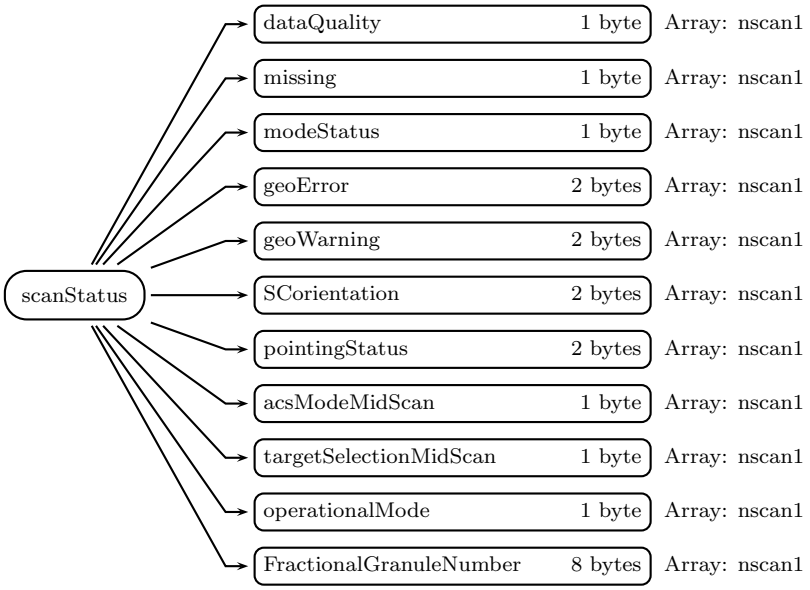


Figure 203: Data Format Structure for 1AGMI, S1, scanStatus

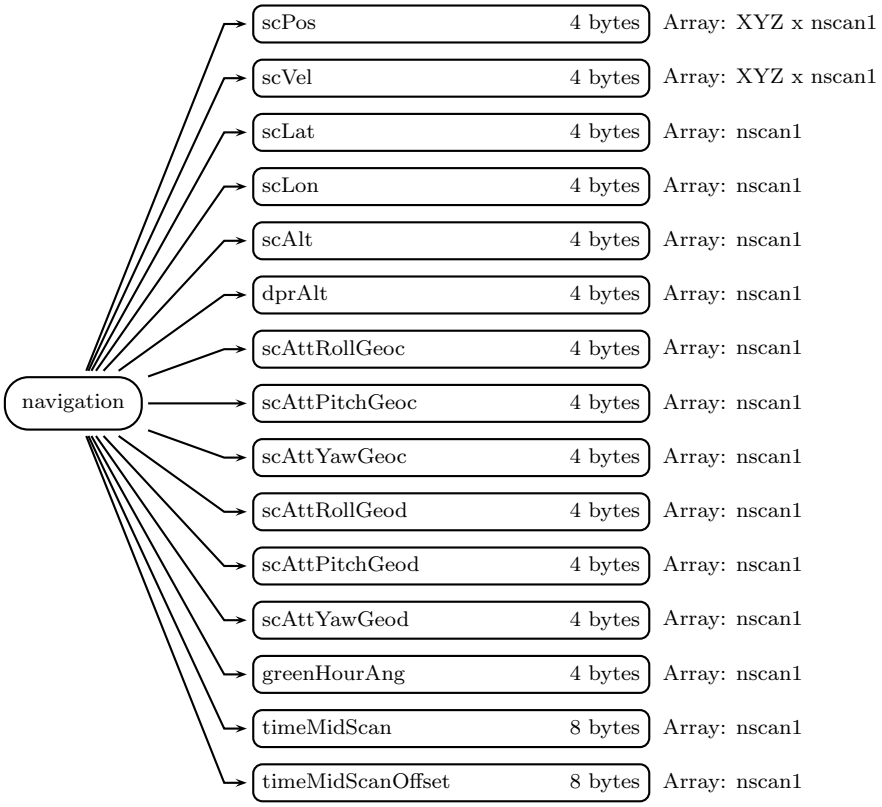


Figure 204: Data Format Structure for 1AGMI, S1, navigation

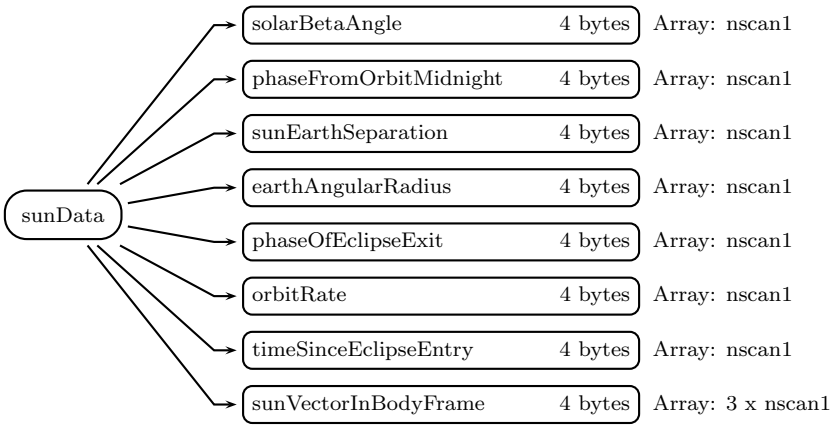


Figure 205: Data Format Structure for 1AGMI, S1, sunData

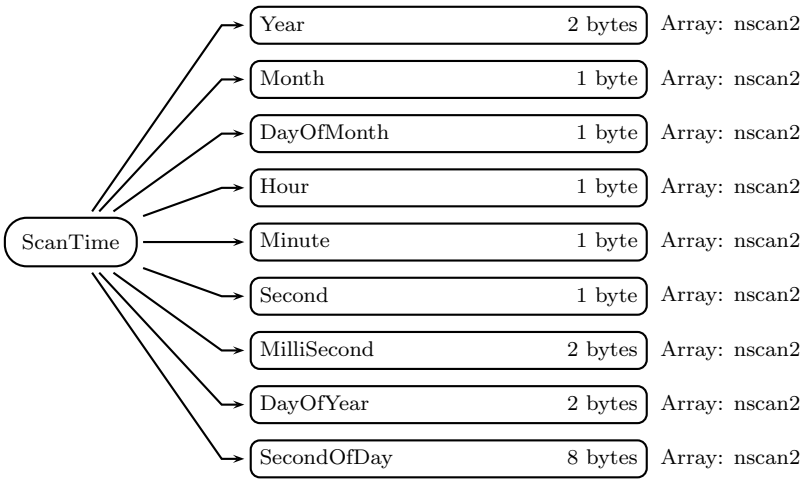


Figure 206: Data Format Structure for 1AGMI, S2, ScanTime

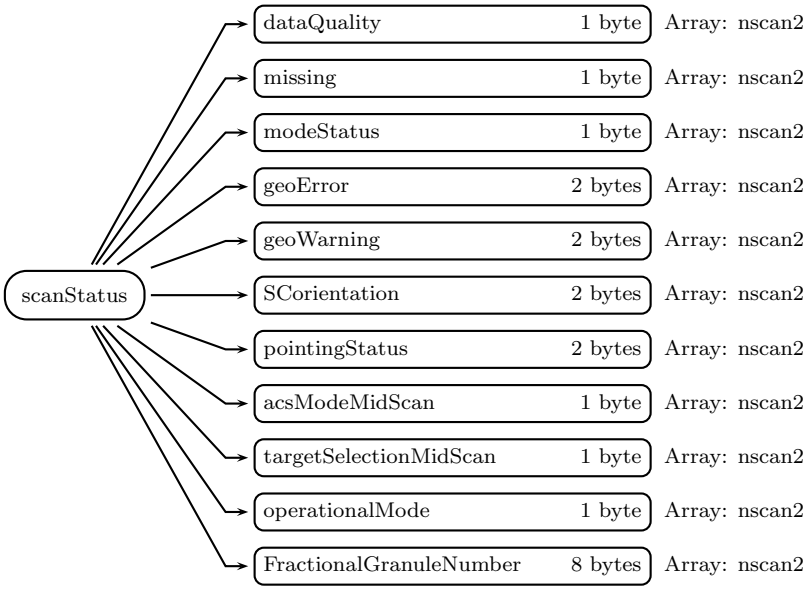


Figure 207: Data Format Structure for 1AGMI, S2, scanStatus

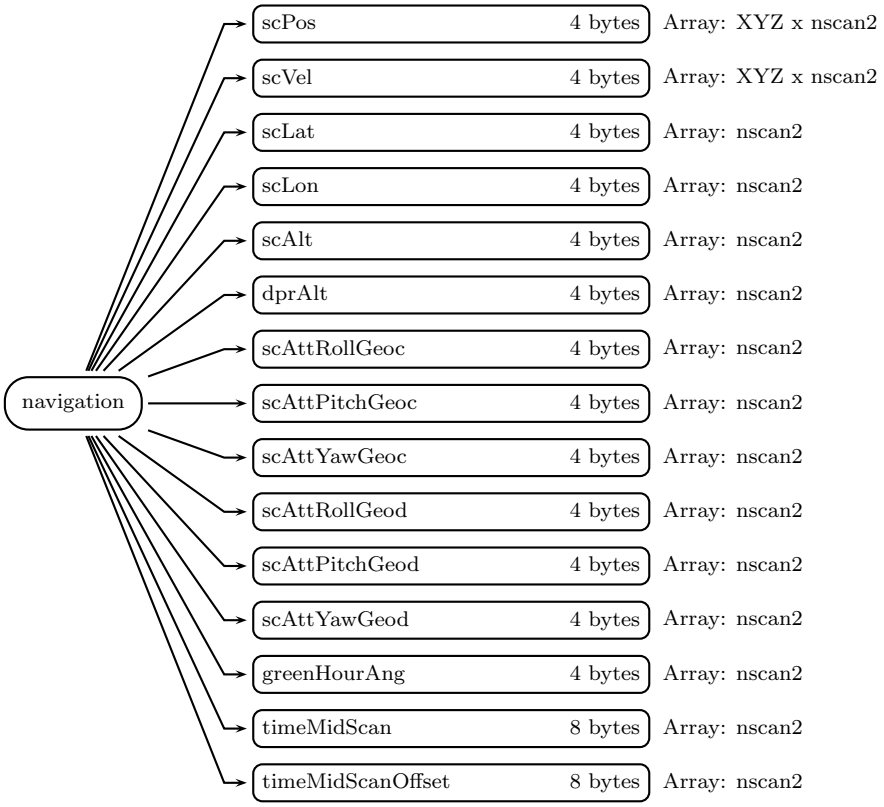


Figure 208: Data Format Structure for 1AGMI, S2, navigation

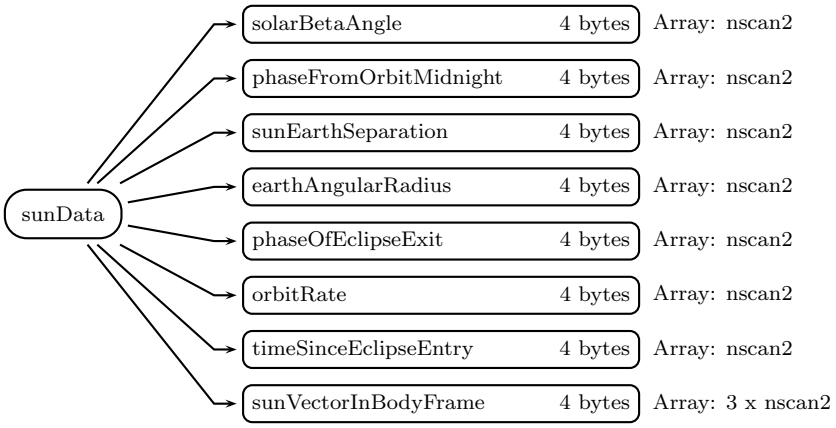


Figure 209: Data Format Structure for 1AGMI, S2, sunData

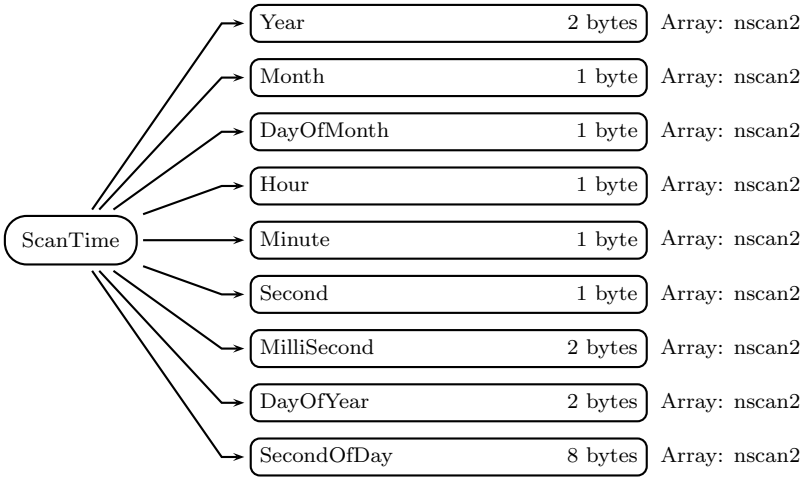


Figure 210: Data Format Structure for 1AGMI, S3, ScanTime

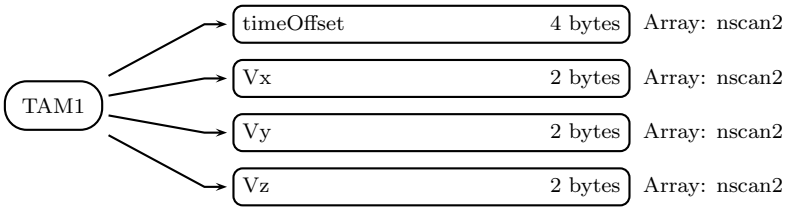


Figure 211: Data Format Structure for 1AGMI, S3, TAM1

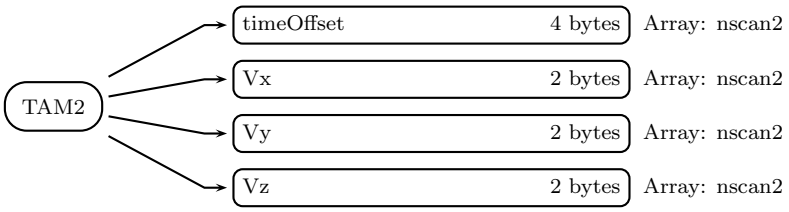


Figure 212: Data Format Structure for 1AGMI, S3, TAM2

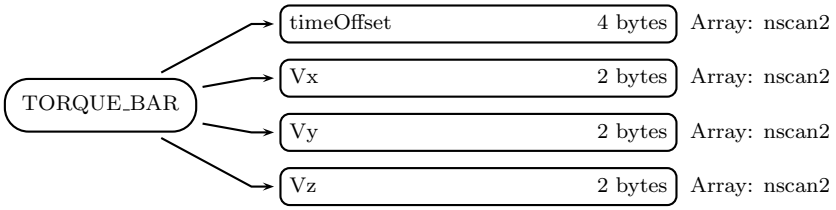


Figure 213: Data Format Structure for 1AGMI, S3, TORQUE_BAR

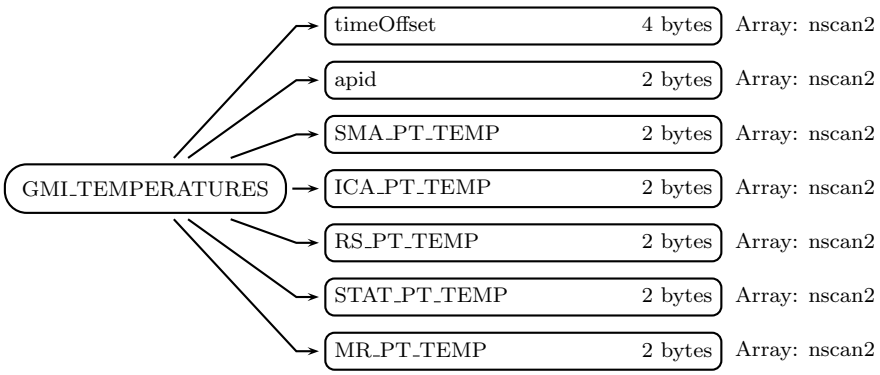


Figure 214: Data Format Structure for 1AGMI, S3, GMI_TEMPERATURES

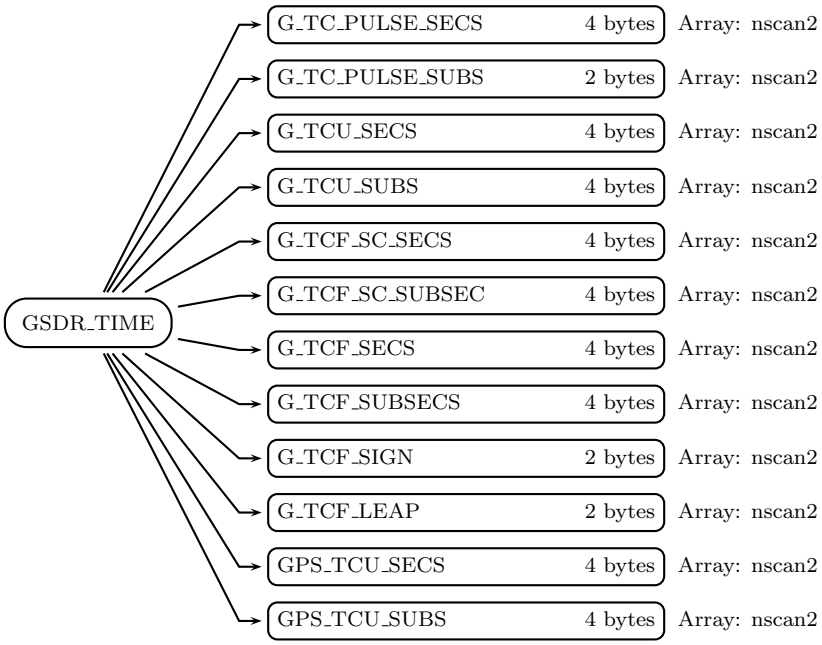
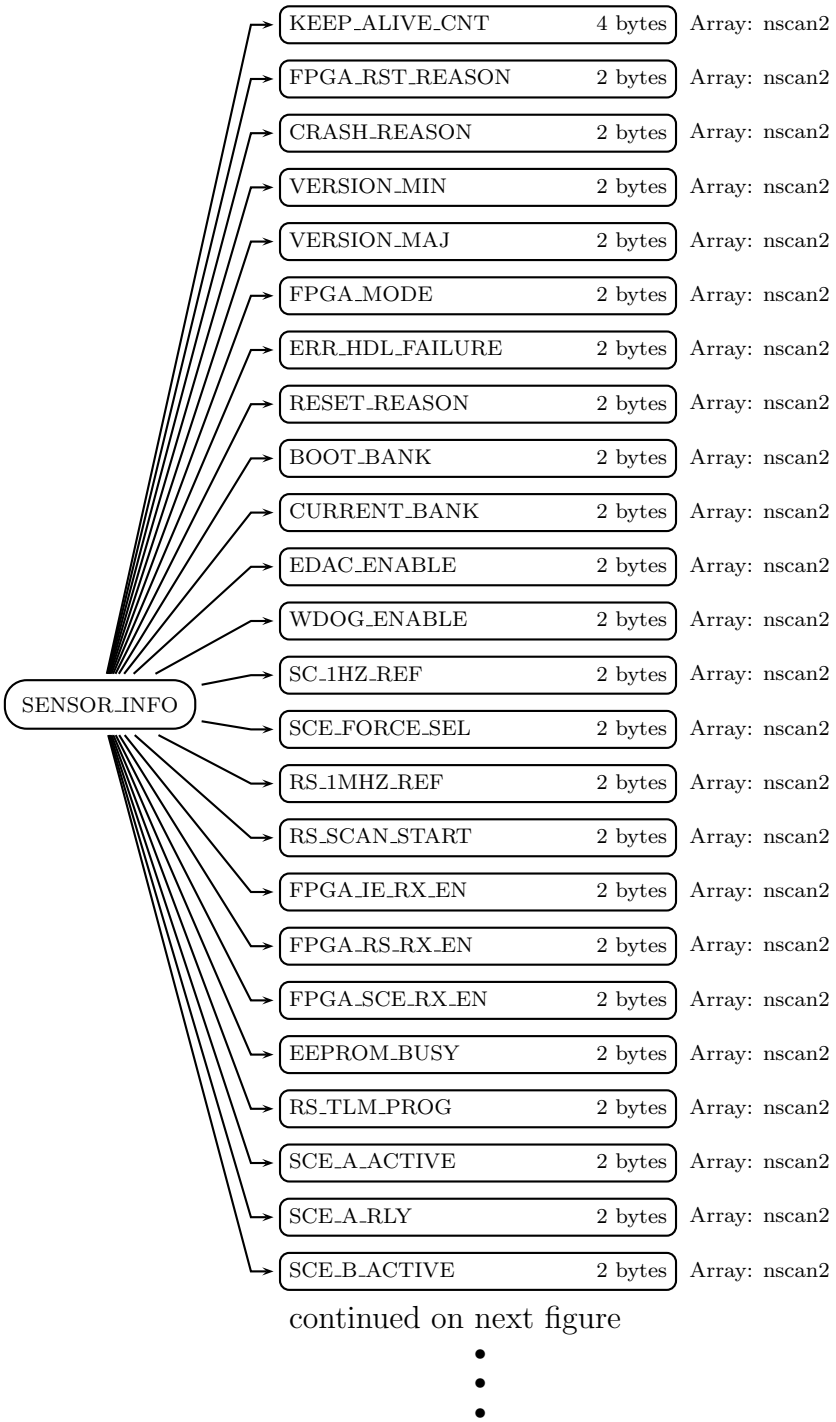


Figure 215: Data Format Structure for 1AGMI, S3, GSDR_TIME



continued on next figure

Figure 216: Data Format Structure for 1AGMI, SENSOR_INFO

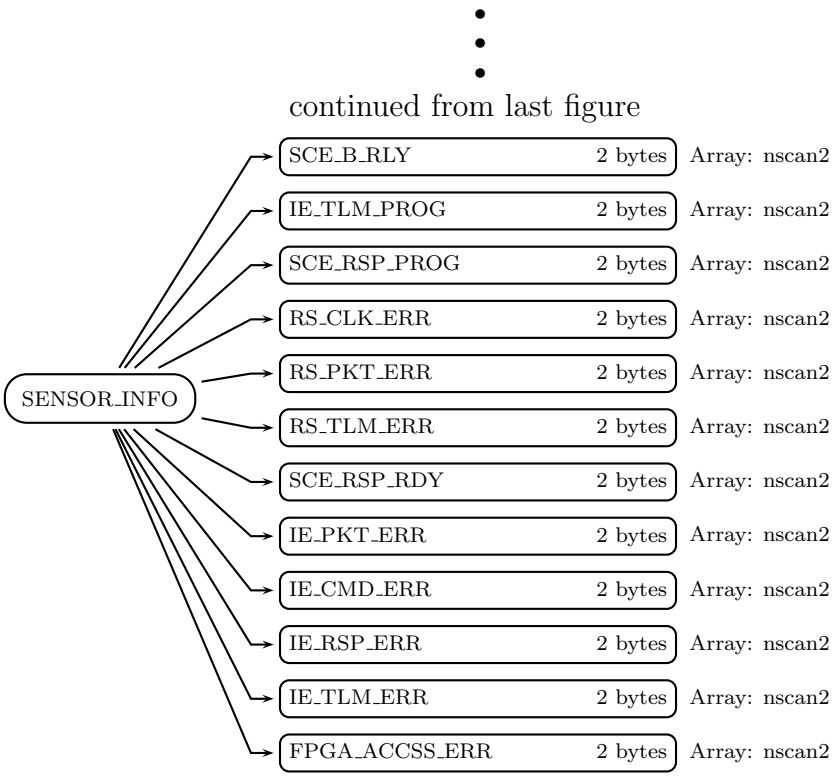
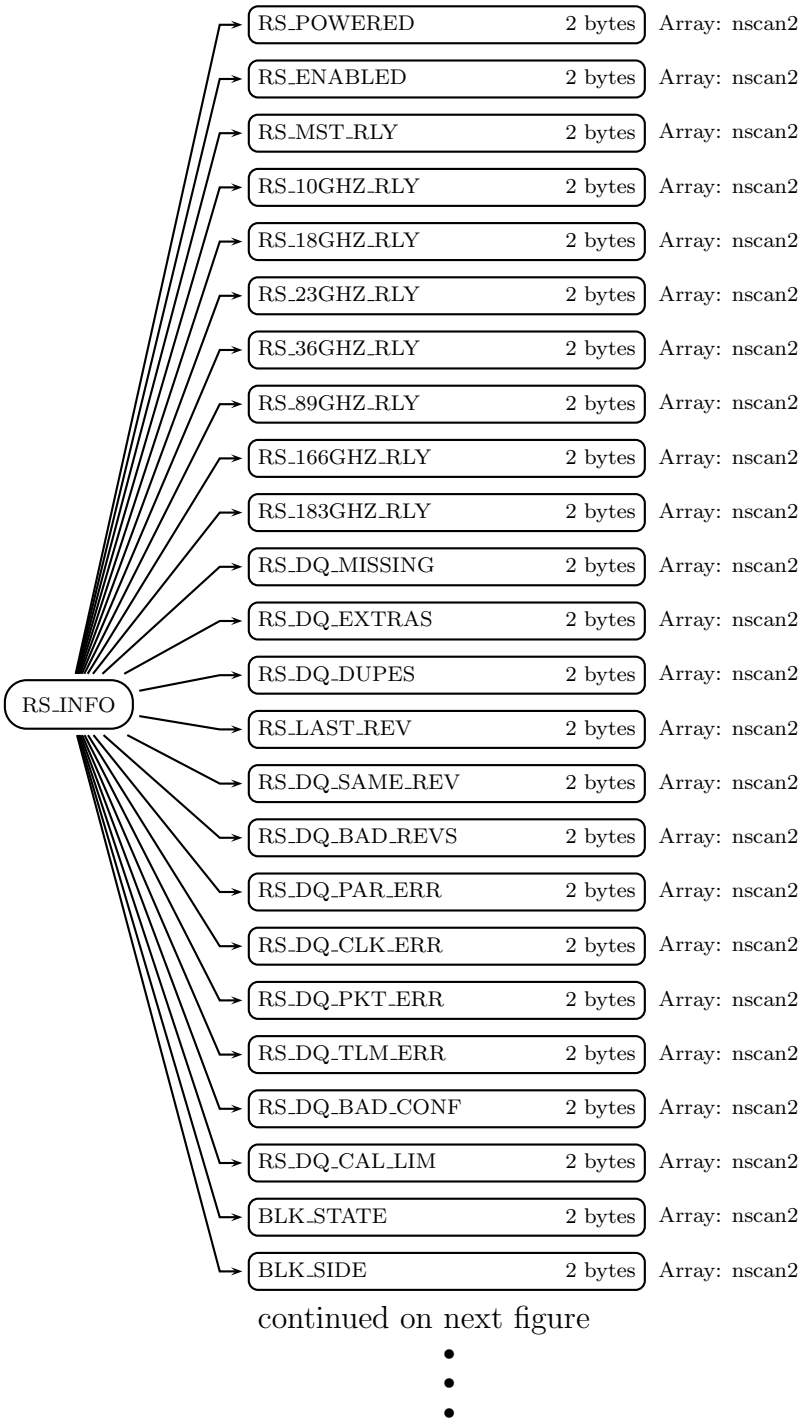


Figure 217: Data Format Structure for 1AGMI, S3, SENSOR_INFO



continued on next figure

Figure 218: Data Format Structure for 1AGMI, RS_INFO

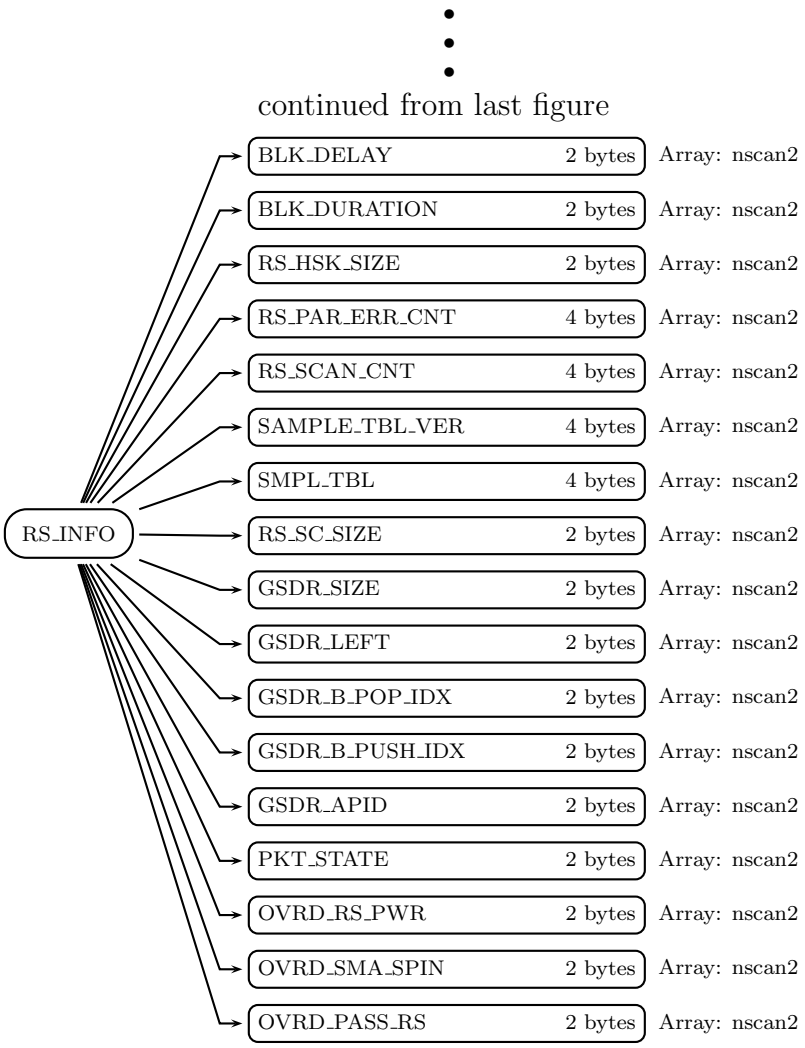


Figure 219: Data Format Structure for 1AGMI, S3, RS_INFO

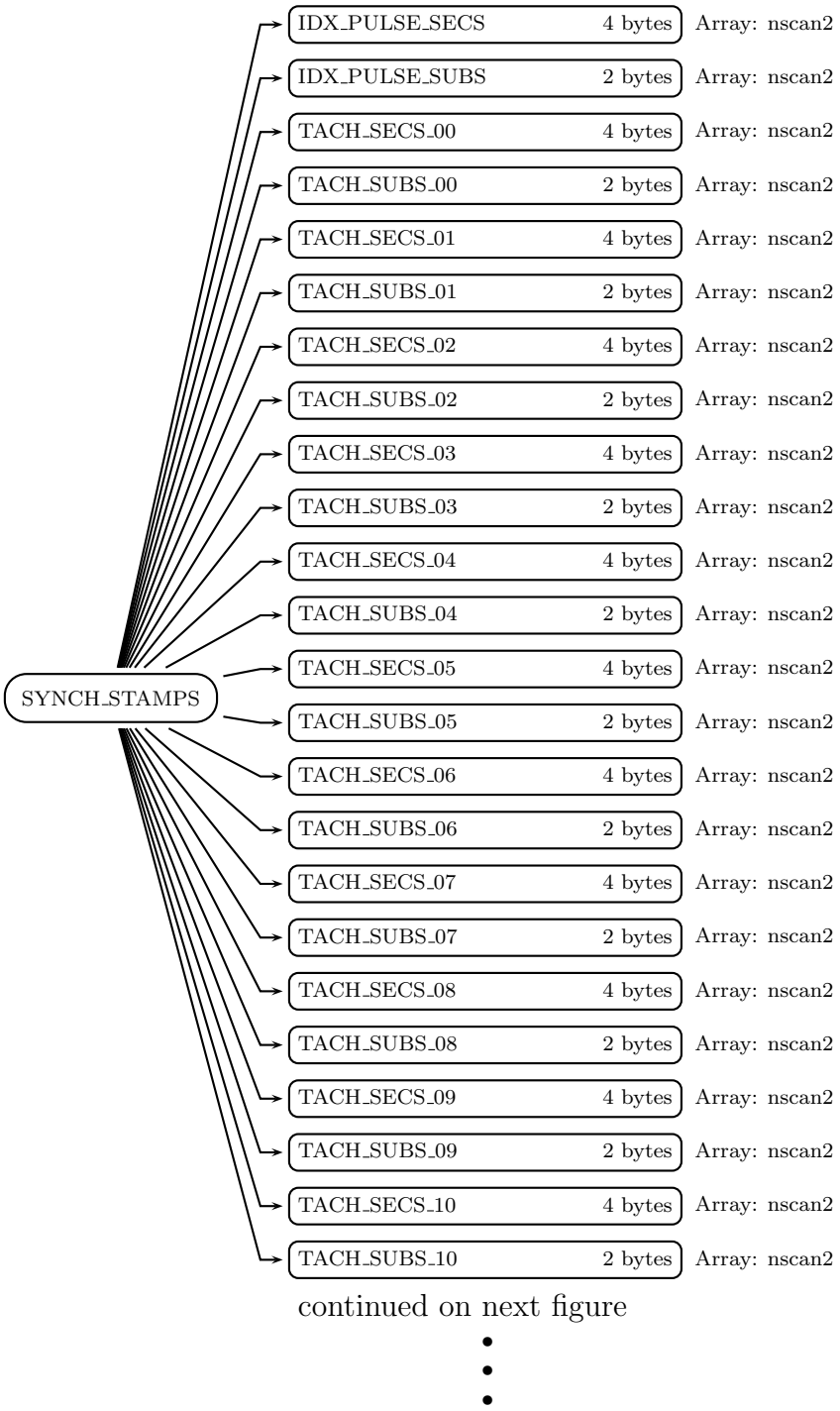


Figure 220: Data Format Structure for 1AGMI, SYNCH_STAMPS

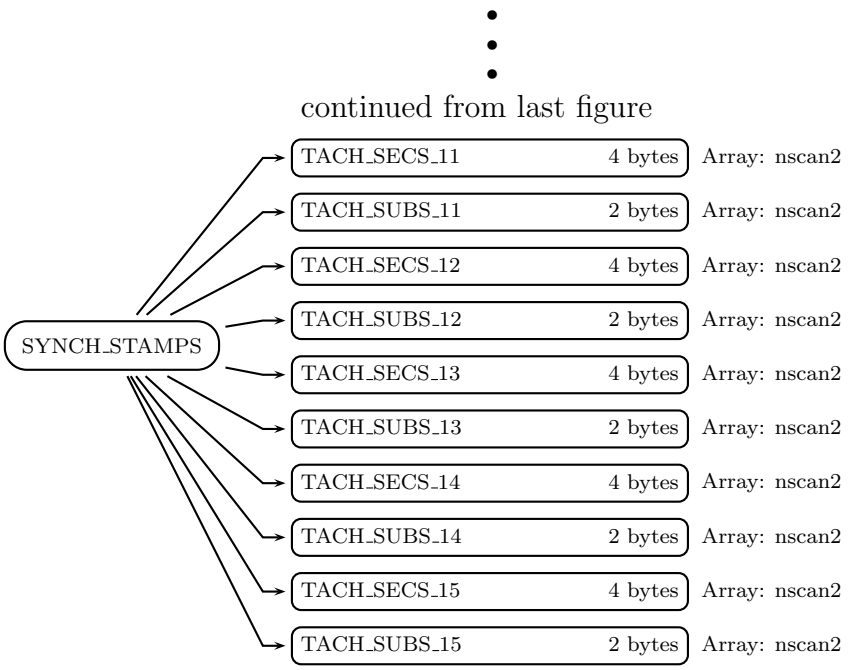


Figure 221: Data Format Structure for 1AGMI, S3, SYNCH_STAMPS

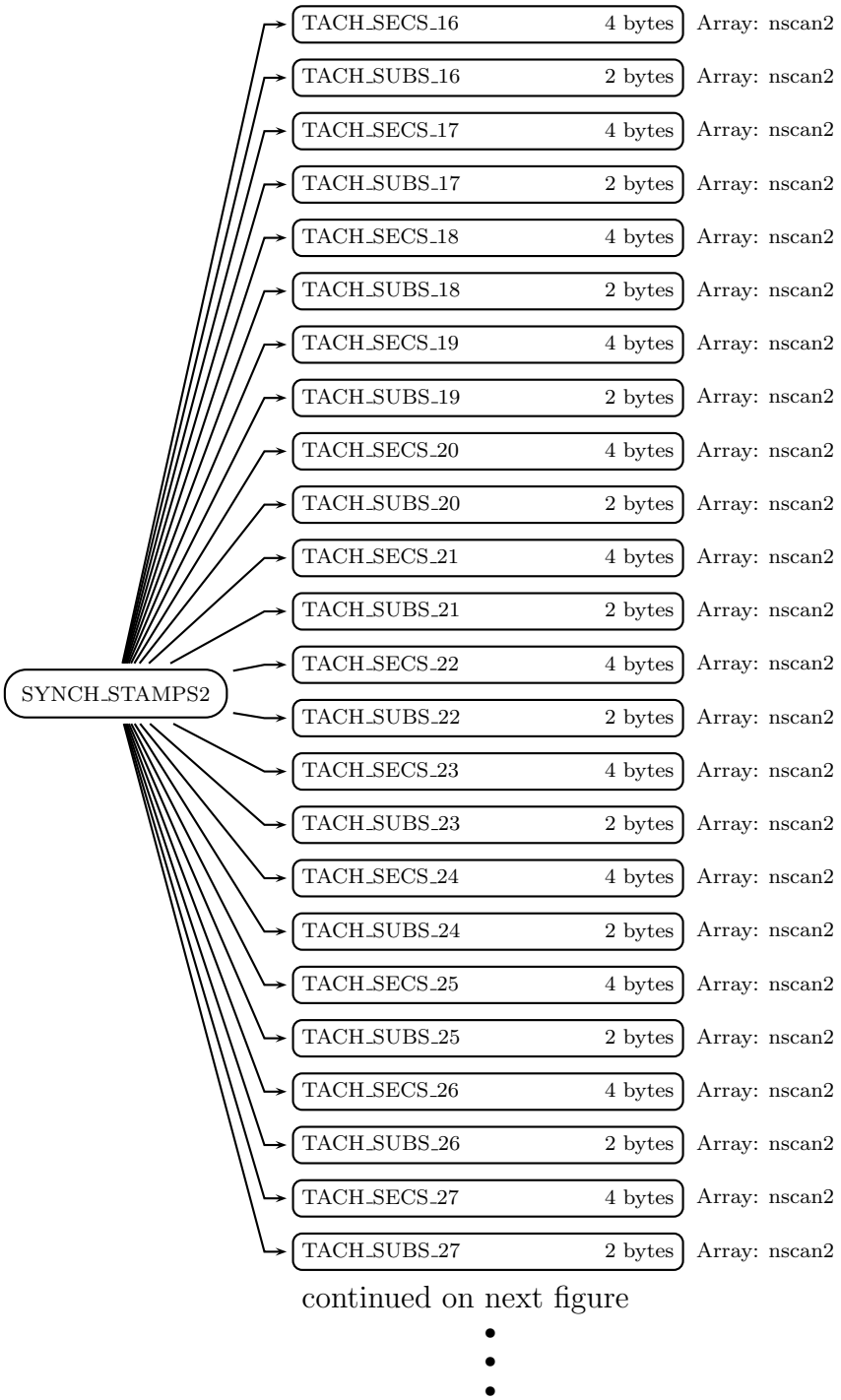


Figure 222: Data Format Structure for 1AGMI, SYNCH_STAMPS2

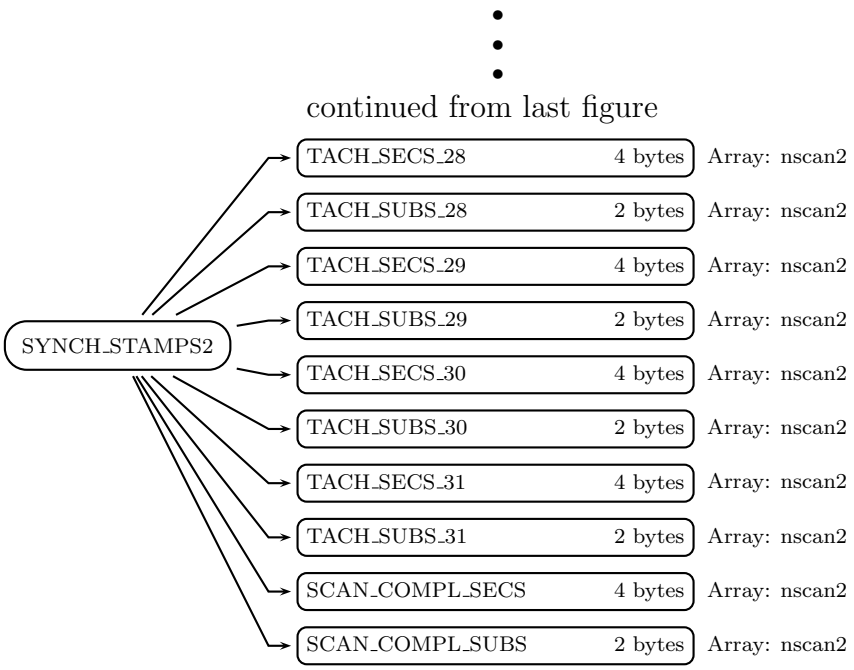


Figure 223: Data Format Structure for 1AGMI, S3, SYNCH_STAMPS2

FileHeader (Metadata):
FileHeader contains metadata of general interest. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

AlgorithmRuntimeInfo (Metadata):
AlgorithmRuntimeInfo contains text runtime information written by the algorithm. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

gmi1aHeader (Group)

sampleRangeFile (2-byte unsigned integer, array size: dim6 x dim7):
The sample range table that was used to subset S1 and S2.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

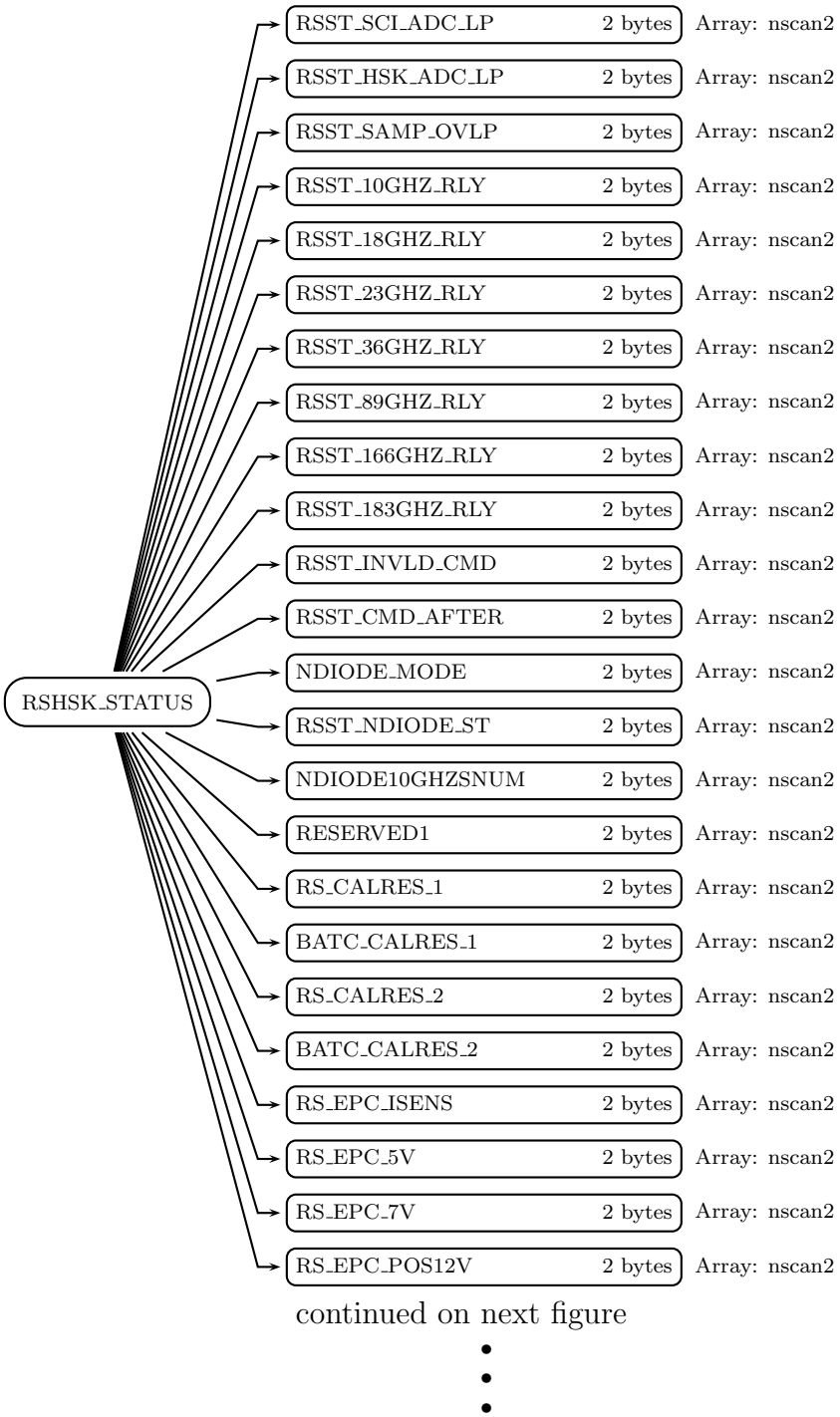


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Figure 224: Data Format Structure for 1AGMI, RSHSK_STATUS

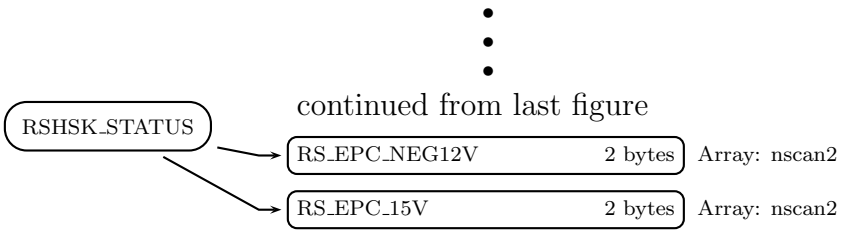

Figure 225: Data Format Structure for 1AGMI, S3, RSHSK_STATUS

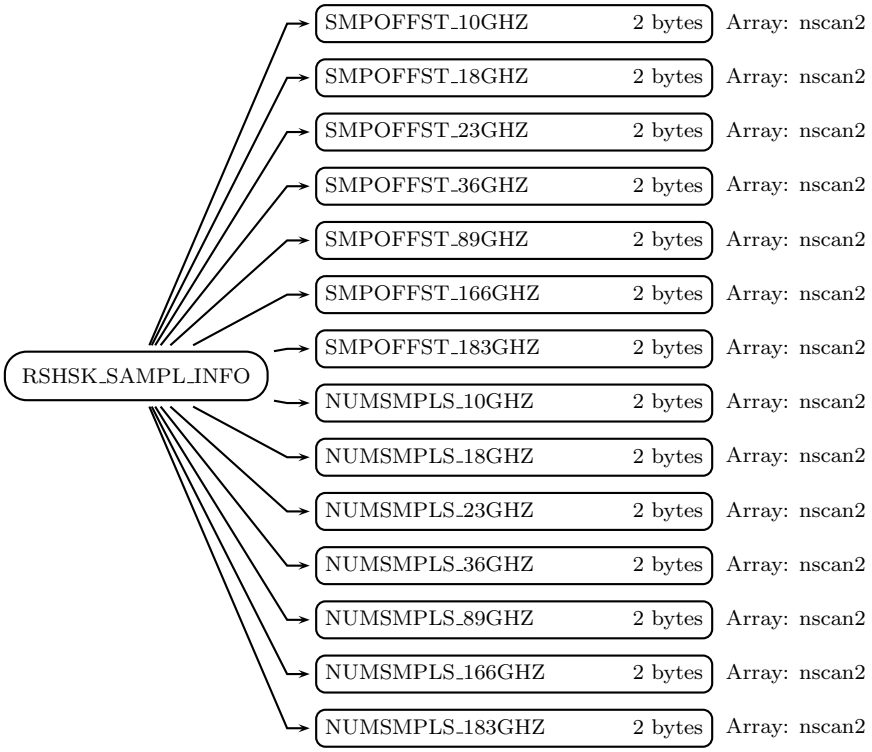

Figure 226: Data Format Structure for 1AGMI, S3, RSHSK_SAMPL_INFO

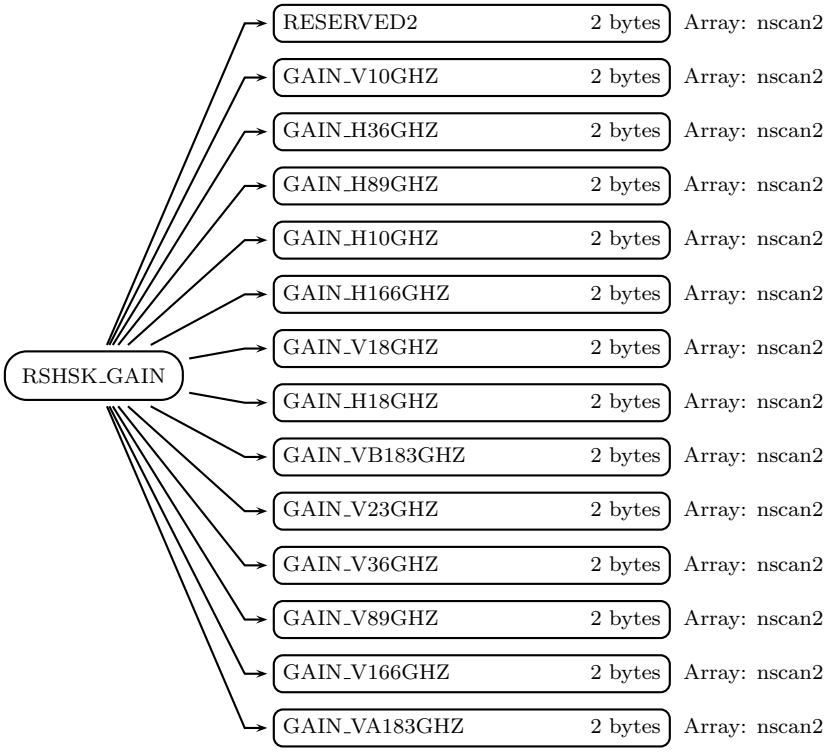

Figure 227: Data Format Structure for 1AGMI, S3, RSHSK_GAIN

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

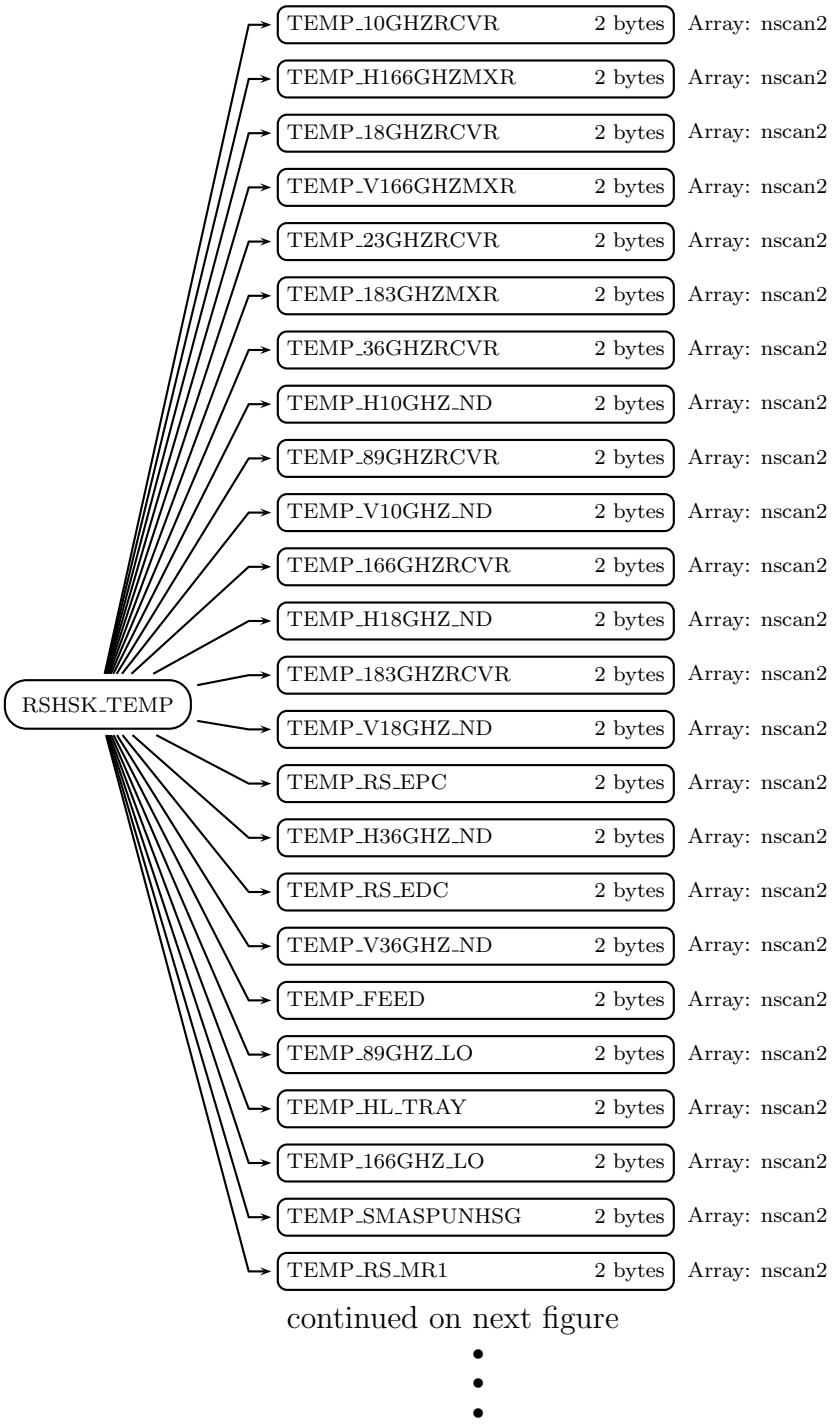

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Figure 228: Data Format Structure for 1AGMI, RSHSK_TEMP

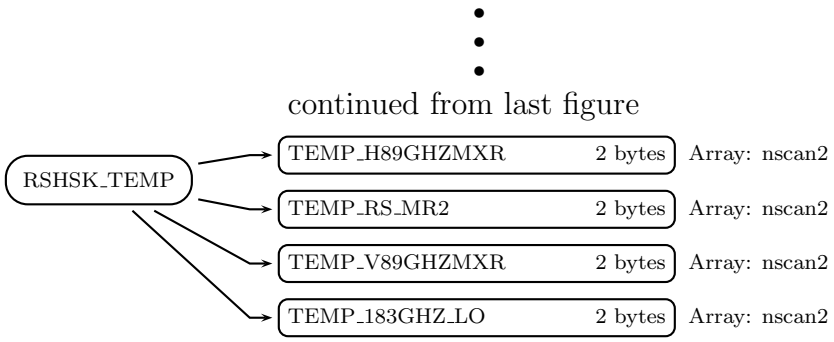

Figure 229: Data Format Structure for 1AGMI, S3, RSHSK_TEMP

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixelev x nscan1):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixelev x nscan1):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S1)

dataQuality (1-byte integer, array size: nscan1):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

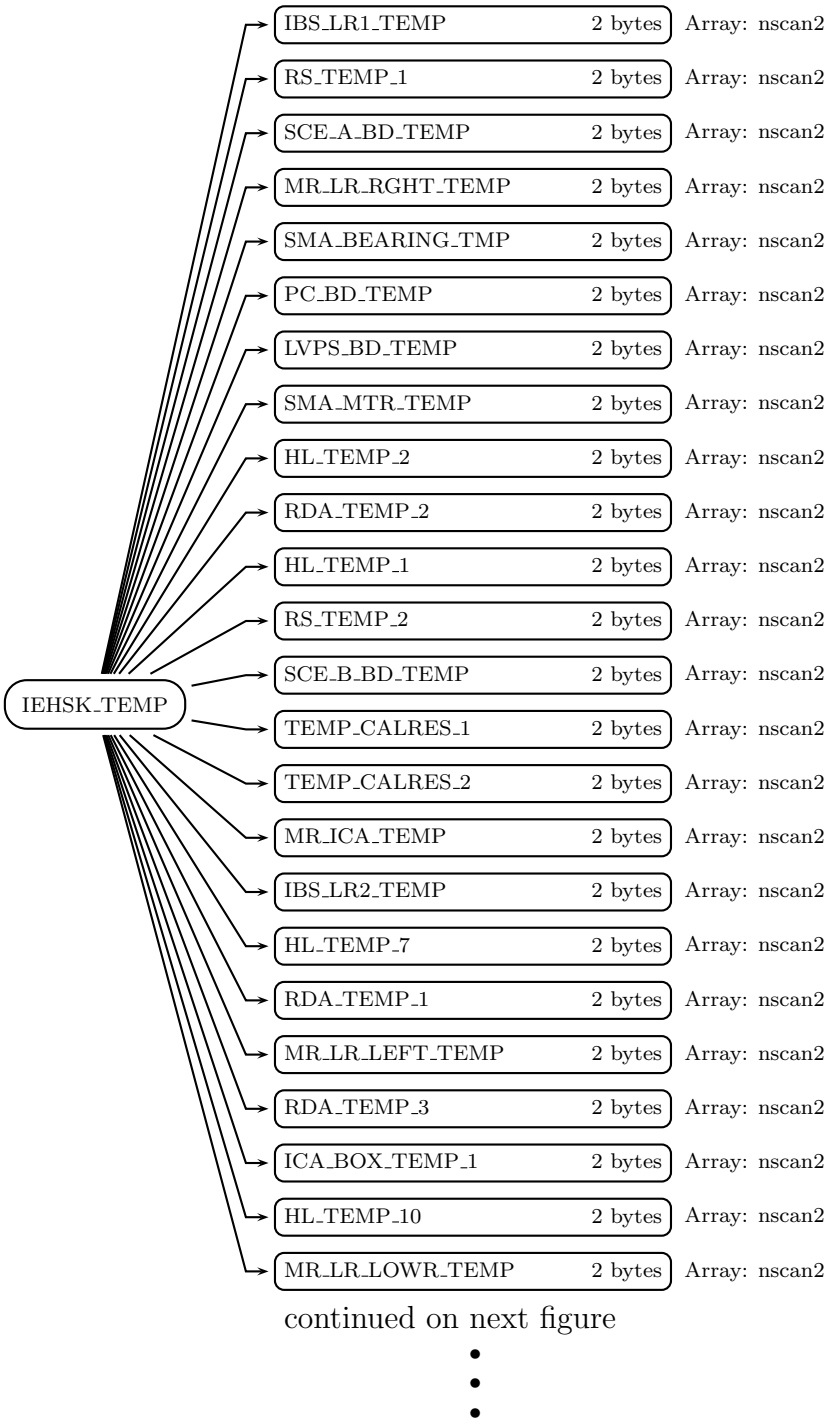

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Figure 230: Data Format Structure for 1AGMI, IEHSK_TEMP

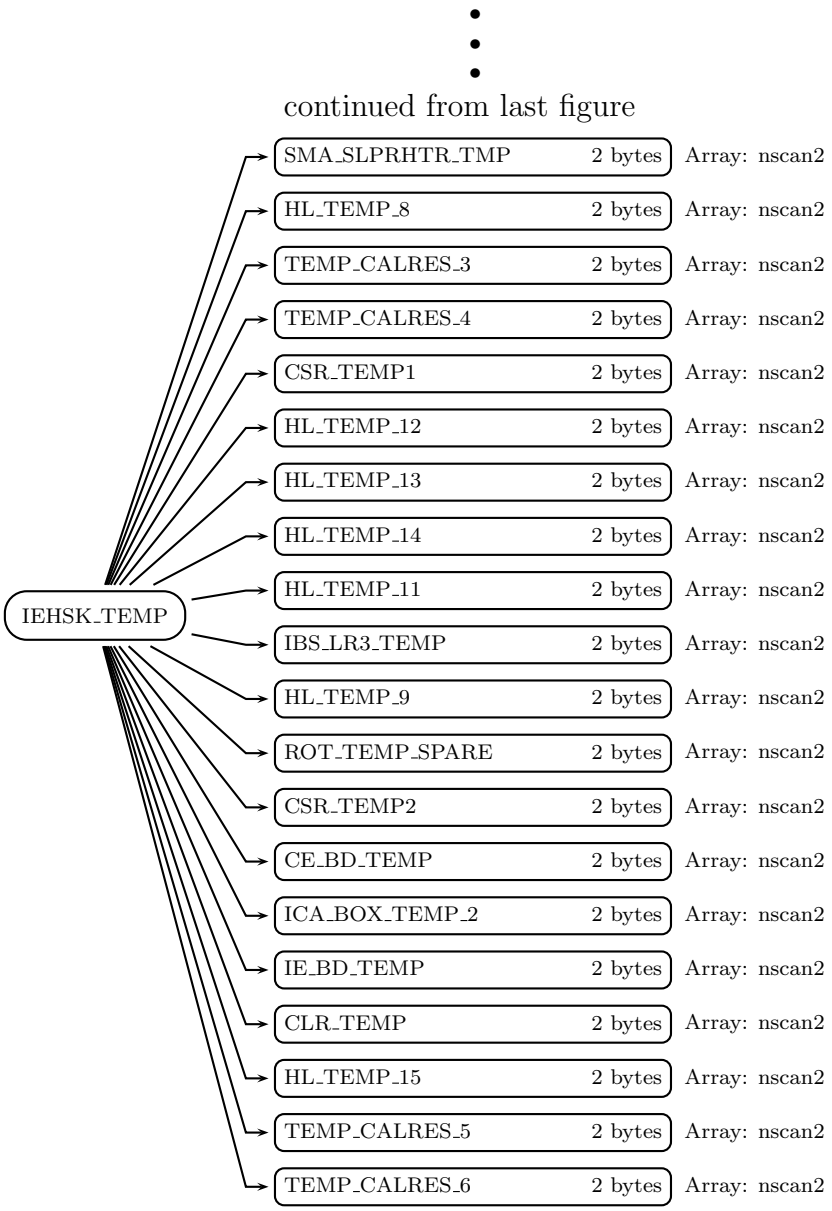

Figure 231: Data Format Structure for 1AGMI, S3, IEHSK_TEMP

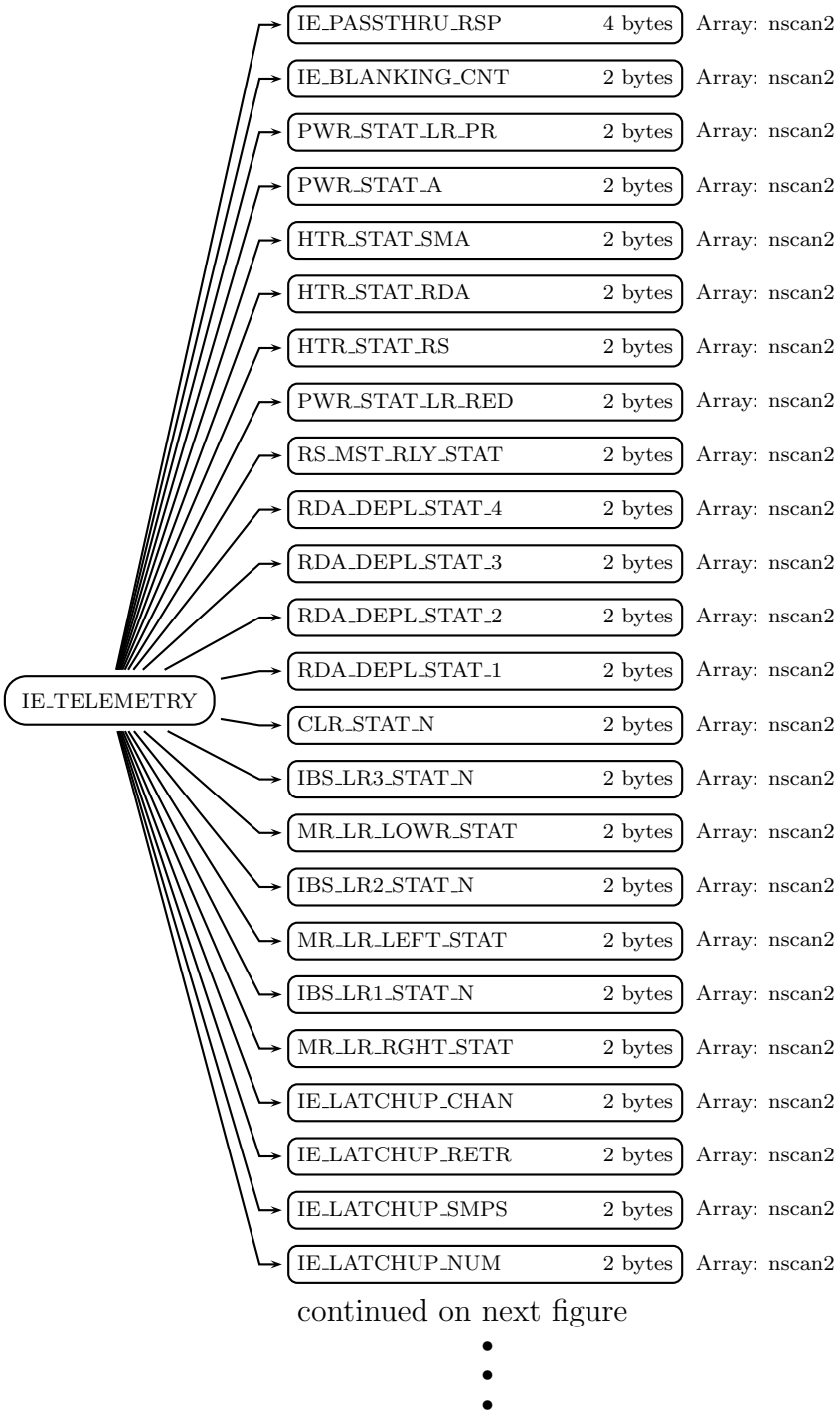

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Figure 232: Data Format Structure for 1AGMI, IE_TELEMETRY

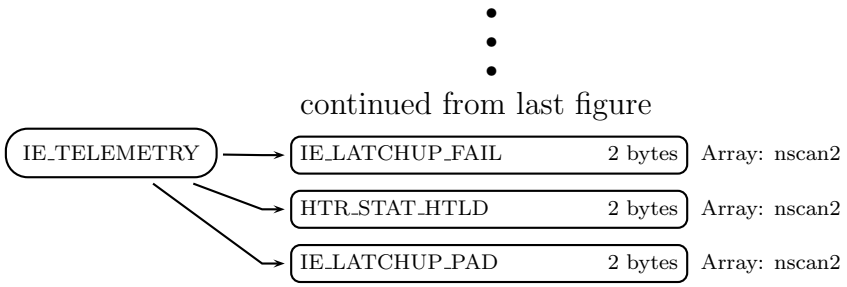


Figure 233: Data Format Structure for 1AGMI, S3, IE_TELEMETRY

missing (1-byte integer, array size: nscan1):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan1):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan1):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken

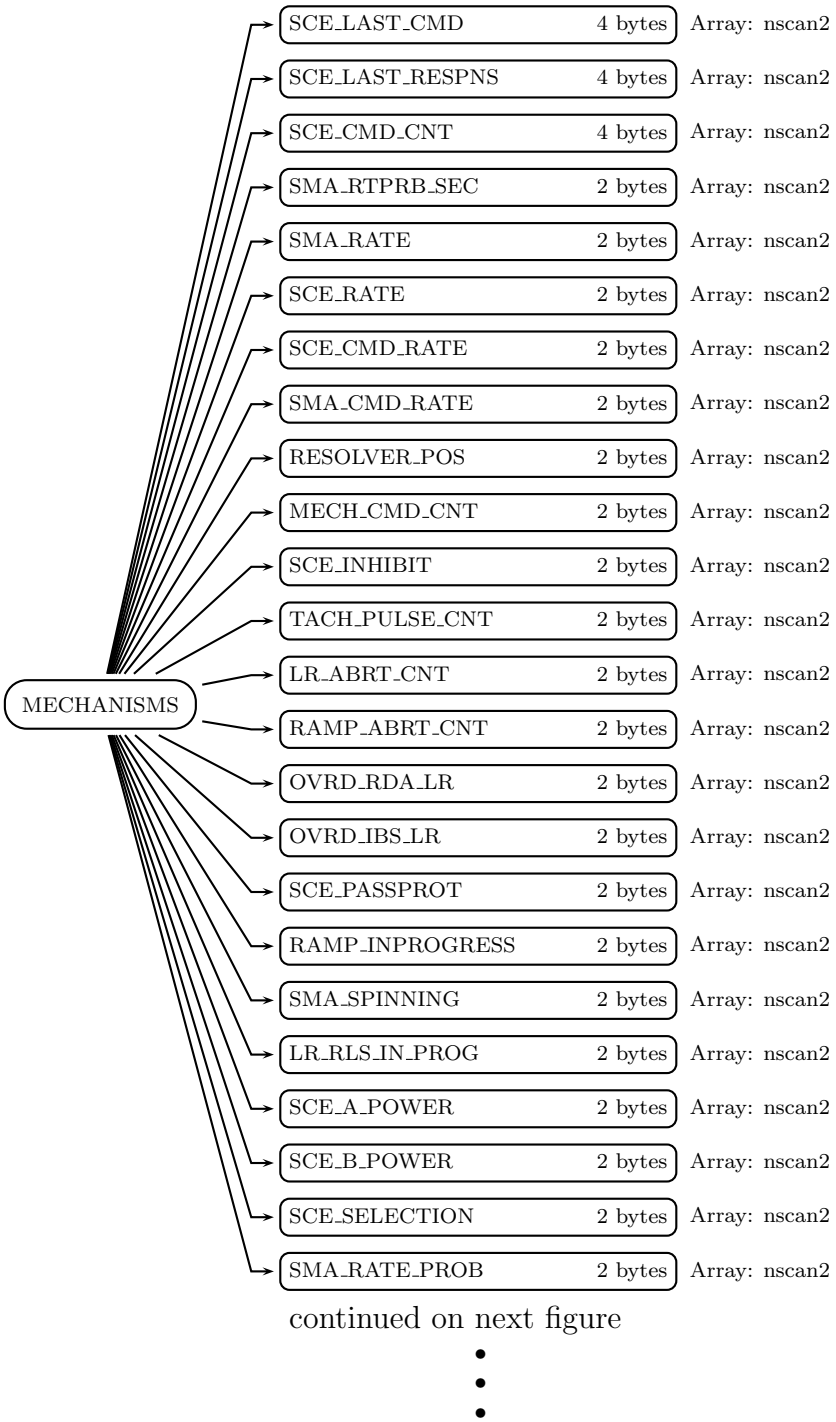


Figure 234: Data Format Structure for 1AGMI, MECHANISMS

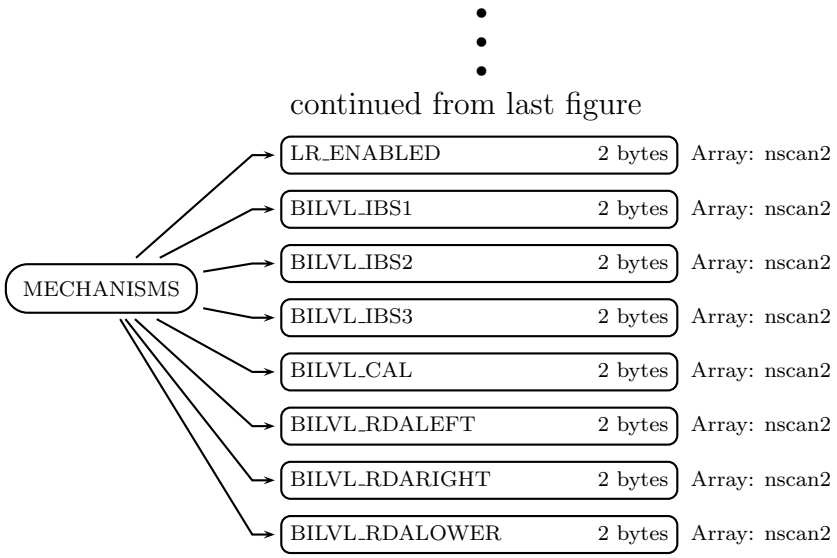
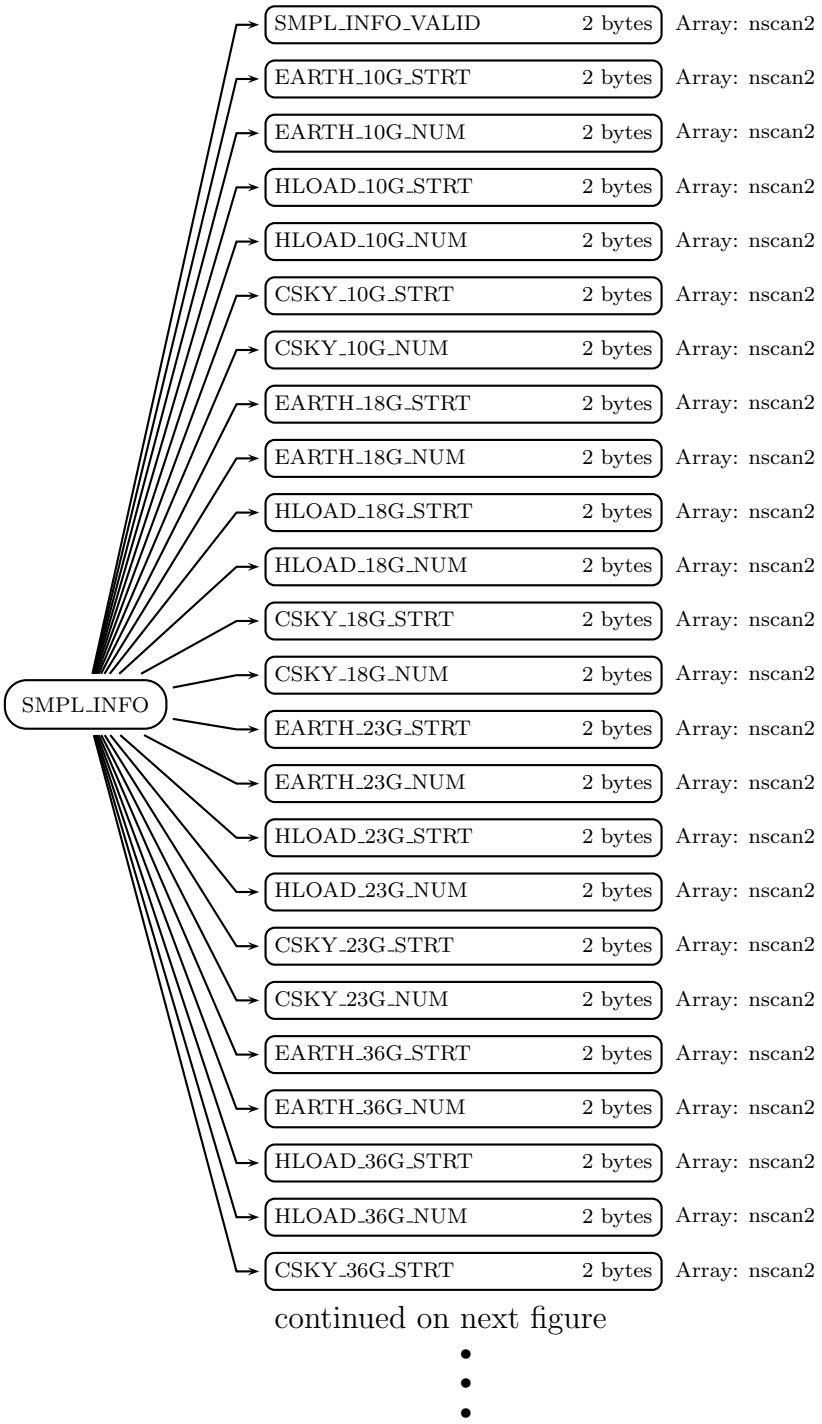


Figure 235: Data Format Structure for 1AGMI, S3, MECHANISMS

down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```



continued on next figure

Figure 236: Data Format Structure for 1AGMI, SMPL_INFO

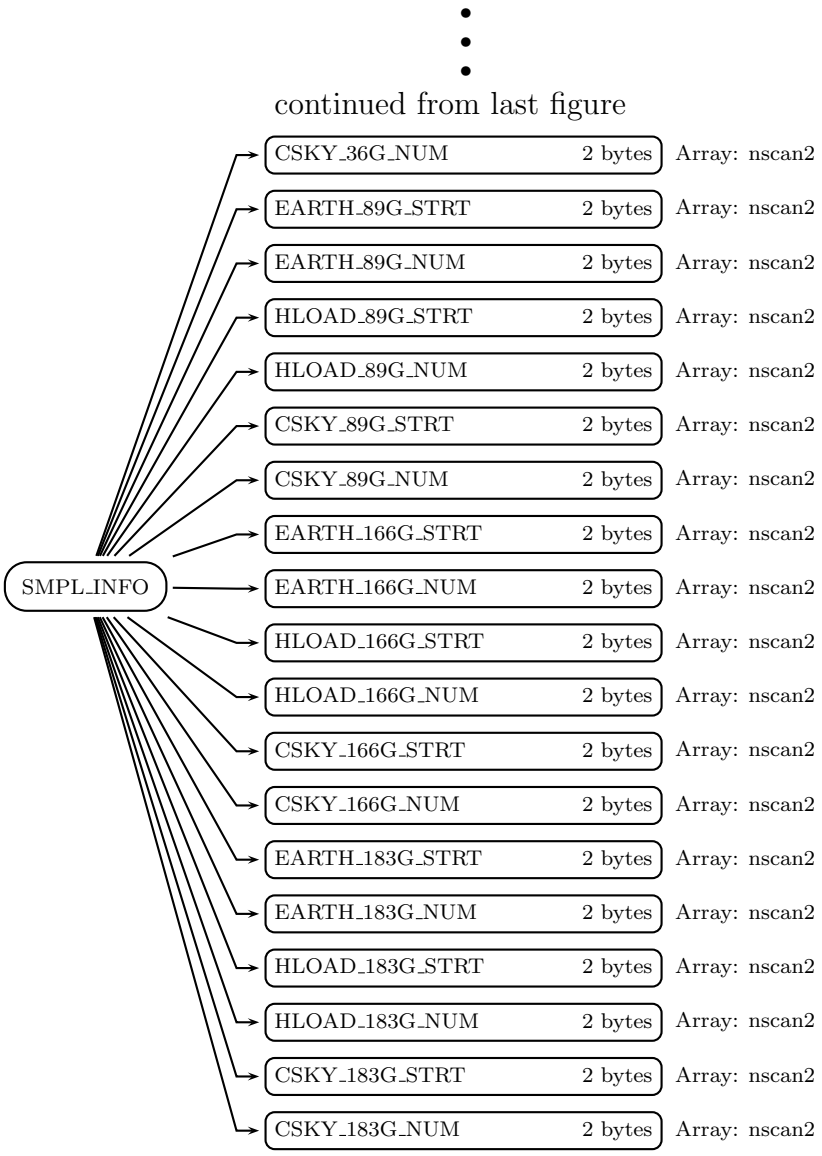


Figure 237: Data Format Structure for 1AGMI, S3, SMPL_INFO

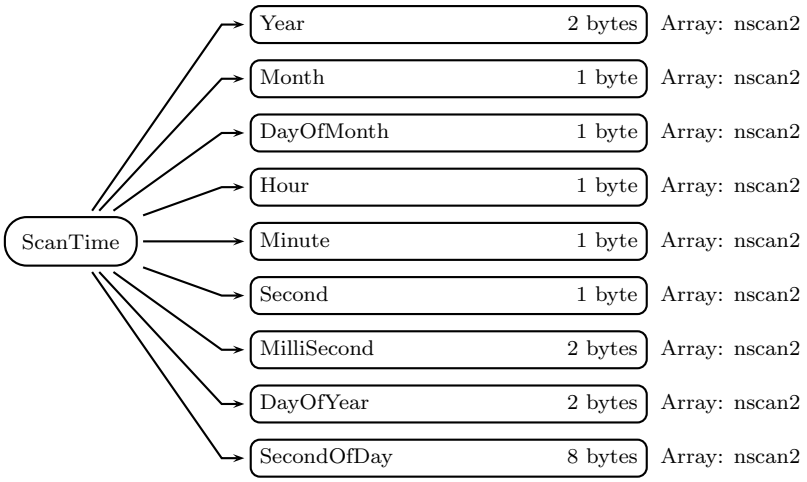


Figure 238: Data Format Structure for 1AGMI, S4, ScanTime

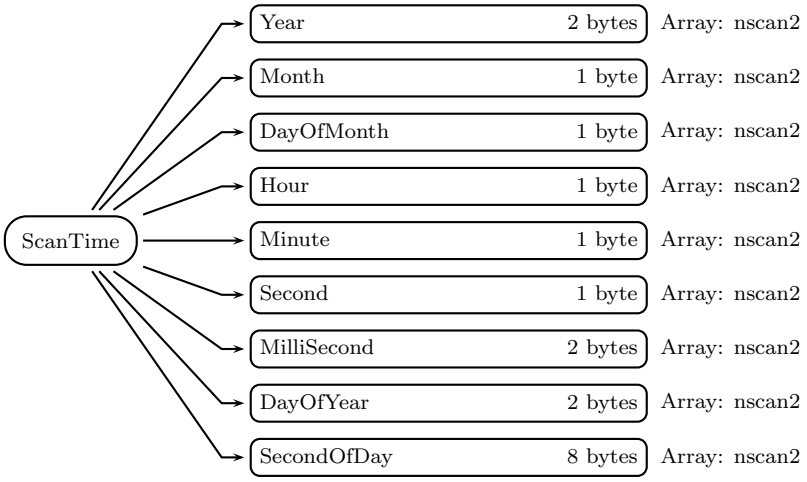


Figure 239: Data Format Structure for 1AGMI, S5, ScanTime

geoWarning (2-byte integer, array size: nscan1):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan1):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan1):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
```

```
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan1):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan1):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan1):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the

spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

ephemerisUsed (1-byte char, array size: dim10 x nscan1):
The ephemeris source used to geolocate the swath. Special values are defined as:
255 Missing value

navigation (Group in S1)

scPos (4-byte float, array size: XYZ x nscan1):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan1):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan1):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan1):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan1):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan1):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan1):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital

Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan1):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan1):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan1):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan1):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan1):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan1):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan1):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan1):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

sunData (Group in S1)

solarBetaAngle (4-byte float, array size: nscan1):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan1):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan1):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan1):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan1):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan1):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan1):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: 3 x nscan1):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npixelev x nscan1):
The angle at the center of the IFOV between the antenna boresight vector and the zenith vector normal to the Earth Ellipsiod. Also known as Satellite Zenith Angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npixelev x nscan1):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npixelev x nscan1):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npixelev x nscan1):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npixelev x nscan1):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

moonVectorInstFrame (4-byte float, array size: GMIxyz x nscan1):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

earthView (2-byte unsigned integer, array size: nchannel1 x npixelev x nscan1):

```
Earth view counts.
```

Special values are defined as:
0 Missing value

hotLoad (2-byte unsigned integer, array size: nchannel1 x npixelht x nscan1):

```
Hot load counts.
```

Special values are defined as:
0 Missing value

coldSky (2-byte unsigned integer, array size: nchannel1 x npixelcs x nscan1):

```
Cold sky counts.
```

Special values are defined as:
0 Missing value

earthViewBlanking (1-byte char, array size: VH x npixelev x nscan1):

```
Earth view blanking counts.
```

Special values are defined as:
0 Missing value

hotLoadBlanking (1-byte char, array size: VH x npixelht x nscan1):

```
Hot load blanking counts.
```

Special values are defined as:
0 Missing value

coldSkyBlanking (1-byte char, array size: VH x npixelcs x nscan1):

```
Cold sky blanking counts.
```

Special values are defined as:
0 Missing value

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixelev x nscan2):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixelev x nscan2):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S2)

dataQuality (1-byte integer, array size: nscan2):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan2):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
```

```
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan2):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan2):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
```

```
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan2):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan2):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
```

```
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan2):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan2):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan2):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan2):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan2):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

ephemerisUsed (1-byte char, array size: dim10 x nscan1):
The ephemeris source used to geolocate the swath. Special values are defined as:
255 Missing value

navigation (Group in S2)

scPos (4-byte float, array size: XYZ x nscan2):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan2):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan2):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan2):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan2):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan2):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000

to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan2):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan2):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan2):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan2):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan2):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan2):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values

range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan2):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan2):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan2):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

sunData (Group in S2)

solarBetaAngle (4-byte float, array size: nscan2):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan2):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan2):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan2):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan2):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan2):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan2):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: 3 x nscan2):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npixelev x nscan2):
The angle at the center of the IFOV between the antenna boresight vector and the zenith vector normal to the Earth Ellipsiod. Also known as Satellite Zenith Angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npixelev x nscan2):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npixelev x nscan2):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npixelev x nscan2):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npixelev x nscan2):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's

surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

moonVectorInstFrame (4-byte float, array size: GMIxyz x nscan2):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

earthView (2-byte unsigned integer, array size: nchannel2 x npixelev x nscan2):

```
Earth view counts.
```

Special values are defined as:
0 Missing value

hotLoad (2-byte unsigned integer, array size: nchannel2 x npixelht x nscan2):

```
Hot load counts.
```

Special values are defined as:
0 Missing value

coldSky (2-byte unsigned integer, array size: nchannel2 x npixelcs x nscan2):

```
Cold sky counts.
```

Special values are defined as:
0 Missing value

S3 (Swath)

S3_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S3)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

ephemerisUsed (1-byte char, array size: dim10 x nscan1):
The ephemeris source used to geolocate the swath. Special values are defined as:
255 Missing value

Latitude (4-byte float, array size: nscan2):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nscan2):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

TAM1 (Group in S3)

timeOffset (4-byte float, array size: nscan2):
Time offset between magnetometer and scan time. Values range from -100 to 100 s. Special values are defined as:
-9999.9 Missing value

Vx (2-byte unsigned integer, array size: nscan2):
Magnetometer one vector, x component. Values range from 0 to 65535 count. Special values are defined as:
65535 Missing value

Vy (2-byte unsigned integer, array size: nscan2):
Magnetometer one vector, y component. Values range from 0 to 65535 count. Special values are defined as:
65535 Missing value

Vz (2-byte unsigned integer, array size: nscan2):
Magnetometer one vector, z component. Values range from 0 to 65535 count. Special values are defined as:
65535 Missing value

TAM2 (Group in S3)

timeOffset (4-byte float, array size: nscan2):
Time offset between magnetometer and scan time. Values range from -100 to 100 s. Special values are defined as:
-9999.9 Missing value

Vx (2-byte unsigned integer, array size: nscan2):
Magnetometer two vector, x component. Values range from 0 to 65535 count. Special values are defined as:
65535 Missing value

Vy (2-byte unsigned integer, array size: nscan2):
Magnetometer two vector, y component. Values range from 0 to 65535 count. Special

values are defined as:
65535 Missing value

Vz (2-byte unsigned integer, array size: nscan2):
Magnetometer two vector, z component. Values range from 0 to 65535 count. Special values are defined as:
65535 Missing value

TORQUE_BAR (Group in S3)

timeOffset (4-byte float, array size: nscan2):
Time offset between torque bar and scan time. Values range from -100 to 100 s. Special values are defined as:
-9999.9 Missing value

Vx (2-byte unsigned integer, array size: nscan2):
Torque bar vector, x component. Values range from 0 to 65535 count. Special values are defined as:
65535 Missing value

Vy (2-byte unsigned integer, array size: nscan2):
Torque bar vector, y component. Values range from 0 to 65535 count. Special values are defined as:
65535 Missing value

Vz (2-byte unsigned integer, array size: nscan2):
Torque bar vector, z component. Values range from 0 to 65535 count. Special values are defined as:
65535 Missing value

GMI_TEMPERATURES (Group in S3)

timeOffset (4-byte float, array size: nscan2):
Time offset between thermisters and scan time. Values range from -100 to 100 s. Special values are defined as:
-9999.9 Missing value

apid (2-byte unsigned integer, array size: nscan2):
APID. 0 is the missing value.

SMA_PT_TEMP (2-byte unsigned integer, array size: nscan2):
SMA_PT_TEMP. 0 is the missing value.

ICA_PT_TEMP (2-byte unsigned integer, array size: nscan2):
ICA_PT_TEMP. 0 is the missing value.

RS_PT_TEMP (2-byte unsigned integer, array size: nscan2):
RS_PT_TEMP. 0 is the missing value.

STAT_PT_TEMP (2-byte unsigned integer, array size: nscan2):
STAT_PT_TEMP. 0 is the missing value.

MR_PT_TEMP (2-byte unsigned integer, array size: nscan2):
MR_PT_TEMP. 0 is the missing value.

version (1-byte integer, array size: nscan2):

type (1-byte integer, array size: nscan2):

secHeaderFlag (1-byte integer, array size: nscan2):

APID (2-byte integer, array size: nscan2):

sequenceFlag (1-byte integer, array size: nscan2):

packetSequenceCount (2-byte integer, array size: nscan2):

packetLength (2-byte unsigned integer, array size: nscan2):

instrTimeSeconds (4-byte unsigned integer, array size: nscan2):

instrTimeSubseconds (2-byte unsigned integer, array size: nscan2):

numPacketSegments (1-byte integer, array size: nscan2):

spare (1-byte integer, array size: nscan2):

RDRversion (2-byte integer, array size: nscan2):

GSDR_TIME (Group in S3)

G_TC_PULSE_SECS (4-byte unsigned integer, array size: nscan2):
GMI Instrument Time Code Pulse Timestamp (Seconds) */ Special values are defined as:
0 Missing value

G_TC_PULSE_SUBS (2-byte unsigned integer, array size: nscan2):
GMI Instrument Time Code Pulse Timestamp (Sub-Seconds) */ Special values are defined as:
0 Missing value

G_TCU_SECS (4-byte unsigned integer, array size: nscan2):
S/C Time Code Update (Seconds) */ Special values are defined as:
0 Missing value

G_TCU_SUBS (4-byte unsigned integer, array size: nscan2):
S/C Time Code Update (Sub-Seconds) */ Special values are defined as:
0 Missing value

G_TCF_SC_SECS (4-byte unsigned integer, array size: nscan2):
Time Correlation Factor spacecraft timestamp (Seconds) */ Special values are defined as:
0 Missing value

G_TCF_SC_SUBSEC (4-byte unsigned integer, array size: nscan2):
Time Correlation Factor spacecraft timestamp (Sub-seconds) */ Special values are defined as:
0 Missing value

G_TCF_SECS (4-byte unsigned integer, array size: nscan2):
Time Correlation Factor (Seconds) */ Special values are defined as:
0 Missing value

G_TCF_SUBSECS (4-byte unsigned integer, array size: nscan2):
Time Correlation Factor (Sub-seconds) */ Special values are defined as:
0 Missing value

G_TCF_SIGN (2-byte unsigned integer, array size: nscan2):
Time Correlation Factor (Sign) */ Special values are defined as:
0 Missing value

G_TCF_LEAP (2-byte unsigned integer, array size: nscan2):
Time Correlation Factor (Leap Seconds) */ Special values are defined as:
0 Missing value

GPS_TCU_SECS (4-byte unsigned integer, array size: nscan2):
S/C Time Code Update in GPS time (Seconds) */ Special values are defined as:
0 Missing value

GPS_TCU_SUBS (4-byte unsigned integer, array size: nscan2):
S/C Time Code Update in GPS time (Sub-Seconds) */ Special values are defined as:
0 Missing value

SENSOR_INFO (Group in S3)

KEEP_ALIVE_CNT (4-byte unsigned integer, array size: nscan2):
Keep Alive Counter */ Special values are defined as:
0 Missing value

FPGA_RST_REASON (2-byte unsigned integer, array size: nscan2):
Reason for last reset */ Special values are defined as:
0 Missing value

CRASH_REASON (2-byte unsigned integer, array size: nscan2):
Reason for last crash */ Special values are defined as:
0 Missing value

VERSION_MIN (2-byte unsigned integer, array size: nscan2):
GMI FSW minor version number */ Special values are defined as:
0 Missing value

VERSION_MAJ (2-byte unsigned integer, array size: nscan2):
GMI FSW major version number */ Special values are defined as:
0 Missing value

FPGA_MODE (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

ERR_HDL_FAILURE (2-byte unsigned integer, array size: nscan2):
Error Handler Failure Flag */ Special values are defined as:
0 Missing value

RESET_REASON (2-byte unsigned integer, array size: nscan2):
Reason for last reset */ Special values are defined as:
0 Missing value

BOOT_BANK (2-byte unsigned integer, array size: nscan2):
EEPROM Bank of last reboot */ Special values are defined as:
0 Missing value

CURRENT_BANK (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

EDAC_ENABLE (2-byte unsigned integer, array size: nscan2):
EDAC enable */ Special values are defined as:
0 Missing value

WDOG_ENABLE (2-byte unsigned integer, array size: nscan2):
FPGA CNTL Special values are defined as:
0 Missing value

SC_1HZ_REF (2-byte unsigned integer, array size: nscan2):
FPGA CNTL Special values are defined as:
0 Missing value

SCE_FORCE_SEL (2-byte unsigned integer, array size: nscan2):
FPGA CNTL Special values are defined as:
0 Missing value

RS_1MHZ_REF (2-byte unsigned integer, array size: nscan2):
FPGA CNTL Special values are defined as:
0 Missing value

RS_SCAN_START (2-byte unsigned integer, array size: nscan2):
FPGA CNTL Special values are defined as:
0 Missing value

FPGA_IE_RX_EN (2-byte unsigned integer, array size: nscan2):
FPGA CNTL Special values are defined as:
0 Missing value

FPGA_RS_RX_EN (2-byte unsigned integer, array size: nscan2):
FPGA CNTL Special values are defined as:
0 Missing value

FPGA_SCE_RX_EN (2-byte unsigned integer, array size: nscan2):
FPGA CNTL Special values are defined as:
0 Missing value

EEPROM_BUSY (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

RS_TLM_PROG (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

SCE_A_ACTIVE (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

SCE_A_RLY (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

SCE_B_ACTIVE (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

SCE_B_RLY (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

IE_TLM_PROG (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

SCE_RSP_PROG (2-byte unsigned integer, array size: nscan2):
SCE response in progress. */ Special values are defined as:
0 Missing value

RS_CLK_ERR (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

RS_PKT_ERR (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

RS_TLM_ERR (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

SCE_RSP_RDY (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

IE_PKT_ERR (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

IE_CMD_ERR (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

IE_RSP_ERR (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

IE_TLM_ERR (2-byte unsigned integer, array size: nscan2):
IE Tlm Error FPGA status bit */ Special values are defined as:
0 Missing value

FPGA_ACCSS_ERR (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

RS_INFO (Group in S3)

RS_POWERED (2-byte unsigned integer, array size: nscan2):
RS Power */ Special values are defined as:
0 Missing value

RS_ENABLED (2-byte unsigned integer, array size: nscan2):
RS Science Enabled */ Special values are defined as:
0 Missing value

RS_MST_RLY (2-byte unsigned integer, array size: nscan2):
RS Master Relay */ Special values are defined as:
0 Missing value

RS_10GHZ_RLY (2-byte unsigned integer, array size: nscan2):
RS 10GHz Relay */ Special values are defined as:
0 Missing value

RS_18GHZ_RLY (2-byte unsigned integer, array size: nscan2):
RS 18GHz Relay */ Special values are defined as:
0 Missing value

RS_23GHZ_RLY (2-byte unsigned integer, array size: nscan2):
RS 23GHz Relay */ Special values are defined as:
0 Missing value

RS_36GHZ_RLY (2-byte unsigned integer, array size: nscan2):
RS 36GHz Relay */ Special values are defined as:
0 Missing value

RS_89GHZ_RLY (2-byte unsigned integer, array size: nscan2):
RS 89GHz Relay */ Special values are defined as:
0 Missing value

RS_166GHZ_RLY (2-byte unsigned integer, array size: nscan2):
RS 166GHz Relay */ Special values are defined as:
0 Missing value

RS_183GHZ_RLY (2-byte unsigned integer, array size: nscan2):
RS 183GHz Relay */ Special values are defined as:
0 Missing value

RS_DQ_MISSING (2-byte unsigned integer, array size: nscan2):
RS Data Quality indicator (Missing samples) */ Special values are defined as:
0 Missing value

RS_DQ_EXTRAS (2-byte unsigned integer, array size: nscan2):
RS Data Quality indicator (Extra samples) */ Special values are defined as:
0 Missing value

RS_DQ_DUPES (2-byte unsigned integer, array size: nscan2):
RS Data Quality indicator (Duplicate samples) */ Special values are defined as:
0 Missing value

RS_LAST_REV (2-byte unsigned integer, array size: nscan2):
RS Data Quality indicator (Latest Revolution) */ Special values are defined as:
0 Missing value

RS_DQ_SAME_REV (2-byte unsigned integer, array size: nscan2):
RS Data Quality indicator (Revolution bit not changing) */ Special values are defined as:
0 Missing value

RS_DQ_BAD_REVS (2-byte unsigned integer, array size: nscan2):
RS Data Quality indicator (Inconsistent Revolutions) */ Special values are defined as:
0 Missing value

RS_DQ_PAR_ERR (2-byte unsigned integer, array size: nscan2):
RS Data Quality indicator (Parity Error) */ Special values are defined as:
0 Missing value

RS_DQ_CLK_ERR (2-byte unsigned integer, array size: nscan2):
RS Data Quality indicator (Clock Error) */ Special values are defined as:
0 Missing value

RS_DQ_PKT_ERR (2-byte unsigned integer, array size: nscan2):
RS Data Quality indicator (Packet Error) */ Special values are defined as:
0 Missing value

RS_DQ_TLM_ERR (2-byte unsigned integer, array size: nscan2):
RS Data Quality indicator (Telemetry Error) */ Special values are defined as:
0 Missing value

RS_DQ_BAD_CONF (2-byte unsigned integer, array size: nscan2):
RS Data Quality indicator (Mismatched configuration) */ Special values are defined as:
0 Missing value

RS_DQ_CAL_LIM (2-byte unsigned integer, array size: nscan2):
RS Data Quality indicator (Calibration Limits) */ Special values are defined as:
0 Missing value

BLK_STATE (2-byte unsigned integer, array size: nscan2):
Blanking State */ Special values are defined as:
0 Missing value

BLK_SIDE (2-byte unsigned integer, array size: nscan2):
Blanking Side */ Special values are defined as:
0 Missing value

BLK_DELAY (2-byte unsigned integer, array size: nscan2):
Blanking Delay */ Special values are defined as:
0 Missing value

BLK_DURATION (2-byte unsigned integer, array size: nscan2):
Blanking Duration */ Special values are defined as:
0 Missing value

RS_HSK_SIZE (2-byte unsigned integer, array size: nscan2):
The number of RS Housekeeping samples */ Special values are defined as:
0 Missing value

RS_PAR_ERR_CNT (4-byte unsigned integer, array size: nscan2):
Number of RS parity errors */ Special values are defined as:
0 Missing value

RS_SCAN_CNT (4-byte unsigned integer, array size: nscan2):
Number of RS scans */ Special values are defined as:
0 Missing value

SAMPLE_TBL_VER (4-byte unsigned integer, array size: nscan2):
Sample table version */ Special values are defined as:
0 Missing value

SMPL_TBL (4-byte unsigned integer, array size: nscan2):
Sample Table Pointer */ Special values are defined as:
0 Missing value

RS_SC_SIZE (2-byte unsigned integer, array size: nscan2):
The number of science samples */ Special values are defined as:
0 Missing value

GSDR_SIZE (2-byte unsigned integer, array size: nscan2):
The size of the latest GSDR */ Special values are defined as:
0 Missing value

GSDR_LEFT (2-byte unsigned integer, array size: nscan2):
GSDR Remainder */ Special values are defined as:
0 Missing value

GSDR_B_POP_IDX (2-byte unsigned integer, array size: nscan2):
GSDR Buffer Pool Index (Pop) */ Special values are defined as:
0 Missing value

GSDR_B_PUSH_IDX (2-byte unsigned integer, array size: nscan2):
GSDR Buffer Pool Index (Push) */ Special values are defined as:
0 Missing value

GSDR_APID (2-byte unsigned integer, array size: nscan2):
GSDR Apid */ Special values are defined as:
0 Missing value

PKT_STATE (2-byte unsigned integer, array size: nscan2):
Packetizing State */ Special values are defined as:
0 Missing value

OVRD_RS_PWR (2-byte unsigned integer, array size: nscan2):
Override RS Power Check */ Special values are defined as:
0 Missing value

OVRD_SMA_SPIN (2-byte unsigned integer, array size: nscan2):
Override SMA Spinning Check */ Special values are defined as:
0 Missing value

OVRD_PASS_RS (2-byte unsigned integer, array size: nscan2):
Override RS Passthru protection indicator. */ Special values are defined as:
0 Missing value

SYNCH_STAMPS (Group in S3)

IDX_PULSE_SECS (4-byte unsigned integer, array size: nscan2):
Index Pulse (Seconds) */ Special values are defined as:
0 Missing value

IDX_PULSE_SUBS (2-byte unsigned integer, array size: nscan2):
Index Pulse (Sub-Seconds) */ Special values are defined as:
0 Missing value

TACH_SECS_00 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 0 */ Special values are defined as:
0 Missing value

TACH_SUBS_00 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 0 */ Special values are defined as:
0 Missing value

TACH_SECS_01 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 1 */ Special values are defined as:
0 Missing value

TACH_SUBS_01 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 1 */ Special values are defined as:
0 Missing value

TACH_SECS_02 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 2 */ Special values are defined as:
0 Missing value

TACH_SUBS_02 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 2 */ Special values are defined as:
0 Missing value

TACH_SECS_03 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 3 */ Special values are defined as:
0 Missing value

TACH_SUBS_03 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 3 */ Special values are defined as:
0 Missing value

TACH_SECS_04 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 4 */ Special values are defined as:
0 Missing value

TACH_SUBS_04 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 4 */ Special values are defined as:
0 Missing value

TACH_SECS_05 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 5 */ Special values are defined as:
0 Missing value

TACH_SUBS_05 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 5 */ Special values are defined as:
0 Missing value

TACH_SECS_06 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 6 */ Special values are defined as:
0 Missing value

TACH_SUBS_06 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 6 */ Special values are defined as:
0 Missing value

TACH_SECS_07 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 7 */ Special values are defined as:
0 Missing value

TACH_SUBS_07 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 7 */ Special values are defined as:
0 Missing value

TACH_SECS_08 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 8 */ Special values are defined as:
0 Missing value

TACH_SUBS_08 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 8 */ Special values are defined as:
0 Missing value

TACH_SECS_09 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 9 */ Special values are defined as:
0 Missing value

TACH_SUBS_09 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 9 */ Special values are defined as:
0 Missing value

TACH_SECS_10 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 10 */ Special values are defined as:
0 Missing value

TACH_SUBS_10 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 10 */ Special values are defined as:
0 Missing value

TACH_SECS_11 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 11 */ Special values are defined as:
0 Missing value

TACH_SUBS_11 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 11 */ Special values are defined as:
0 Missing value

TACH_SECS_12 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 12 */ Special values are defined as:
0 Missing value

TACH_SUBS_12 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 12 */ Special values are defined as:
0 Missing value

TACH_SECS_13 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 13 */ Special values are defined as:
0 Missing value

TACH_SUBS_13 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 13 */ Special values are defined as:
0 Missing value

TACH_SECS_14 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 14 */ Special values are defined as:
0 Missing value

TACH_SUBS_14 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 14 */ Special values are defined as:
0 Missing value

TACH_SECS_15 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 15 */ Special values are defined as:
0 Missing value

TACH_SUBS_15 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 15 */ Special values are defined as:
0 Missing value

SYNCH_STAMPS2 (Group in S3)

TACH_SECS_16 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 16 */ Special values are defined as:
0 Missing value

TACH_SUBS_16 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 16 */ Special values are defined as:
0 Missing value

TACH_SECS_17 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 17 */ Special values are defined as:
0 Missing value

TACH_SUBS_17 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 17 */ Special values are defined as:
0 Missing value

TACH_SECS_18 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 18 */ Special values are defined as:
0 Missing value

TACH_SUBS_18 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 18 */ Special values are defined as:
0 Missing value

TACH_SECS_19 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 19 */ Special values are defined as:
0 Missing value

TACH_SUBS_19 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 19 */ Special values are defined as:
0 Missing value

TACH_SECS_20 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 20 */ Special values are defined as:
0 Missing value

TACH_SUBS_20 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 20 */ Special values are defined as:
0 Missing value

TACH_SECS_21 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 21 */ Special values are defined as:
0 Missing value

TACH_SUBS_21 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 21 */ Special values are defined as:
0 Missing value

TACH_SECS_22 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 22 */ Special values are defined as:
0 Missing value

TACH_SUBS_22 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 22 */ Special values are defined as:
0 Missing value

TACH_SECS_23 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 23 */ Special values are defined as:
0 Missing value

TACH_SUBS_23 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 23 */ Special values are defined as:
0 Missing value

TACH_SECS_24 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 24 */ Special values are defined as:
0 Missing value

TACH_SUBS_24 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 24 */ Special values are defined as:
0 Missing value

TACH_SECS_25 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 25 */ Special values are defined as:
0 Missing value

TACH_SUBS_25 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 25 */ Special values are defined as:
0 Missing value

TACH_SECS_26 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 26 */ Special values are defined as:
0 Missing value

TACH_SUBS_26 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 26 */ Special values are defined as:
0 Missing value

TACH_SECS_27 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 27 */ Special values are defined as:
0 Missing value

TACH_SUBS_27 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 27 */ Special values are defined as:
0 Missing value

TACH_SECS_28 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 28 */ Special values are defined as:
0 Missing value

TACH_SUBS_28 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 28 */ Special values are defined as:
0 Missing value

TACH_SECS_29 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 29 */ Special values are defined as:
0 Missing value

TACH_SUBS_29 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 29 */ Special values are defined as:
0 Missing value

TACH_SECS_30 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 30 */ Special values are defined as:
0 Missing value

TACH_SUBS_30 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 30 */ Special values are defined as:
0 Missing value

TACH_SECS_31 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 31 */ Special values are defined as:
0 Missing value

TACH_SUBS_31 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 31 */ Special values are defined as:
0 Missing value

SCAN_COMPL_SECS (4-byte unsigned integer, array size: nscan2):
Scan Complete Time Tag Seconds */ Special values are defined as:
0 Missing value

SCAN_COMPL_SUBS (2-byte unsigned integer, array size: nscan2):
Scan Complete Time Tag Subseconds */ Special values are defined as:
0 Missing value

RSHSK_STATUS (Group in S3)

RSST_SCI_ADC_LP (2-byte unsigned integer, array size: nscan2):
RS Science channel latchup */ Special values are defined as:
0 Missing value

RSST_HSK_ADC_LP (2-byte unsigned integer, array size: nscan2):
RS Housekeeping channel ADC latchup */ Special values are defined as:
0 Missing value

RSST_SAMP_OVLP (2-byte unsigned integer, array size: nscan2):
Sample offset overlap */ Special values are defined as:
0 Missing value

RSST_10GHZ_RLY (2-byte unsigned integer, array size: nscan2):
10 GHz relay status */ Special values are defined as:
0 Missing value

RSST_18GHZ_RLY (2-byte unsigned integer, array size: nscan2):
18 GHz relay status */ Special values are defined as:
0 Missing value

RSST_23GHZ_RLY (2-byte unsigned integer, array size: nscan2):
23 GHz relay status */ Special values are defined as:
0 Missing value

RSST_36GHZ_RLY (2-byte unsigned integer, array size: nscan2):
36 GHz relay status */ Special values are defined as:
0 Missing value

RSST_89GHZ_RLY (2-byte unsigned integer, array size: nscan2):
89 GHz relay status */ Special values are defined as:
0 Missing value

RSST_166GHZ_RLY (2-byte unsigned integer, array size: nscan2):
166 GHz relay status */ Special values are defined as:
0 Missing value

RSST_183GHZ_RLY (2-byte unsigned integer, array size: nscan2):
183 GHz relay status */ Special values are defined as:
0 Missing value

RSST_INVLD_CMD (2-byte unsigned integer, array size: nscan2):
Invalid command received */ Special values are defined as:
0 Missing value

RSST_CMD_AFTER (2-byte unsigned integer, array size: nscan2):
Command received after scan start */ Special values are defined as:
0 Missing value

NDIODE_MODE (2-byte unsigned integer, array size: nscan2):
RS Configuration of Noise Diode Mode */ Special values are defined as:
0 Missing value

RSST_NDIODE_ST (2-byte unsigned integer, array size: nscan2):
Noise diode state during the scan */ Special values are defined as:
0 Missing value

NDIODE10GHZSNUM (2-byte unsigned integer, array size: nscan2):
RS Configuration of Noise Diode Start Sample Number */ Special values are defined as:
0 Missing value

RESERVED1 (2-byte unsigned integer, array size: nscan2):
Unused item */ Special values are defined as:
0 Missing value

RS_CALRES_1 (2-byte unsigned integer, array size: nscan2):
RS Calibration Resistor for RS telemetry num 1 */ Special values are defined as:
0 Missing value

BATC_CALRES_1 (2-byte unsigned integer, array size: nscan2):
RS Calibration Resistor for BATC telemetry num 1 */ Special values are defined as:
0 Missing value

RS_CALRES_2 (2-byte unsigned integer, array size: nscan2):
RS Calibration Resistor for BATC telemetry num 2 */ Special values are defined as:
0 Missing value

BATC_CALRES_2 (2-byte unsigned integer, array size: nscan2):
RS Calibration Resistor for BATC telemetry num 2 */ Special values are defined as:
0 Missing value

RS_EPC_ISENS (2-byte unsigned integer, array size: nscan2):
Receiver Subsystem EPC Current Sense */ Special values are defined as:
0 Missing value

RS_EPC_5V (2-byte unsigned integer, array size: nscan2):
EPC 5V Telemetry */ Special values are defined as:
0 Missing value

RS_EPC_7V (2-byte unsigned integer, array size: nscan2):
EPC 7V Telemetry */ Special values are defined as:
0 Missing value

RS_EPC_POS12V (2-byte unsigned integer, array size: nscan2):
EPC +12V Telemetry */ Special values are defined as:
0 Missing value

RS_EPC_NEG12V (2-byte unsigned integer, array size: nscan2):
EPC -12V Telemetry */ Special values are defined as:
0 Missing value

RS_EPC_15V (2-byte unsigned integer, array size: nscan2):
EPC 15V Telemetry */ Special values are defined as:
0 Missing value

RSHSK_SAMPL_INFO (Group in S3)

SMPOFFST_10GHZ (2-byte unsigned integer, array size: nscan2):
RS-Reported Sample Offset for the 10GHz Channels (4us) */ Special values are defined as:
0 Missing value

SMPOFFST_18GHZ (2-byte unsigned integer, array size: nscan2):
RS-Reported Sample Offset for the 18 GHz Channels (4us) */ Special values are defined as:
0 Missing value

SMPOFFST_23GHZ (2-byte unsigned integer, array size: nscan2):
RS-Reported Sample Offset for the 23 GHz Channel (4us) */ Special values are defined as:
0 Missing value

SMPOFFST_36GHZ (2-byte unsigned integer, array size: nscan2):
RS-Reported Sample Offset for the 36 GHz Channels (4us) */ Special values are defined as:
0 Missing value

SMPOFFST_89GHZ (2-byte unsigned integer, array size: nscan2):
RS-Reported Sample Offset for the 89 GHz Channels (4us) */ Special values are defined

as:
0 Missing value

SMPOFFST_166GHZ (2-byte unsigned integer, array size: nscan2):
RS-Reported Sample Offset for the 166 GHz Channels (4us) */ Special values are defined as:
0 Missing value

SMPOFFST_183GHZ (2-byte unsigned integer, array size: nscan2):
RS-Reported Sample Offset for the 183 GHz Channels (4us) */ Special values are defined as:
0 Missing value

NUMSMPLS_10GHZ (2-byte unsigned integer, array size: nscan2):
RS Configuration of Number of Samples for the 10 GHz channels */ Special values are defined as:
0 Missing value

NUMSMPLS_18GHZ (2-byte unsigned integer, array size: nscan2):
RS Configuration of Number of Samples for the 10 GHz channels */ Special values are defined as:
0 Missing value

NUMSMPLS_23GHZ (2-byte unsigned integer, array size: nscan2):
RS Configuration of Number of Samples for the 10 GHz channels */ Special values are defined as:
0 Missing value

NUMSMPLS_36GHZ (2-byte unsigned integer, array size: nscan2):
RS Configuration of Number of Samples for the 10 GHz channels */ Special values are defined as:
0 Missing value

NUMSMPLS_89GHZ (2-byte unsigned integer, array size: nscan2):
RS Configuration of Number of Samples for the 10 GHz channels */ Special values are defined as:
0 Missing value

NUMSMPLS_166GHZ (2-byte unsigned integer, array size: nscan2):
RS Configuration of Number of Samples for the 166 GHz channels */ Special values are defined as:
0 Missing value

NUMSMPLS_183GHZ (2-byte unsigned integer, array size: nscan2):
RS Configuration of Number of Samples for the 183 GHz channels */ Special values are defined as:
0 Missing value

RSHSK_GAIN (Group in S3)

RESERVED2 (2-byte unsigned integer, array size: nscan2):
Unused item */ Special values are defined as:
0 Missing value

GAIN_V10GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 10 GHz V-pol channel */ Special values are defined as:
0 Missing value

GAIN_H36GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 36 GHz H-pol channel */ Special values are defined as:
0 Missing value

GAIN_H89GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 89 GHz H-pol channel */ Special values are defined as:
0 Missing value

GAIN_H10GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 10 GHz H-pol channel */ Special values are defined as:
0 Missing value

GAIN_H166GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 166 GHz H-pol channel */ Special values are defined as:
0 Missing value

GAIN_V18GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 18 GHz V-pol channel */ Special values are defined as:
0 Missing value

GAIN_H18GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 18 GHz H-pol channel */ Special values are defined as:
0 Missing value

GAIN_VB183GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 183.31 +/ Special values are defined as:
0 Missing value

GAIN_V23GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 23 GHz V-pol channel */ Special values are defined as:
0 Missing value

GAIN_V36GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 36 GHz V-pol channel */ Special values are defined as:
0 Missing value

GAIN_V89GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 89 GHz V-pol channel */ Special values are defined as:
0 Missing value

GAIN_V166GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 166 GHz V-pol channel */ Special values are defined as:
0 Missing value

GAIN_VA183GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 183.31 +/ Special values are defined as:
0 Missing value

RSHSK_TEMP (Group in S3)

TEMP_10GHZRCVR (2-byte unsigned integer, array size: nscan2):
10 GHz Box Receiver Temperature */ Special values are defined as:
0 Missing value

TEMP_H166GHZMXR (2-byte unsigned integer, array size: nscan2):
166 H GHz Mixer Pre-Amp Temperature */ Special values are defined as:
0 Missing value

TEMP_18GHZRCVR (2-byte unsigned integer, array size: nscan2):
18 GHz Box Receiver Temperature */ Special values are defined as:
0 Missing value

TEMP_V166GHZMXR (2-byte unsigned integer, array size: nscan2):
166 V GHz Mixer Pre-amp Temperature */ Special values are defined as:
0 Missing value

TEMP_23GHZRCVR (2-byte unsigned integer, array size: nscan2):
23 GHz Box Receiver Temperature */ Special values are defined as:
0 Missing value

TEMP_183GHZMXR (2-byte unsigned integer, array size: nscan2):
183 GHz Mixer Pre-amp Temperature */ Special values are defined as:
0 Missing value

TEMP_36GHZRCVR (2-byte unsigned integer, array size: nscan2):
36 GHz Box Receiver Temperature */ Special values are defined as:
0 Missing value

TEMP_H10GHZ_ND (2-byte unsigned integer, array size: nscan2):
10 GHz H-pol Noise Diode Temperature */ Special values are defined as:
0 Missing value

TEMP_89GHZRCVR (2-byte unsigned integer, array size: nscan2):
89 GHz Box Receiver Temperature */ Special values are defined as:
0 Missing value

TEMP_V10GHZ_ND (2-byte unsigned integer, array size: nscan2):
10 GHz V-pol Noise Diode Temperature */ Special values are defined as:
0 Missing value

TEMP_166GHZRCVR (2-byte unsigned integer, array size: nscan2):
166 GHz Box Receiver Temperature */ Special values are defined as:
0 Missing value

TEMP_H18GHZ_ND (2-byte unsigned integer, array size: nscan2):
18 GHz H-pol Noise Diode Temperature */ Special values are defined as:
0 Missing value

TEMP_183GHZRCVR (2-byte unsigned integer, array size: nscan2):
183 GHz Box Receiver Temperature */ Special values are defined as:
0 Missing value

TEMP_V18GHZ_ND (2-byte unsigned integer, array size: nscan2):
18 GHz V-pol Noise Diode Temperature */ Special values are defined as:
0 Missing value

TEMP_RS_EPC (2-byte unsigned integer, array size: nscan2):
Receiver Subsystem EPC Box Temperature */ Special values are defined as:
0 Missing value

TEMP_H36GHZ_ND (2-byte unsigned integer, array size: nscan2):
36 GHz H-pol Noise Diode Temperature */ Special values are defined as:
0 Missing value

TEMP_RS_EDC (2-byte unsigned integer, array size: nscan2):
Receiver Subsystem EDC Box Temperature */ Special values are defined as:
0 Missing value

TEMP_V36GHZ_ND (2-byte unsigned integer, array size: nscan2):
36 GHz V-pol Noise Diode Temperature */ Special values are defined as:
0 Missing value

TEMP_FEED (2-byte unsigned integer, array size: nscan2):
Feedhorn Assembly Temperature */ Special values are defined as:
0 Missing value

TEMP_89GHZ_LO (2-byte unsigned integer, array size: nscan2):
89 GHz Local Oscillator Temperature */ Special values are defined as:
0 Missing value

TEMP_HL_TRAY (2-byte unsigned integer, array size: nscan2):
Hot Load tray temperature */ Special values are defined as:
0 Missing value

TEMP_166GHZ_LO (2-byte unsigned integer, array size: nscan2):
166 GHz Local Oscillator Temperature */ Special values are defined as:
0 Missing value

TEMP_SMASPUNHSG (2-byte unsigned integer, array size: nscan2):
Temp SMA spun HSG */ Special values are defined as:
0 Missing value

TEMP_RS_MR1 (2-byte unsigned integer, array size: nscan2):
Main Reflector Temperature read by RS num 1 */ Special values are defined as:
0 Missing value

TEMP_H89GHZMXR (2-byte unsigned integer, array size: nscan2):
Temp H89GHZMXR */ Special values are defined as:
0 Missing value

TEMP_RS_MR2 (2-byte unsigned integer, array size: nscan2):
Main Reflector Temperature read by RS num 2 */ Special values are defined as:
0 Missing value

TEMP_V89GHZMXR (2-byte unsigned integer, array size: nscan2):
Temp V89GHZMXR */ Special values are defined as:
0 Missing value

TEMP_183GHZ_LO (2-byte unsigned integer, array size: nscan2):
183 GHz Local Oscillator Temperature */ Special values are defined as:
0 Missing value

IEHSK_TEMP (Group in S3)

IBS_LR1_TEMP (2-byte unsigned integer, array size: nscan2):
IBS Launch Restraint 1 temperature */ Special values are defined as:
0 Missing value

RS_TEMP_1 (2-byte unsigned integer, array size: nscan2):
Receiver Subsystem Temperature num 1 */ Special values are defined as:
0 Missing value

SCE_A_BD_TEMP (2-byte unsigned integer, array size: nscan2):
SCE A Board Temperature */ Special values are defined as:
0 Missing value

MR_LR_RGHT_TEMP (2-byte unsigned integer, array size: nscan2):
Main Reflector Right Launch Restraint Temperature */ Special values are defined as:
0 Missing value

SMA_BEARING_TMP (2-byte unsigned integer, array size: nscan2):
SMA Bearing Temperature */ Special values are defined as:
0 Missing value

PC_BD_TEMP (2-byte unsigned integer, array size: nscan2):
Power Controller Board Temperature */ Special values are defined as:
0 Missing value

LVPS_BD_TEMP (2-byte unsigned integer, array size: nscan2):
Low Voltage Power Supply Board Temperature */ Special values are defined as:
0 Missing value

SMA_MTR_TEMP (2-byte unsigned integer, array size: nscan2):
SMA Motor Temperature */ Special values are defined as:
0 Missing value

HL_TEMP_2 (2-byte unsigned integer, array size: nscan2):
Hot Load Temperature num 2 */ Special values are defined as:
0 Missing value

RDA_TEMP_2 (2-byte unsigned integer, array size: nscan2):
RDA Temperature num 2 */ Special values are defined as:
0 Missing value

HL_TEMP_1 (2-byte unsigned integer, array size: nscan2):
Hot Load Temperature num 1 */ Special values are defined as:
0 Missing value

RS_TEMP_2 (2-byte unsigned integer, array size: nscan2):
Receiver Subsystem Temperature num 2 */ Special values are defined as:
0 Missing value

SCE_B_BD_TEMP (2-byte unsigned integer, array size: nscan2):
SCE B Board Temperature */ Special values are defined as:
0 Missing value

TEMP_CALRES_1 (2-byte unsigned integer, array size: nscan2):
ICA IE Telemetry Calibration Resistor num 1 */ Special values are defined as:
0 Missing value

TEMP_CALRES_2 (2-byte unsigned integer, array size: nscan2):
ICA IE Telemetry Calibration Resistor num 2 */ Special values are defined as:
0 Missing value

MR_ICA_TEMP (2-byte unsigned integer, array size: nscan2):
Main Reflector temperature read by the ICA */ Special values are defined as:
0 Missing value

IBS_LR2_TEMP (2-byte unsigned integer, array size: nscan2):
IBS Launch Restraint 2 temperature */ Special values are defined as:
0 Missing value

HL_TEMP_7 (2-byte unsigned integer, array size: nscan2):
Hot Load Temperature num 3 */ Special values are defined as:
0 Missing value

RDA_TEMP_1 (2-byte unsigned integer, array size: nscan2):
RDA Temperature num 1 */ Special values are defined as:
0 Missing value

MR_LR_LEFT_TEMP (2-byte unsigned integer, array size: nscan2):
Main Reflector Left Launch Restraint Temperature */ Special values are defined as:
0 Missing value

RDA_TEMP_3 (2-byte unsigned integer, array size: nscan2):
RDA Temperature num 3 */ Special values are defined as:
0 Missing value

ICA_BOX_TEMP_1 (2-byte unsigned integer, array size: nscan2):
ICA Box Temperature num 1 */ Special values are defined as:
0 Missing value

HL_TEMP_10 (2-byte unsigned integer, array size: nscan2):
Hot Load Temperature num 10 */ Special values are defined as:
0 Missing value

MR_LR_LOWR_TEMP (2-byte unsigned integer, array size: nscan2):
Main Reflector Lower Launch Restraint Temperature */ Special values are defined as:
0 Missing value

SMA_SLPRHTR_TMP (2-byte unsigned integer, array size: nscan2):
SMA Slip Ring Heater Temperature */ Special values are defined as:
0 Missing value

HL_TEMP_8 (2-byte unsigned integer, array size: nscan2):
Hot Load Temperature num 8 */ Special values are defined as:
0 Missing value

TEMP_CALRES_3 (2-byte unsigned integer, array size: nscan2):
ICA IE Telemetry Calibration Resistor num 3 */ Special values are defined as:
0 Missing value

TEMP_CALRES_4 (2-byte unsigned integer, array size: nscan2):
ICA IE Telemetry Calibration Resistor num 4 */ Special values are defined as:
0 Missing value

CSR_TEMP1 (2-byte unsigned integer, array size: nscan2):
Cold Sky Reflector Temperature */ Special values are defined as:
0 Missing value

HL_TEMP_12 (2-byte unsigned integer, array size: nscan2):
Hot Load Temperature num 12 */ Special values are defined as:
0 Missing value

HL_TEMP_13 (2-byte unsigned integer, array size: nscan2):
Hot Load Temperature num 13 */ Special values are defined as:
0 Missing value

HL_TEMP_14 (2-byte unsigned integer, array size: nscan2):
Hot Load Temperature num 14 */ Special values are defined as:
0 Missing value

HL_TEMP_11 (2-byte unsigned integer, array size: nscan2):
Hot Load Temperature num 11 */ Special values are defined as:
0 Missing value

IBS_LR3_TEMP (2-byte unsigned integer, array size: nscan2):
IBS Launch Restraint 3 temperature */ Special values are defined as:
0 Missing value

HL_TEMP_9 (2-byte unsigned integer, array size: nscan2):
Hot Load Temperature num 9 */ Special values are defined as:
0 Missing value

ROT_TEMP_SPARE (2-byte unsigned integer, array size: nscan2):
Spare Temperature (Rotational Side) */ Special values are defined as:
0 Missing value

CSR_TEMP2 (2-byte unsigned integer, array size: nscan2):
Cold Sky Reflector temperature 2 */ Special values are defined as:
0 Missing value

CE_BD_TEMP (2-byte unsigned integer, array size: nscan2):
CE Board Temperature */ Special values are defined as:
0 Missing value

ICA_BOX_TEMP_2 (2-byte unsigned integer, array size: nscan2):
ICA Box Temperature num 2 */ Special values are defined as:
0 Missing value

IE_BD_TEMP (2-byte unsigned integer, array size: nscan2):
Interface Electronics Board Temperature */ Special values are defined as:
0 Missing value

CLR_TEMP (2-byte unsigned integer, array size: nscan2):
CLR Temperature */ Special values are defined as:
0 Missing value

HL_TEMP_15 (2-byte unsigned integer, array size: nscan2):
Hot Load Temperature num 15 */ Special values are defined as:
0 Missing value

TEMP_CALRES_5 (2-byte unsigned integer, array size: nscan2):
ICA IE Telemetry Calibration Resistor num 5 */ Special values are defined as:
0 Missing value

TEMP_CALRES_6 (2-byte unsigned integer, array size: nscan2):
ICA IE Telemetry Calibration Resistor num 6 */ Special values are defined as:
0 Missing value

IE_TELEMETRY (Group in S3)

IE_PASSTHRU_RSP (4-byte unsigned integer, array size: nscan2):
The response to the last pass through command. */ Special values are defined as:
0 Missing value

IE_BLANKING_CNT (2-byte unsigned integer, array size: nscan2):
Number of blanking output pulses since last tlm cycle. */ Special values are defined as:
0 Missing value

PWR_STAT_LR_PR (2-byte unsigned integer, array size: nscan2):
Power Controller Special values are defined as:
0 Missing value

PWR_STAT_A (2-byte unsigned integer, array size: nscan2):
Operational Power A status */ Special values are defined as:
0 Missing value

HTR_STAT_SMA (2-byte unsigned integer, array size: nscan2):
Operational heater status for the SMA */ Special values are defined as:
0 Missing value

HTR_STAT_RDA (2-byte unsigned integer, array size: nscan2):
Operational heater status for the RDA */ Special values are defined as:
0 Missing value

HTR_STAT_RS (2-byte unsigned integer, array size: nscan2):
Receiver Subsystem operational heater */ Special values are defined as:
0 Missing value

PWR_STAT_LR_RED (2-byte unsigned integer, array size: nscan2):
Redundant Launch Restraint status */ Special values are defined as:
0 Missing value

RS_MST_RLY_STAT (2-byte unsigned integer, array size: nscan2):
Receiver Subsytem Master Relay status */ Special values are defined as:
0 Missing value

RDA_DEPL_STAT_4 (2-byte unsigned integer, array size: nscan2):
Reflector Deployment Assembly deployment status num 4 */ Special values are defined as:
0 Missing value

RDA_DEPL_STAT_3 (2-byte unsigned integer, array size: nscan2):
Reflector Deployment Assembly deployment status num 3 */ Special values are defined as:
0 Missing value

RDA_DEPL_STAT_2 (2-byte unsigned integer, array size: nscan2):
Reflector Deployment Assembly deployment status num 2 */ Special values are defined as:
0 Missing value

RDA_DEPL_STAT_1 (2-byte unsigned integer, array size: nscan2):
Reflector Deployment Assembly deployment status num 1 */ Special values are defined as:
0 Missing value

CLR_STAT_N (2-byte unsigned integer, array size: nscan2):
Calibration Launch Restraint Status */ Special values are defined as:
0 Missing value

IBS_LR3_STAT_N (2-byte unsigned integer, array size: nscan2):
Instrument Bay Structure Launch Restraint */ Special values are defined as:
0 Missing value

MR_LR_LOWR_STAT (2-byte unsigned integer, array size: nscan2):
Main Reflector Lower Launch Restraint */ Special values are defined as:
0 Missing value

IBS_LR2_STAT_N (2-byte unsigned integer, array size: nscan2):
Instrument Bay Structure Launch Restraint */ Special values are defined as:
0 Missing value

MR_LR_LEFT_STAT (2-byte unsigned integer, array size: nscan2):
Main Reflector Left Launch Restraint */ Special values are defined as:
0 Missing value

IBS_LR1_STAT_N (2-byte unsigned integer, array size: nscan2):
Instrument Bay Structure Launch Restraint */ Special values are defined as:
0 Missing value

MR_LR_RGHT_STAT (2-byte unsigned integer, array size: nscan2):
Main Reflector Right Launch Restraint */ Special values are defined as:
0 Missing value

IE_LATCHUP_CHAN (2-byte unsigned integer, array size: nscan2):
Indicates the telemetry sample which observed the last */ Special values are defined as:
0 Missing value

IE_LATCHUP_RETR (2-byte unsigned integer, array size: nscan2):
Number of Retries */ Special values are defined as:
0 Missing value

IE_LATCHUP_SMPS (2-byte unsigned integer, array size: nscan2):
Number of Samples with Latchup. */ Special values are defined as:
0 Missing value

IE_LATCHUP_NUM (2-byte unsigned integer, array size: nscan2):
Number of Latchups Detected */ Special values are defined as:
0 Missing value

IE_LATCHUP_FAIL (2-byte unsigned integer, array size: nscan2):
Latchup Failure. */ Special values are defined as:
0 Missing value

HTR_STAT_HTLD (2-byte unsigned integer, array size: nscan2):
Operational heater status for the Hot Load */ Special values are defined as:
0 Missing value

IE_LATCHUP_PAD (2-byte unsigned integer, array size: nscan2):
PADDING */ Special values are defined as:
0 Missing value

MECHANISMS (Group in S3)

SCE_LAST_CMD (4-byte unsigned integer, array size: nscan2):
Last command sent to the SCE. */ Special values are defined as:
0 Missing value

SCE_LAST_RESPNS (4-byte unsigned integer, array size: nscan2):
Response from the SCE of the last command sent */ Special values are defined as:
0 Missing value

SCE_CMD_CNT (4-byte unsigned integer, array size: nscan2):
Total number of cmds to the SCE. */ Special values are defined as:
0 Missing value

SMA_RTPRB_SEC (2-byte unsigned integer, array size: nscan2):
The time since the beginning of the rate problem. 20 seconds to */ Special values are defined as:
0 Missing value

SMA_RATE (2-byte unsigned integer, array size: nscan2):
The ICA calculated rotational rate of the SMA in integer scaled rpm */ Special values are defined as:
0 Missing value

SCE_RATE (2-byte unsigned integer, array size: nscan2):
The SMA rotational rate reported by the SCE */ Special values are defined as:
0 Missing value

SCE_CMD_RATE (2-byte unsigned integer, array size: nscan2):
Last rate value commanded to the SCE. Used for rate limits */ Special values are defined as:
0 Missing value

SMA_CMD_RATE (2-byte unsigned integer, array size: nscan2):
Last rate value commanded to the SCE, converted to integer */ Special values are defined as:
0 Missing value

RESOLVER_POS (2-byte unsigned integer, array size: nscan2):
The resolver position reported by the SCE */ Special values are defined as:
0 Missing value

MECH_CMD_CNT (2-byte unsigned integer, array size: nscan2):
Number of commands received by the Mechanisms CSC */ Special values are defined as:
0 Missing value

SCE_INHIBIT (2-byte unsigned integer, array size: nscan2):
Indicator that commanding to the SCE is inhibited */ Special values are defined as:
0 Missing value

TACH_PULSE_CNT (2-byte unsigned integer, array size: nscan2):
Array indexer for tach pulses */ Special values are defined as:
0 Missing value

LR_ABRT_CNT (2-byte unsigned integer, array size: nscan2):
The number of launch restraint release procedures that have been */ Special values are defined as:
0 Missing value

RAMP_ABRT_CNT (2-byte unsigned integer, array size: nscan2):
The number of ramp procedures that have been aborted. */ Special values are defined as:
0 Missing value

OVRD_RDA_LR (2-byte unsigned integer, array size: nscan2):
Flag indicating the RDA launch restraints order protection is */ Special values are defined as:
0 Missing value

OVRD_IBS_LR (2-byte unsigned integer, array size: nscan2):
Flag indicating the IBS launch restraints order protection is */ Special values are defined as:
0 Missing value

SCE_PASSPROT (2-byte unsigned integer, array size: nscan2):
Flag indicating the RDA launch restraints order protection is */ Special values are defined as:
0 Missing value

RAMP_INPROGRESS (2-byte unsigned integer, array size: nscan2):
A SMA speed modification procedure is in progress. */ Special values are defined as:
0 Missing value

SMA_SPINNING (2-byte unsigned integer, array size: nscan2):
Indicator of whether SMA is spinning, based on speed */ Special values are defined as:
0 Missing value

LR_RLS_IN_PROG (2-byte unsigned integer, array size: nscan2):
Reports state of launch release fire command */ Special values are defined as:
0 Missing value

SCE_A_POWER (2-byte unsigned integer, array size: nscan2):
FSW status of SCE A Card power */ Special values are defined as:
0 Missing value

SCE_B_POWER (2-byte unsigned integer, array size: nscan2):
FSW status of SCE B Card power */ Special values are defined as:
0 Missing value

SCE_SELECTION (2-byte unsigned integer, array size: nscan2):
The current SCE selection setting. */ Special values are defined as:
0 Missing value

SMA_RATE_PROB (2-byte unsigned integer, array size: nscan2):
This field indicates the SMA is out of rate tolerances. */ Special values are defined as:
0 Missing value

LR_ENABLED (2-byte unsigned integer, array size: nscan2):
This tlm point indicates that one of launch restraint power buses is */ Special values are defined as:
0 Missing value

BILVL_IBS1 (2-byte unsigned integer, array size: nscan2):
A bilevel to control the Limits Monitor CSU. */ Special values are defined as:
0 Missing value

BILVL_IBS2 (2-byte unsigned integer, array size: nscan2):
A bilevel to control the Limits Monitor CSU. */ Special values are defined as:
0 Missing value

BILVL_IBS3 (2-byte unsigned integer, array size: nscan2):
A bilevel to control the Limits Monitor CSU. */ Special values are defined as:
0 Missing value

BILVL_CAL (2-byte unsigned integer, array size: nscan2):
A bilevel to control the Limits Monitor CSU. */ Special values are defined as:
0 Missing value

BILVL_RDALEFT (2-byte unsigned integer, array size: nscan2):
A bilevel to control the Limits Monitor CSU. */ Special values are defined as:
0 Missing value

BILVL_RDARIGHT (2-byte unsigned integer, array size: nscan2):
A bilevel to control the Limits Monitor CSU. */ Special values are defined as:
0 Missing value

BILVL_RDALOWER (2-byte unsigned integer, array size: nscan2):
A bilevel to control the Limits Monitor CSU. */ Special values are defined as:
0 Missing value

SMPL_INFO (Group in S3)

SMPL_INFO_VALID (2-byte unsigned integer, array size: nscan2):
Sample Table Valid */ Special values are defined as:
0 Missing value

EARTH_10G_STRT (2-byte unsigned integer, array size: nscan2):
Earth viewing start (10GHz) */ Special values are defined as:
0 Missing value

EARTH_10G_NUM (2-byte unsigned integer, array size: nscan2):
Earth viewing samples (10GHz) */ Special values are defined as:
0 Missing value

HLOAD_10G_STRT (2-byte unsigned integer, array size: nscan2):
Hot Load start (10GHz) */ Special values are defined as:
0 Missing value

HLOAD_10G_NUM (2-byte unsigned integer, array size: nscan2):
Hot Load samples (10GHz) */ Special values are defined as:
0 Missing value

CSKY_10G_STRT (2-byte unsigned integer, array size: nscan2):
Cold Sky start (10GHz) */ Special values are defined as:
0 Missing value

CSKY_10G_NUM (2-byte unsigned integer, array size: nscan2):
Cold Sky samples (10GHz) */ Special values are defined as:
0 Missing value

EARTH_18G_STRT (2-byte unsigned integer, array size: nscan2):
Earth viewing start (18GHz) */ Special values are defined as:
0 Missing value

EARTH_18G_NUM (2-byte unsigned integer, array size: nscan2):
Earth viewing samples (18GHz) */ Special values are defined as:
0 Missing value

HLOAD_18G_STRT (2-byte unsigned integer, array size: nscan2):
Hot Load start (18GHz) */ Special values are defined as:
0 Missing value

HLOAD_18G_NUM (2-byte unsigned integer, array size: nscan2):
Hot Load samples (18GHz) */ Special values are defined as:
0 Missing value

CSKY_18G_STRT (2-byte unsigned integer, array size: nscan2):
Cold Sky start (18GHz) */ Special values are defined as:
0 Missing value

CSKY_18G_NUM (2-byte unsigned integer, array size: nscan2):
Cold Sky samples (18GHz) */ Special values are defined as:
0 Missing value

EARTH_23G_STRT (2-byte unsigned integer, array size: nscan2):
Earth viewing start (23GHz) */ Special values are defined as:
0 Missing value

EARTH_23G_NUM (2-byte unsigned integer, array size: nscan2):
Earth viewing samples (23GHz) */ Special values are defined as:
0 Missing value

HLOAD_23G_STRT (2-byte unsigned integer, array size: nscan2):
Hot Load start (23GHz) */ Special values are defined as:
0 Missing value

HLOAD_23G_NUM (2-byte unsigned integer, array size: nscan2):
Hot Load samples (23GHz) */ Special values are defined as:
0 Missing value

CSKY_23G_STRT (2-byte unsigned integer, array size: nscan2):
Cold Sky start (23GHz) */ Special values are defined as:
0 Missing value

CSKY_23G_NUM (2-byte unsigned integer, array size: nscan2):
Cold Sky samples (23GHz) */ Special values are defined as:
0 Missing value

EARTH_36G_STRT (2-byte unsigned integer, array size: nscan2):
Earth viewing start (36GHz) */ Special values are defined as:
0 Missing value

EARTH_36G_NUM (2-byte unsigned integer, array size: nscan2):
Earth viewing samples (36GHz) */ Special values are defined as:
0 Missing value

HLOAD_36G_STRT (2-byte unsigned integer, array size: nscan2):
Hot Load start (36GHz) */ Special values are defined as:
0 Missing value

HLOAD_36G_NUM (2-byte unsigned integer, array size: nscan2):
Hot Load samples (36GHz) */ Special values are defined as:
0 Missing value

CSKY_36G_STRT (2-byte unsigned integer, array size: nscan2):
Cold Sky start (36GHz) */ Special values are defined as:
0 Missing value

CSKY_36G_NUM (2-byte unsigned integer, array size: nscan2):
Cold Sky samples (36GHz) */ Special values are defined as:
0 Missing value

EARTH_89G_STRT (2-byte unsigned integer, array size: nscan2):
Earth viewing start (89GHz) */ Special values are defined as:
0 Missing value

EARTH_89G_NUM (2-byte unsigned integer, array size: nscan2):
Earth viewing samples (89GHz) */ Special values are defined as:
0 Missing value

HLOAD_89G_STRT (2-byte unsigned integer, array size: nscan2):
Hot Load start (89GHz) */ Special values are defined as:
0 Missing value

HLOAD_89G_NUM (2-byte unsigned integer, array size: nscan2):
Hot Load samples (89GHz) */ Special values are defined as:
0 Missing value

CSKY_89G_STRT (2-byte unsigned integer, array size: nscan2):
Cold Sky start (89GHz) */ Special values are defined as:
0 Missing value

CSKY_89G_NUM (2-byte unsigned integer, array size: nscan2):
Cold Sky samples (89GHz) */ Special values are defined as:
0 Missing value

EARTH_166G_STRT (2-byte unsigned integer, array size: nscan2):
Earth viewing start (166GHz) */ Special values are defined as:
0 Missing value

EARTH_166G_NUM (2-byte unsigned integer, array size: nscan2):
Earth viewing samples (166GHz) */ Special values are defined as:
0 Missing value

HLOAD_166G_STRT (2-byte unsigned integer, array size: nscan2):
Hot Load start (166GHz) */ Special values are defined as:
0 Missing value

HLOAD_166G_NUM (2-byte unsigned integer, array size: nscan2):
Hot Load samples (166GHz) */ Special values are defined as:
0 Missing value

CSKY_166G_STRT (2-byte unsigned integer, array size: nscan2):
Cold Sky start (166GHz) */ Special values are defined as:
0 Missing value

CSKY_166G_NUM (2-byte unsigned integer, array size: nscan2):
Cold Sky samples (166GHz) */ Special values are defined as:
0 Missing value

EARTH_183G_STRT (2-byte unsigned integer, array size: nscan2):
Earth viewing start (183GHz) */ Special values are defined as:
0 Missing value

EARTH_183G_NUM (2-byte unsigned integer, array size: nscan2):
Earth viewing samples (183GHz) */ Special values are defined as:
0 Missing value

HLOAD_183G_STRT (2-byte unsigned integer, array size: nscan2):
Hot Load start (183GHz) */ Special values are defined as:
0 Missing value

HLOAD_183G_NUM (2-byte unsigned integer, array size: nscan2):
Hot Load samples (183GHz) */ Special values are defined as:
0 Missing value

CSKY_183G_STRT (2-byte unsigned integer, array size: nscan2):
Cold Sky start (183GHz) */ Special values are defined as:
0 Missing value

CSKY_183G_NUM (2-byte unsigned integer, array size: nscan2):
Cold Sky samples (183GHz) */ Special values are defined as:
0 Missing value

S4 (Swath)

S4_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S4)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

ephemerisUsed (1-byte char, array size: dim10 x nscan1):
The ephemeris source used to geolocate the swath. Special values are defined as:
255 Missing value

Latitude (4-byte float, array size: npixelfr x nscan2):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixelfr x nscan2):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npixelfr x nscan2):
The angle at the center of the IFOV between the antenna boresight vector and the zenith vector normal to the Earth Ellipsiod. Also known as Satellite Zenith Angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

fullRotation (2-byte unsigned integer, array size: nchannel1 x npixelfr x nscan2):

```
Full rotation counts.
```

Special values are defined as:
0 Missing value

fullRotBlanking (1-byte char, array size: VH x npixelfr x nscan2):

```
Full rotation blanking counts.
```

Special values are defined as:
0 Missing value

S5 (Swath)

S5_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S5)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

ephemerisUsed (1-byte char, array size: dim10 x nscan1):
The ephemeris source used to geolocate the swath. Special values are defined as:
255 Missing value

Latitude (4-byte float, array size: npixelfr x nscan2):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixelfr x nscan2):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npixelfr x nscan2):
The angle at the center of the IFOV between the antenna boresight vector and the zenith vector normal to the Earth Ellipsiod. Also known as Satellite Zenith Angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

fullRotation (2-byte unsigned integer, array size: nchannel2 x npixelfr x nscan2):

```
Full rotation counts.
```

Special values are defined as:
0 Missing value

C Structure Header file:

```
#ifndef _TK_1AGMI_H_
#define _TK_1AGMI_H_
```

```
#ifndef _L1AGMI_S5_
#define _L1AGMI_S5_

typedef struct {
    SCANTIME ScanTime;
    unsigned char ephemerisUsed[10];
    float Latitude[500];
    float Longitude[500];
    float incidenceAngle[500];
    unsigned short fullRotation[500][4];
} L1AGMI_S5;

#endif

#ifndef _L1AGMI_S4_
#define _L1AGMI_S4_

typedef struct {
    SCANTIME ScanTime;
    unsigned char ephemerisUsed[10];
    float Latitude[500];
    float Longitude[500];
    float incidenceAngle[500];
    unsigned short fullRotation[500][9];
    unsigned char fullRotBlanking[500][2];
} L1AGMI_S4;

#endif

#ifndef _L1AGMI_S3_SMPL_INFO_
#define _L1AGMI_S3_SMPL_INFO_

typedef struct {
    unsigned short SMPL_INFO_VALID;
    unsigned short EARTH_10G_STRT;
    unsigned short EARTH_10G_NUM;
    unsigned short HLOAD_10G_STRT;
    unsigned short HLOAD_10G_NUM;
    unsigned short CSKY_10G_STRT;
    unsigned short CSKY_10G_NUM;
    unsigned short EARTH_18G_STRT;
    unsigned short EARTH_18G_NUM;
    unsigned short HLOAD_18G_STRT;
```

```
    unsigned short HLOAD_18G_NUM;
    unsigned short CSKY_18G_STRT;
    unsigned short CSKY_18G_NUM;
    unsigned short EARTH_23G_STRT;
    unsigned short EARTH_23G_NUM;
    unsigned short HLOAD_23G_STRT;
    unsigned short HLOAD_23G_NUM;
    unsigned short CSKY_23G_STRT;
    unsigned short CSKY_23G_NUM;
    unsigned short EARTH_36G_STRT;
    unsigned short EARTH_36G_NUM;
    unsigned short HLOAD_36G_STRT;
    unsigned short HLOAD_36G_NUM;
    unsigned short CSKY_36G_STRT;
    unsigned short CSKY_36G_NUM;
    unsigned short EARTH_89G_STRT;
    unsigned short EARTH_89G_NUM;
    unsigned short HLOAD_89G_STRT;
    unsigned short HLOAD_89G_NUM;
    unsigned short CSKY_89G_STRT;
    unsigned short CSKY_89G_NUM;
    unsigned short EARTH_166G_STRT;
    unsigned short EARTH_166G_NUM;
    unsigned short HLOAD_166G_STRT;
    unsigned short HLOAD_166G_NUM;
    unsigned short CSKY_166G_STRT;
    unsigned short CSKY_166G_NUM;
    unsigned short EARTH_183G_STRT;
    unsigned short EARTH_183G_NUM;
    unsigned short HLOAD_183G_STRT;
    unsigned short HLOAD_183G_NUM;
    unsigned short CSKY_183G_STRT;
    unsigned short CSKY_183G_NUM;
} L1AGMI_S3_SMPL_INFO;

#endif

#ifndef _L1AGMI_S3_MECHANISMS_
#define _L1AGMI_S3_MECHANISMS_

typedef struct {
    unsigned int SCE_LAST_CMD;
    unsigned int SCE_LAST_RESPNS;
```

```
    unsigned int SCE_CMD_CNT;
    unsigned short SMA_RTPRB_SEC;
    unsigned short SMA_RATE;
    unsigned short SCE_RATE;
    unsigned short SCE_CMD_RATE;
    unsigned short SMA_CMD_RATE;
    unsigned short RESOLVER_POS;
    unsigned short MECH_CMD_CNT;
    unsigned short SCE_INHIBIT;
    unsigned short TACH_PULSE_CNT;
    unsigned short LR_ABRT_CNT;
    unsigned short RAMP_ABRT_CNT;
    unsigned short OVRD_RDA_LR;
    unsigned short OVRD_IBS_LR;
    unsigned short SCE_PASSPROT;
    unsigned short RAMP_INPROGRESS;
    unsigned short SMA_SPINNING;
    unsigned short LR_RLS_IN_PROG;
    unsigned short SCE_A_POWER;
    unsigned short SCE_B_POWER;
    unsigned short SCE_SELECTION;
    unsigned short SMA_RATE_PROB;
    unsigned short LR_ENABLED;
    unsigned short BILVL_IBS1;
    unsigned short BILVL_IBS2;
    unsigned short BILVL_IBS3;
    unsigned short BILVL_CAL;
    unsigned short BILVL_RDALEFT;
    unsigned short BILVL_RDARIGHT;
    unsigned short BILVL_RDALOWER;
} L1AGMI_S3_MECHANISMS;

#endif

#ifndef _L1AGMI_S3_IE_TELEMETRY_
#define _L1AGMI_S3_IE_TELEMETRY_

typedef struct {
    unsigned int IE_PASSTHRU_RSP;
    unsigned short IE_BLANKING_CNT;
    unsigned short PWR_STAT_LR_PR;
    unsigned short PWR_STAT_A;
    unsigned short HTR_STAT_SMA;
```

```
    unsigned short HTR_STAT_RDA;
    unsigned short HTR_STAT_RS;
    unsigned short PWR_STAT_LR_RED;
    unsigned short RS_MST_RLY_STAT;
    unsigned short RDA_DEPL_STAT_4;
    unsigned short RDA_DEPL_STAT_3;
    unsigned short RDA_DEPL_STAT_2;
    unsigned short RDA_DEPL_STAT_1;
    unsigned short CLR_STAT_N;
    unsigned short IBS_LR3_STAT_N;
    unsigned short MR_LR_LOWR_STAT;
    unsigned short IBS_LR2_STAT_N;
    unsigned short MR_LR_LEFT_STAT;
    unsigned short IBS_LR1_STAT_N;
    unsigned short MR_LR_RGHT_STAT;
    unsigned short IE_LATCHUP_CHAN;
    unsigned short IE_LATCHUP_RETR;
    unsigned short IE_LATCHUP_SMPS;
    unsigned short IE_LATCHUP_NUM;
    unsigned short IE_LATCHUP_FAIL;
    unsigned short HTR_STAT_HTLD;
    unsigned short IE_LATCHUP_PAD;
} L1AGMI_S3_IE_TELEMETRY;

#endif

#ifndef _L1AGMI_S3_IEHSK_TEMP_
#define _L1AGMI_S3_IEHSK_TEMP_

typedef struct {
    unsigned short IBS_LR1_TEMP;
    unsigned short RS_TEMP_1;
    unsigned short SCE_A_BD_TEMP;
    unsigned short MR_LR_RGHT_TEMP;
    unsigned short SMA_BEARING_TMP;
    unsigned short PC_BD_TEMP;
    unsigned short LVPS_BD_TEMP;
    unsigned short SMA_MTR_TEMP;
    unsigned short HL_TEMP_2;
    unsigned short RDA_TEMP_2;
    unsigned short HL_TEMP_1;
    unsigned short RS_TEMP_2;
    unsigned short SCE_B_BD_TEMP;
```

```
    unsigned short TEMP_CALRES_1;
    unsigned short TEMP_CALRES_2;
    unsigned short MR_ICA_TEMP;
    unsigned short IBS_LR2_TEMP;
    unsigned short HL_TEMP_7;
    unsigned short RDA_TEMP_1;
    unsigned short MR_LR_LEFT_TEMP;
    unsigned short RDA_TEMP_3;
    unsigned short ICA_BOX_TEMP_1;
    unsigned short HL_TEMP_10;
    unsigned short MR_LR_LOWR_TEMP;
    unsigned short SMA_SLPRHTR_TMP;
    unsigned short HL_TEMP_8;
    unsigned short TEMP_CALRES_3;
    unsigned short TEMP_CALRES_4;
    unsigned short CSR_TEMP1;
    unsigned short HL_TEMP_12;
    unsigned short HL_TEMP_13;
    unsigned short HL_TEMP_14;
    unsigned short HL_TEMP_11;
    unsigned short IBS_LR3_TEMP;
    unsigned short HL_TEMP_9;
    unsigned short ROT_TEMP_SPARE;
    unsigned short CSR_TEMP2;
    unsigned short CE_BD_TEMP;
    unsigned short ICA_BOX_TEMP_2;
    unsigned short IE_BD_TEMP;
    unsigned short CLR_TEMP;
    unsigned short HL_TEMP_15;
    unsigned short TEMP_CALRES_5;
    unsigned short TEMP_CALRES_6;
} L1AGMI_S3_IEHSK_TEMP;

#endif

#ifndef _L1AGMI_S3_RSHSK_TEMP_
#define _L1AGMI_S3_RSHSK_TEMP_

typedef struct {
    unsigned short TEMP_10GHZRCVR;
    unsigned short TEMP_H166GHZMXR;
    unsigned short TEMP_18GHZRCVR;
    unsigned short TEMP_V166GHZMXR;
```

```
    unsigned short TEMP_23GHZRCVR;
    unsigned short TEMP_183GHZMXR;
    unsigned short TEMP_36GHZRCVR;
    unsigned short TEMP_H10GHZ_ND;
    unsigned short TEMP_89GHZRCVR;
    unsigned short TEMP_V10GHZ_ND;
    unsigned short TEMP_166GHZRCVR;
    unsigned short TEMP_H18GHZ_ND;
    unsigned short TEMP_183GHZRCVR;
    unsigned short TEMP_V18GHZ_ND;
    unsigned short TEMP_RS_EPC;
    unsigned short TEMP_H36GHZ_ND;
    unsigned short TEMP_RS_EDC;
    unsigned short TEMP_V36GHZ_ND;
    unsigned short TEMP_FEED;
    unsigned short TEMP_89GHZ_LO;
    unsigned short TEMP_HL_TRAY;
    unsigned short TEMP_166GHZ_LO;
    unsigned short TEMP_SMASPUNHSG;
    unsigned short TEMP_RS_MR1;
    unsigned short TEMP_H89GHZMXR;
    unsigned short TEMP_RS_MR2;
    unsigned short TEMP_V89GHZMXR;
    unsigned short TEMP_183GHZ_LO;
} L1AGMI_S3_RSHSK_TEMP;

#endif

#ifndef _L1AGMI_S3_RSHSK_GAIN_
#define _L1AGMI_S3_RSHSK_GAIN_

typedef struct {
    unsigned short RESERVED2;
    unsigned short GAIN_V10GHZ;
    unsigned short GAIN_H36GHZ;
    unsigned short GAIN_H89GHZ;
    unsigned short GAIN_H10GHZ;
    unsigned short GAIN_H166GHZ;
    unsigned short GAIN_V18GHZ;
    unsigned short GAIN_H18GHZ;
    unsigned short GAIN_VB183GHZ;
    unsigned short GAIN_V23GHZ;
    unsigned short GAIN_V36GHZ;
```

```
    unsigned short GAIN_V89GHZ;
    unsigned short GAIN_V166GHZ;
    unsigned short GAIN_VA183GHZ;
} L1AGMI_S3_RSHSK_GAIN;

#endif

#ifndef _L1AGMI_S3_RSHSK_SAMPL_INFO_
#define _L1AGMI_S3_RSHSK_SAMPL_INFO_

typedef struct {
    unsigned short SMPOFFST_10GHZ;
    unsigned short SMPOFFST_18GHZ;
    unsigned short SMPOFFST_23GHZ;
    unsigned short SMPOFFST_36GHZ;
    unsigned short SMPOFFST_89GHZ;
    unsigned short SMPOFFST_166GHZ;
    unsigned short SMPOFFST_183GHZ;
    unsigned short NUMSMPLS_10GHZ;
    unsigned short NUMSMPLS_18GHZ;
    unsigned short NUMSMPLS_23GHZ;
    unsigned short NUMSMPLS_36GHZ;
    unsigned short NUMSMPLS_89GHZ;
    unsigned short NUMSMPLS_166GHZ;
    unsigned short NUMSMPLS_183GHZ;
} L1AGMI_S3_RSHSK_SAMPL_INFO;

#endif

#ifndef _L1AGMI_S3_RSHSK_STATUS_
#define _L1AGMI_S3_RSHSK_STATUS_

typedef struct {
    unsigned short RSST_SCI_ADC_LP;
    unsigned short RSST_HSK_ADC_LP;
    unsigned short RSST_SAMP_OVLP;
    unsigned short RSST_10GHZ_RLY;
    unsigned short RSST_18GHZ_RLY;
    unsigned short RSST_23GHZ_RLY;
    unsigned short RSST_36GHZ_RLY;
    unsigned short RSST_89GHZ_RLY;
    unsigned short RSST_166GHZ_RLY;
    unsigned short RSST_183GHZ_RLY;
```

```
    unsigned short RSST_INVLD_CMD;
    unsigned short RSST_CMD_AFTER;
    unsigned short NDIODE_MODE;
    unsigned short RSST_NDIODE_ST;
    unsigned short NDIODE10GHZSNUM;
    unsigned short RESERVED1;
    unsigned short RS_CALRES_1;
    unsigned short BATC_CALRES_1;
    unsigned short RS_CALRES_2;
    unsigned short BATC_CALRES_2;
    unsigned short RS_EPC_ISENS;
    unsigned short RS_EPC_5V;
    unsigned short RS_EPC_7V;
    unsigned short RS_EPC_POS12V;
    unsigned short RS_EPC_NEG12V;
    unsigned short RS_EPC_15V;
} L1AGMI_S3_RSHSK_STATUS;

#endif

#ifndef _L1AGMI_S3_SYNCH_STAMPS2_
#define _L1AGMI_S3_SYNCH_STAMPS2_

typedef struct {
    unsigned int TACH_SECS_16;
    unsigned short TACH_SUBS_16;
    unsigned int TACH_SECS_17;
    unsigned short TACH_SUBS_17;
    unsigned int TACH_SECS_18;
    unsigned short TACH_SUBS_18;
    unsigned int TACH_SECS_19;
    unsigned short TACH_SUBS_19;
    unsigned int TACH_SECS_20;
    unsigned short TACH_SUBS_20;
    unsigned int TACH_SECS_21;
    unsigned short TACH_SUBS_21;
    unsigned int TACH_SECS_22;
    unsigned short TACH_SUBS_22;
    unsigned int TACH_SECS_23;
    unsigned short TACH_SUBS_23;
    unsigned int TACH_SECS_24;
    unsigned short TACH_SUBS_24;
    unsigned int TACH_SECS_25;
```

```
    unsigned short TACH_SUBS_25;
    unsigned int TACH_SECS_26;
    unsigned short TACH_SUBS_26;
    unsigned int TACH_SECS_27;
    unsigned short TACH_SUBS_27;
    unsigned int TACH_SECS_28;
    unsigned short TACH_SUBS_28;
    unsigned int TACH_SECS_29;
    unsigned short TACH_SUBS_29;
    unsigned int TACH_SECS_30;
    unsigned short TACH_SUBS_30;
    unsigned int TACH_SECS_31;
    unsigned short TACH_SUBS_31;
    unsigned int SCAN_COMPL_SECS;
    unsigned short SCAN_COMPL_SUBS;
} L1AGMI_S3_SYNCH_STAMPS2;

#endif

#ifndef _L1AGMI_S3_SYNCH_STAMPS_
#define _L1AGMI_S3_SYNCH_STAMPS_

typedef struct {
    unsigned int IDX_PULSE_SECS;
    unsigned short IDX_PULSE_SUBS;
    unsigned int TACH_SECS_00;
    unsigned short TACH_SUBS_00;
    unsigned int TACH_SECS_01;
    unsigned short TACH_SUBS_01;
    unsigned int TACH_SECS_02;
    unsigned short TACH_SUBS_02;
    unsigned int TACH_SECS_03;
    unsigned short TACH_SUBS_03;
    unsigned int TACH_SECS_04;
    unsigned short TACH_SUBS_04;
    unsigned int TACH_SECS_05;
    unsigned short TACH_SUBS_05;
    unsigned int TACH_SECS_06;
    unsigned short TACH_SUBS_06;
    unsigned int TACH_SECS_07;
    unsigned short TACH_SUBS_07;
    unsigned int TACH_SECS_08;
    unsigned short TACH_SUBS_08;
```

```
    unsigned int TACH_SECS_09;
    unsigned short TACH_SUBS_09;
    unsigned int TACH_SECS_10;
    unsigned short TACH_SUBS_10;
    unsigned int TACH_SECS_11;
    unsigned short TACH_SUBS_11;
    unsigned int TACH_SECS_12;
    unsigned short TACH_SUBS_12;
    unsigned int TACH_SECS_13;
    unsigned short TACH_SUBS_13;
    unsigned int TACH_SECS_14;
    unsigned short TACH_SUBS_14;
    unsigned int TACH_SECS_15;
    unsigned short TACH_SUBS_15;
} L1AGMI_S3_SYNCH_STAMPS;

#endif

#ifndef _L1AGMI_S3_RS_INFO_
#define _L1AGMI_S3_RS_INFO_

typedef struct {
    unsigned short RS_POWERED;
    unsigned short RS_ENABLED;
    unsigned short RS_MST_RLY;
    unsigned short RS_10GHZ_RLY;
    unsigned short RS_18GHZ_RLY;
    unsigned short RS_23GHZ_RLY;
    unsigned short RS_36GHZ_RLY;
    unsigned short RS_89GHZ_RLY;
    unsigned short RS_166GHZ_RLY;
    unsigned short RS_183GHZ_RLY;
    unsigned short RS_DQ_MISSING;
    unsigned short RS_DQ_EXTRAS;
    unsigned short RS_DQ_DUPES;
    unsigned short RS_LAST_REV;
    unsigned short RS_DQ_SAME_REV;
    unsigned short RS_DQ_BAD_REVS;
    unsigned short RS_DQ_PAR_ERR;
    unsigned short RS_DQ_CLK_ERR;
    unsigned short RS_DQ_PKT_ERR;
    unsigned short RS_DQ_TLM_ERR;
    unsigned short RS_DQ_BAD_CONF;
```

```
    unsigned short RS_DQ_CAL_LIM;
    unsigned short BLK_STATE;
    unsigned short BLK_SIDE;
    unsigned short BLK_DELAY;
    unsigned short BLK_DURATION;
    unsigned short RS_HSK_SIZE;
    unsigned int RS_PAR_ERR_CNT;
    unsigned int RS_SCAN_CNT;
    unsigned int SAMPLE_TBL_VER;
    unsigned int SMPL_TBL;
    unsigned short RS_SC_SIZE;
    unsigned short GSDR_SIZE;
    unsigned short GSDR_LEFT;
    unsigned short GSDR_B_POP_IDX;
    unsigned short GSDR_B_PUSH_IDX;
    unsigned short GSDR_APID;
    unsigned short PKT_STATE;
    unsigned short OVRD_RS_PWR;
    unsigned short OVRD_SMA_SPIN;
    unsigned short OVRD_PASS_RS;
} L1AGMI_S3_RS_INFO;

#endif

#ifndef _L1AGMI_S3_SENSOR_INFO_
#define _L1AGMI_S3_SENSOR_INFO_

typedef struct {
    unsigned int KEEP_ALIVE_CNT;
    unsigned short FPGA_RST_REASON;
    unsigned short CRASH_REASON;
    unsigned short VERSION_MIN;
    unsigned short VERSION_MAJ;
    unsigned short FPGA_MODE;
    unsigned short ERR_HDL_FAILURE;
    unsigned short RESET_REASON;
    unsigned short BOOT_BANK;
    unsigned short CURRENT_BANK;
    unsigned short EDAC_ENABLE;
    unsigned short WDOG_ENABLE;
    unsigned short SC_1HZ_REF;
    unsigned short SCE_FORCE_SEL;
    unsigned short RS_1MHZ_REF;
```

```
    unsigned short RS_SCAN_START;
    unsigned short FPGA_IE_RX_EN;
    unsigned short FPGA_RS_RX_EN;
    unsigned short FPGA_SCE_RX_EN;
    unsigned short EEPROM_BUSY;
    unsigned short RS_TLM_PROG;
    unsigned short SCE_A_ACTIVE;
    unsigned short SCE_A_RLY;
    unsigned short SCE_B_ACTIVE;
    unsigned short SCE_B_RLY;
    unsigned short IE_TLM_PROG;
    unsigned short SCE_RSP_PROG;
    unsigned short RS_CLK_ERR;
    unsigned short RS_PKT_ERR;
    unsigned short RS_TLM_ERR;
    unsigned short SCE_RSP_RDY;
    unsigned short IE_PKT_ERR;
    unsigned short IE_CMD_ERR;
    unsigned short IE_RSP_ERR;
    unsigned short IE_TLM_ERR;
    unsigned short FPGA_ACCSS_ERR;
} L1AGMI_S3_SENSOR_INFO;

#endif

#ifndef _L1AGMI_S3_GSDR_TIME_
#define _L1AGMI_S3_GSDR_TIME_

typedef struct {
    unsigned int G_TC_PULSE_SECS;
    unsigned short G_TC_PULSE_SUBS;
    unsigned int G_TCU_SECS;
    unsigned int G_TCU_SUBS;
    unsigned int G_TCF_SC_SECS;
    unsigned int G_TCF_SC_SUBSEC;
    unsigned int G_TCF_SECS;
    unsigned int G_TCF_SUBSECS;
    unsigned short G_TCF_SIGN;
    unsigned short G_TCF_LEAP;
    unsigned int GPS_TCU_SECS;
    unsigned int GPS_TCU_SUBS;
} L1AGMI_S3_GSDR_TIME;
```

```
#endif

#ifndef _L1AGMI_S3_GMI_TEMPERATURES_
#define _L1AGMI_S3_GMI_TEMPERATURES_

typedef struct {
    float timeOffset;
    unsigned short apid;
    unsigned short SMA_PT_TEMP;
    unsigned short ICA_PT_TEMP;
    unsigned short RS_PT_TEMP;
    unsigned short STAT_PT_TEMP;
    unsigned short MR_PT_TEMP;
} L1AGMI_S3_GMI_TEMPERATURES;

#endif

#ifndef _L1AGMI_S3_TORQUE_BAR_
#define _L1AGMI_S3_TORQUE_BAR_

typedef struct {
    float timeOffset;
    unsigned short Vx;
    unsigned short Vy;
    unsigned short Vz;
} L1AGMI_S3_TORQUE_BAR;

#endif

#ifndef _L1AGMI_S3_TAM2_
#define _L1AGMI_S3_TAM2_

typedef struct {
    float timeOffset;
    unsigned short Vx;
    unsigned short Vy;
    unsigned short Vz;
} L1AGMI_S3_TAM2;

#endif

#ifndef _L1AGMI_S3_TAM1_
#define _L1AGMI_S3_TAM1_
```

```
typedef struct {
    float timeOffset;
    unsigned short Vx;
    unsigned short Vy;
    unsigned short Vz;
} L1AGMI_S3_TAM1;

#endif

#ifndef _L1AGMI_S3_
#define _L1AGMI_S3_

typedef struct {
    SCANTIME ScanTime;
    unsigned char ephemerisUsed[10];
    float Latitude;
    float Longitude;
    L1AGMI_S3_TAM1 TAM1;
    L1AGMI_S3_TAM2 TAM2;
    L1AGMI_S3_TORQUE_BAR TORQUE_BAR;
    L1AGMI_S3_GMI_TEMPERATURES GMI_TEMPERATURES;
    signed char version;
    signed char type;
    signed char secHeaderFlag;
    short APID;
    signed char sequenceFlag;
    short packetSequenceCount;
    unsigned short packetLength;
    unsigned int instrTimeSeconds;
    unsigned short instrTimeSubseconds;
    signed char numPacketSegments;
    signed char spare;
    short RDRversion;
    L1AGMI_S3_GSDR_TIME GSDR_TIME;
    L1AGMI_S3_SENSOR_INFO SENSOR_INFO;
    L1AGMI_S3_RS_INFO RS_INFO;
    L1AGMI_S3_SYNCH_STAMPS SYNCH_STAMPS;
    L1AGMI_S3_SYNCH_STAMPS2 SYNCH_STAMPS2;
    L1AGMI_S3_RSHSK_STATUS RSHSK_STATUS;
    L1AGMI_S3_RSHSK_SAMPL_INFO RSHSK_SAMPL_INFO;
    L1AGMI_S3_RSHSK_GAIN RSHSK_GAIN;
    L1AGMI_S3_RSHSK_TEMP RSHSK_TEMP;
```

```
    L1AGMI_S3_IEHSK_TEMP IEHSK_TEMP;
    L1AGMI_S3_IE_TELEMETRY IE_TELEMETRY;
    L1AGMI_S3_MECHANISMS MECHANISMS;
    L1AGMI_S3_SMPL_INFO SMPL_INFO;
} L1AGMI_S3;

#endif

#ifndef _L1AGMI_S2_SUNDATA_
#define _L1AGMI_S2_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1AGMI_S2_SUNDATA;

#endif

#ifndef _L1AGMI_S2_SCANSTATUS_
#define _L1AGMI_S2_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} L1AGMI_S2_SCANSTATUS;

#endif
```

```
#ifndef _L1AGMI_S2_
#define _L1AGMI_S2_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    L1AGMI_S2_SCANSTATUS scanStatus;
    unsigned char ephemerisUsed[10];
    NAVIGATION navigation;
    L1AGMI_S2_SUNDATA sunData;
    float incidenceAngle[221];
    float satAzimuthAngle[221];
    float solarZenAngle[221];
    float solarAzimuthAngle[221];
    float sunGlintAngle[221];
    float moonVectorInstFrame[3];
    unsigned short earthView[221][4];
    unsigned short hotLoad[221][4];
    unsigned short coldSky[221][4];
} L1AGMI_S2;

#endif

#ifndef _L1AGMI_S1_SUNDATA_
#define _L1AGMI_S1_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1AGMI_S1_SUNDATA;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_
```

```
typedef struct {
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _L1AGMI_S1_SCANSTATUS_
#define _L1AGMI_S1_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} L1AGMI_S1_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
```

```
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1AGMI_S1_
#define _L1AGMI_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    L1AGMI_S1_SCANSTATUS scanStatus;
    unsigned char ephemerisUsed[10];
    NAVIGATION navigation;
    L1AGMI_S1_SUNDATA sunData;
    float incidenceAngle[221];
    float satAzimuthAngle[221];
    float solarZenAngle[221];
    float solarAzimuthAngle[221];
    float sunGlintAngle[221];
    float moonVectorInstFrame[3];
    unsigned short earthView[221][9];
    unsigned short hotLoad[221][9];
    unsigned short coldSky[221][9];
    unsigned char earthViewBlanking[221][2];
    unsigned char hotLoadBlanking[221][2];
    unsigned char coldSkyBlanking[221][2];
} L1AGMI_S1;

#endif

#ifndef _L1AGMI_SWATHS_
#define _L1AGMI_SWATHS_
```

```
typedef struct {
    L1AGMI_S1 S1;
    L1AGMI_S2 S2;
    L1AGMI_S3 S3;
    L1AGMI_S4 S4;
    L1AGMI_S5 S5;
} L1AGMI_SWATHS;

#endif

#ifndef _L1AGMI_GMI1AHEADER_
#define _L1AGMI_GMI1AHEADER_

typedef struct {
    unsigned short sampleRangeFile[7][6];
} L1AGMI_GMI1AHEADER;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1AGMI_S5/
    RECORD /SCANTIME/ ScanTime
    CHARACTER ephemerisUsed(10)
    REAL*4 Latitude(500)
    REAL*4 Longitude(500)
    REAL*4 incidenceAngle(500)
    INTEGER*2 fullRotation(4,500)
END STRUCTURE

STRUCTURE /L1AGMI_S4/
    RECORD /SCANTIME/ ScanTime
    CHARACTER ephemerisUsed(10)
    REAL*4 Latitude(500)
    REAL*4 Longitude(500)
    REAL*4 incidenceAngle(500)
    INTEGER*2 fullRotation(9,500)
    CHARACTER fullRotBlanking(2,500)
END STRUCTURE

STRUCTURE /L1AGMI_S3_SMPL_INFO/
```

```
INTEGER*2 SMPL_INFO_VALID
INTEGER*2 EARTH_10G_STRT
INTEGER*2 EARTH_10G_NUM
INTEGER*2 HLOAD_10G_STRT
INTEGER*2 HLOAD_10G_NUM
INTEGER*2 CSKY_10G_STRT
INTEGER*2 CSKY_10G_NUM
INTEGER*2 EARTH_18G_STRT
INTEGER*2 EARTH_18G_NUM
INTEGER*2 HLOAD_18G_STRT
INTEGER*2 HLOAD_18G_NUM
INTEGER*2 CSKY_18G_STRT
INTEGER*2 CSKY_18G_NUM
INTEGER*2 EARTH_23G_STRT
INTEGER*2 EARTH_23G_NUM
INTEGER*2 HLOAD_23G_STRT
INTEGER*2 HLOAD_23G_NUM
INTEGER*2 CSKY_23G_STRT
INTEGER*2 CSKY_23G_NUM
INTEGER*2 EARTH_36G_STRT
INTEGER*2 EARTH_36G_NUM
INTEGER*2 HLOAD_36G_STRT
INTEGER*2 HLOAD_36G_NUM
INTEGER*2 CSKY_36G_STRT
INTEGER*2 CSKY_36G_NUM
INTEGER*2 EARTH_89G_STRT
INTEGER*2 EARTH_89G_NUM
INTEGER*2 HLOAD_89G_STRT
INTEGER*2 HLOAD_89G_NUM
INTEGER*2 CSKY_89G_STRT
INTEGER*2 CSKY_89G_NUM
INTEGER*2 EARTH_166G_STRT
INTEGER*2 EARTH_166G_NUM
INTEGER*2 HLOAD_166G_STRT
INTEGER*2 HLOAD_166G_NUM
INTEGER*2 CSKY_166G_STRT
INTEGER*2 CSKY_166G_NUM
INTEGER*2 EARTH_183G_STRT
INTEGER*2 EARTH_183G_NUM
INTEGER*2 HLOAD_183G_STRT
INTEGER*2 HLOAD_183G_NUM
INTEGER*2 CSKY_183G_STRT
INTEGER*2 CSKY_183G_NUM
```

```
END STRUCTURE

STRUCTURE /L1AGMI_S3_MECHANISMS/
    INTEGER*4 SCE_LAST_CMD
    INTEGER*4 SCE_LAST_RESPNS
    INTEGER*4 SCE_CMD_CNT
    INTEGER*2 SMA_RTPRB_SEC
    INTEGER*2 SMA_RATE
    INTEGER*2 SCE_RATE
    INTEGER*2 SCE_CMD_RATE
    INTEGER*2 SMA_CMD_RATE
    INTEGER*2 RESOLVER_POS
    INTEGER*2 MECH_CMD_CNT
    INTEGER*2 SCE_INHIBIT
    INTEGER*2 TACH_PULSE_CNT
    INTEGER*2 LR_ABRT_CNT
    INTEGER*2 RAMP_ABRT_CNT
    INTEGER*2 OVRD_RDA_LR
    INTEGER*2 OVRD_IBS_LR
    INTEGER*2 SCE_PASSPROT
    INTEGER*2 RAMP_INPROGRESS
    INTEGER*2 SMA_SPINNING
    INTEGER*2 LR_RLS_IN_PROG
    INTEGER*2 SCE_A_POWER
    INTEGER*2 SCE_B_POWER
    INTEGER*2 SCE_SELECTION
    INTEGER*2 SMA_RATE_PROB
    INTEGER*2 LR_ENABLED
    INTEGER*2 BILVL_IBS1
    INTEGER*2 BILVL_IBS2
    INTEGER*2 BILVL_IBS3
    INTEGER*2 BILVL_CAL
    INTEGER*2 BILVL_RDALEFT
    INTEGER*2 BILVL_RDARIGHT
    INTEGER*2 BILVL_RDALOWER
END STRUCTURE

STRUCTURE /L1AGMI_S3_IE_TELEMETRY/
    INTEGER*4 IE_PASSTHRU_RSP
    INTEGER*2 IE_BLANKING_CNT
    INTEGER*2 PWR_STAT_LR_PR
    INTEGER*2 PWR_STAT_A
    INTEGER*2 HTR_STAT_SMA
```

```
    INTEGER*2 HTR_STAT_RDA
    INTEGER*2 HTR_STAT_RS
    INTEGER*2 PWR_STAT_LR_RED
    INTEGER*2 RS_MST_RLY_STAT
    INTEGER*2 RDA_DEPL_STAT_4
    INTEGER*2 RDA_DEPL_STAT_3
    INTEGER*2 RDA_DEPL_STAT_2
    INTEGER*2 RDA_DEPL_STAT_1
    INTEGER*2 CLR_STAT_N
    INTEGER*2 IBS_LR3_STAT_N
    INTEGER*2 MR_LR_LOWR_STAT
    INTEGER*2 IBS_LR2_STAT_N
    INTEGER*2 MR_LR_LEFT_STAT
    INTEGER*2 IBS_LR1_STAT_N
    INTEGER*2 MR_LR_RGHT_STAT
    INTEGER*2 IE_LATCHUP_CHAN
    INTEGER*2 IE_LATCHUP_RETR
    INTEGER*2 IE_LATCHUP_SMPS
    INTEGER*2 IE_LATCHUP_NUM
    INTEGER*2 IE_LATCHUP_FAIL
    INTEGER*2 HTR_STAT_HTLD
    INTEGER*2 IE_LATCHUP_PAD
END STRUCTURE

STRUCTURE /L1AGMI_S3_IEHSK_TEMP/
    INTEGER*2 IBS_LR1_TEMP
    INTEGER*2 RS_TEMP_1
    INTEGER*2 SCE_A_BD_TEMP
    INTEGER*2 MR_LR_RGHT_TEMP
    INTEGER*2 SMA_BEARING_TMP
    INTEGER*2 PC_BD_TEMP
    INTEGER*2 LVPS_BD_TEMP
    INTEGER*2 SMA_MTR_TEMP
    INTEGER*2 HL_TEMP_2
    INTEGER*2 RDA_TEMP_2
    INTEGER*2 HL_TEMP_1
    INTEGER*2 RS_TEMP_2
    INTEGER*2 SCE_B_BD_TEMP
    INTEGER*2 TEMP_CALRES_1
    INTEGER*2 TEMP_CALRES_2
    INTEGER*2 MR_ICA_TEMP
    INTEGER*2 IBS_LR2_TEMP
    INTEGER*2 HL_TEMP_7
```

```
    INTEGER*2 RDA_TEMP_1
    INTEGER*2 MR_LR_LEFT_TEMP
    INTEGER*2 RDA_TEMP_3
    INTEGER*2 ICA_BOX_TEMP_1
    INTEGER*2 HL_TEMP_10
    INTEGER*2 MR_LR_LOWR_TEMP
    INTEGER*2 SMA_SLPRHTR_TMP
    INTEGER*2 HL_TEMP_8
    INTEGER*2 TEMP_CALRES_3
    INTEGER*2 TEMP_CALRES_4
    INTEGER*2 CSR_TEMP1
    INTEGER*2 HL_TEMP_12
    INTEGER*2 HL_TEMP_13
    INTEGER*2 HL_TEMP_14
    INTEGER*2 HL_TEMP_11
    INTEGER*2 IBS_LR3_TEMP
    INTEGER*2 HL_TEMP_9
    INTEGER*2 ROT_TEMP_SPARE
    INTEGER*2 CSR_TEMP2
    INTEGER*2 CE_BD_TEMP
    INTEGER*2 ICA_BOX_TEMP_2
    INTEGER*2 IE_BD_TEMP
    INTEGER*2 CLR_TEMP
    INTEGER*2 HL_TEMP_15
    INTEGER*2 TEMP_CALRES_5
    INTEGER*2 TEMP_CALRES_6
END STRUCTURE

STRUCTURE /L1AGMI_S3_RSHSK_TEMP/
    INTEGER*2 TEMP_10GHZRCVR
    INTEGER*2 TEMP_H166GHZMXR
    INTEGER*2 TEMP_18GHZRCVR
    INTEGER*2 TEMP_V166GHZMXR
    INTEGER*2 TEMP_23GHZRCVR
    INTEGER*2 TEMP_183GHZMXR
    INTEGER*2 TEMP_36GHZRCVR
    INTEGER*2 TEMP_H10GHZ_ND
    INTEGER*2 TEMP_89GHZRCVR
    INTEGER*2 TEMP_V10GHZ_ND
    INTEGER*2 TEMP_166GHZRCVR
    INTEGER*2 TEMP_H18GHZ_ND
    INTEGER*2 TEMP_183GHZRCVR
    INTEGER*2 TEMP_V18GHZ_ND
```

```
    INTEGER*2 TEMP_RS_EPC
    INTEGER*2 TEMP_H36GHZ_ND
    INTEGER*2 TEMP_RS_EDC
    INTEGER*2 TEMP_V36GHZ_ND
    INTEGER*2 TEMP_FEED
    INTEGER*2 TEMP_89GHZ_LO
    INTEGER*2 TEMP_HL_TRAY
    INTEGER*2 TEMP_166GHZ_LO
    INTEGER*2 TEMP_SMASPUNHSG
    INTEGER*2 TEMP_RS_MR1
    INTEGER*2 TEMP_H89GHZMXR
    INTEGER*2 TEMP_RS_MR2
    INTEGER*2 TEMP_V89GHZMXR
    INTEGER*2 TEMP_183GHZ_LO
END STRUCTURE

STRUCTURE /L1AGMI_S3_RSHSK_GAIN/
    INTEGER*2 RESERVED2
    INTEGER*2 GAIN_V10GHZ
    INTEGER*2 GAIN_H36GHZ
    INTEGER*2 GAIN_H89GHZ
    INTEGER*2 GAIN_H10GHZ
    INTEGER*2 GAIN_H166GHZ
    INTEGER*2 GAIN_V18GHZ
    INTEGER*2 GAIN_H18GHZ
    INTEGER*2 GAIN_VB183GHZ
    INTEGER*2 GAIN_V23GHZ
    INTEGER*2 GAIN_V36GHZ
    INTEGER*2 GAIN_V89GHZ
    INTEGER*2 GAIN_V166GHZ
    INTEGER*2 GAIN_VA183GHZ
END STRUCTURE

STRUCTURE /L1AGMI_S3_RSHSK_SAMPL_INFO/
    INTEGER*2 SMPOFFST_10GHZ
    INTEGER*2 SMPOFFST_18GHZ
    INTEGER*2 SMPOFFST_23GHZ
    INTEGER*2 SMPOFFST_36GHZ
    INTEGER*2 SMPOFFST_89GHZ
    INTEGER*2 SMPOFFST_166GHZ
    INTEGER*2 SMPOFFST_183GHZ
    INTEGER*2 NUMSMPLS_10GHZ
    INTEGER*2 NUMSMPLS_18GHZ
```

```
    INTEGER*2 NUMSMPLS_23GHZ
    INTEGER*2 NUMSMPLS_36GHZ
    INTEGER*2 NUMSMPLS_89GHZ
    INTEGER*2 NUMSMPLS_166GHZ
    INTEGER*2 NUMSMPLS_183GHZ
END STRUCTURE

STRUCTURE /L1AGMI_S3_RSHSK_STATUS/
    INTEGER*2 RSST_SCI_ADC_LP
    INTEGER*2 RSST_HSK_ADC_LP
    INTEGER*2 RSST_SAMP_OVLP
    INTEGER*2 RSST_10GHZ_RLY
    INTEGER*2 RSST_18GHZ_RLY
    INTEGER*2 RSST_23GHZ_RLY
    INTEGER*2 RSST_36GHZ_RLY
    INTEGER*2 RSST_89GHZ_RLY
    INTEGER*2 RSST_166GHZ_RLY
    INTEGER*2 RSST_183GHZ_RLY
    INTEGER*2 RSST_INVLD_CMD
    INTEGER*2 RSST_CMD_AFTER
    INTEGER*2 NDIODE_MODE
    INTEGER*2 RSST_NDIODE_ST
    INTEGER*2 NDIODE10GHZSNUM
    INTEGER*2 RESERVED1
    INTEGER*2 RS_CALRES_1
    INTEGER*2 BATC_CALRES_1
    INTEGER*2 RS_CALRES_2
    INTEGER*2 BATC_CALRES_2
    INTEGER*2 RS_EPC_ISENS
    INTEGER*2 RS_EPC_5V
    INTEGER*2 RS_EPC_7V
    INTEGER*2 RS_EPC_POS12V
    INTEGER*2 RS_EPC_NEG12V
    INTEGER*2 RS_EPC_15V
END STRUCTURE

STRUCTURE /L1AGMI_S3_SYNCH_STAMPS2/
    INTEGER*4 TACH_SECS_16
    INTEGER*2 TACH_SUBS_16
    INTEGER*4 TACH_SECS_17
    INTEGER*2 TACH_SUBS_17
    INTEGER*4 TACH_SECS_18
    INTEGER*2 TACH_SUBS_18
```

```
    INTEGER*4 TACH_SECS_19
    INTEGER*2 TACH_SUBS_19
    INTEGER*4 TACH_SECS_20
    INTEGER*2 TACH_SUBS_20
    INTEGER*4 TACH_SECS_21
    INTEGER*2 TACH_SUBS_21
    INTEGER*4 TACH_SECS_22
    INTEGER*2 TACH_SUBS_22
    INTEGER*4 TACH_SECS_23
    INTEGER*2 TACH_SUBS_23
    INTEGER*4 TACH_SECS_24
    INTEGER*2 TACH_SUBS_24
    INTEGER*4 TACH_SECS_25
    INTEGER*2 TACH_SUBS_25
    INTEGER*4 TACH_SECS_26
    INTEGER*2 TACH_SUBS_26
    INTEGER*4 TACH_SECS_27
    INTEGER*2 TACH_SUBS_27
    INTEGER*4 TACH_SECS_28
    INTEGER*2 TACH_SUBS_28
    INTEGER*4 TACH_SECS_29
    INTEGER*2 TACH_SUBS_29
    INTEGER*4 TACH_SECS_30
    INTEGER*2 TACH_SUBS_30
    INTEGER*4 TACH_SECS_31
    INTEGER*2 TACH_SUBS_31
    INTEGER*4 SCAN_COMPL_SECS
    INTEGER*2 SCAN_COMPL_SUBS
END STRUCTURE

STRUCTURE /L1AGMI_S3_SYNCH_STAMPS/
    INTEGER*4 IDX_PULSE_SECS
    INTEGER*2 IDX_PULSE_SUBS
    INTEGER*4 TACH_SECS_00
    INTEGER*2 TACH_SUBS_00
    INTEGER*4 TACH_SECS_01
    INTEGER*2 TACH_SUBS_01
    INTEGER*4 TACH_SECS_02
    INTEGER*2 TACH_SUBS_02
    INTEGER*4 TACH_SECS_03
    INTEGER*2 TACH_SUBS_03
    INTEGER*4 TACH_SECS_04
    INTEGER*2 TACH_SUBS_04
```

```
    INTEGER*4 TACH_SECS_05
    INTEGER*2 TACH_SUBS_05
    INTEGER*4 TACH_SECS_06
    INTEGER*2 TACH_SUBS_06
    INTEGER*4 TACH_SECS_07
    INTEGER*2 TACH_SUBS_07
    INTEGER*4 TACH_SECS_08
    INTEGER*2 TACH_SUBS_08
    INTEGER*4 TACH_SECS_09
    INTEGER*2 TACH_SUBS_09
    INTEGER*4 TACH_SECS_10
    INTEGER*2 TACH_SUBS_10
    INTEGER*4 TACH_SECS_11
    INTEGER*2 TACH_SUBS_11
    INTEGER*4 TACH_SECS_12
    INTEGER*2 TACH_SUBS_12
    INTEGER*4 TACH_SECS_13
    INTEGER*2 TACH_SUBS_13
    INTEGER*4 TACH_SECS_14
    INTEGER*2 TACH_SUBS_14
    INTEGER*4 TACH_SECS_15
    INTEGER*2 TACH_SUBS_15
END STRUCTURE

STRUCTURE /L1AGMI_S3_RS_INFO/
    INTEGER*2 RS_POWERED
    INTEGER*2 RS_ENABLED
    INTEGER*2 RS_MST_RLY
    INTEGER*2 RS_10GHZ_RLY
    INTEGER*2 RS_18GHZ_RLY
    INTEGER*2 RS_23GHZ_RLY
    INTEGER*2 RS_36GHZ_RLY
    INTEGER*2 RS_89GHZ_RLY
    INTEGER*2 RS_166GHZ_RLY
    INTEGER*2 RS_183GHZ_RLY
    INTEGER*2 RS_DQ_MISSING
    INTEGER*2 RS_DQ_EXTRAS
    INTEGER*2 RS_DQ_DUPES
    INTEGER*2 RS_LAST_REV
    INTEGER*2 RS_DQ_SAME_REV
    INTEGER*2 RS_DQ_BAD_REVS
    INTEGER*2 RS_DQ_PAR_ERR
    INTEGER*2 RS_DQ_CLK_ERR
```

```
    INTEGER*2 RS_DQ_PKT_ERR
    INTEGER*2 RS_DQ_TLM_ERR
    INTEGER*2 RS_DQ_BAD_CONF
    INTEGER*2 RS_DQ_CAL_LIM
    INTEGER*2 BLK_STATE
    INTEGER*2 BLK_SIDE
    INTEGER*2 BLK_DELAY
    INTEGER*2 BLK_DURATION
    INTEGER*2 RS_HSK_SIZE
    INTEGER*4 RS_PAR_ERR_CNT
    INTEGER*4 RS_SCAN_CNT
    INTEGER*4 SAMPLE_TBL_VER
    INTEGER*4 SMPL_TBL
    INTEGER*2 RS_SC_SIZE
    INTEGER*2 GSDR_SIZE
    INTEGER*2 GSDR_LEFT
    INTEGER*2 GSDR_B_POP_IDX
    INTEGER*2 GSDR_B_PUSH_IDX
    INTEGER*2 GSDR_APID
    INTEGER*2 PKT_STATE
    INTEGER*2 OVRD_RS_PWR
    INTEGER*2 OVRD_SMA_SPIN
    INTEGER*2 OVRD_PASS_RS
END STRUCTURE

STRUCTURE /L1AGMI_S3_SENSOR_INFO/
    INTEGER*4 KEEP_ALIVE_CNT
    INTEGER*2 FPGA_RST_REASON
    INTEGER*2 CRASH_REASON
    INTEGER*2 VERSION_MIN
    INTEGER*2 VERSION_MAJ
    INTEGER*2 FPGA_MODE
    INTEGER*2 ERR_HDL_FAILURE
    INTEGER*2 RESET_REASON
    INTEGER*2 BOOT_BANK
    INTEGER*2 CURRENT_BANK
    INTEGER*2 EDAC_ENABLE
    INTEGER*2 WDOG_ENABLE
    INTEGER*2 SC_1HZ_REF
    INTEGER*2 SCE_FORCE_SEL
    INTEGER*2 RS_1MHZ_REF
    INTEGER*2 RS_SCAN_START
    INTEGER*2 FPGA_IE_RX_EN
```

```
    INTEGER*2 FPGA_RS_RX_EN
    INTEGER*2 FPGA_SCE_RX_EN
    INTEGER*2 EEPROM_BUSY
    INTEGER*2 RS_TLM_PROG
    INTEGER*2 SCE_A_ACTIVE
    INTEGER*2 SCE_A_RLY
    INTEGER*2 SCE_B_ACTIVE
    INTEGER*2 SCE_B_RLY
    INTEGER*2 IE_TLM_PROG
    INTEGER*2 SCE_RSP_PROG
    INTEGER*2 RS_CLK_ERR
    INTEGER*2 RS_PKT_ERR
    INTEGER*2 RS_TLM_ERR
    INTEGER*2 SCE_RSP_RDY
    INTEGER*2 IE_PKT_ERR
    INTEGER*2 IE_CMD_ERR
    INTEGER*2 IE_RSP_ERR
    INTEGER*2 IE_TLM_ERR
    INTEGER*2 FPGA_ACCSS_ERR
END STRUCTURE

STRUCTURE /L1AGMI_S3_GSDR_TIME/
    INTEGER*4 G_TC_PULSE_SECS
    INTEGER*2 G_TC_PULSE_SUBS
    INTEGER*4 G_TCU_SECS
    INTEGER*4 G_TCU_SUBS
    INTEGER*4 G_TCF_SC_SECS
    INTEGER*4 G_TCF_SC_SUBSEC
    INTEGER*4 G_TCF_SECS
    INTEGER*4 G_TCF_SUBSECS
    INTEGER*2 G_TCF_SIGN
    INTEGER*2 G_TCF_LEAP
    INTEGER*4 GPS_TCU_SECS
    INTEGER*4 GPS_TCU_SUBS
END STRUCTURE

STRUCTURE /L1AGMI_S3_GMI_TEMPERATURES/
    REAL*4 timeOffset
    INTEGER*2 apid
    INTEGER*2 SMA_PT_TEMP
    INTEGER*2 ICA_PT_TEMP
    INTEGER*2 RS_PT_TEMP
    INTEGER*2 STAT_PT_TEMP
```

```
    INTEGER*2 MR_PT_TEMP
END STRUCTURE

STRUCTURE /L1AGMI_S3_TORQUE_BAR/
    REAL*4 timeOffset
    INTEGER*2 Vx
    INTEGER*2 Vy
    INTEGER*2 Vz
END STRUCTURE

STRUCTURE /L1AGMI_S3_TAM2/
    REAL*4 timeOffset
    INTEGER*2 Vx
    INTEGER*2 Vy
    INTEGER*2 Vz
END STRUCTURE

STRUCTURE /L1AGMI_S3_TAM1/
    REAL*4 timeOffset
    INTEGER*2 Vx
    INTEGER*2 Vy
    INTEGER*2 Vz
END STRUCTURE

STRUCTURE /L1AGMI_S3/
    RECORD /SCANTIME/ ScanTime
    CHARACTER ephemerisUsed(10)
    REAL*4 Latitude
    REAL*4 Longitude
    RECORD /L1AGMI_S3_TAM1/ TAM1
    RECORD /L1AGMI_S3_TAM2/ TAM2
    RECORD /L1AGMI_S3_TORQUE_BAR/ TORQUE_BAR
    RECORD /L1AGMI_S3_GMI_TEMPERATURES/ GMI_TEMPERATURES
    BYTE version
    BYTE type
    BYTE secHeaderFlag
    INTEGER*2 APID
    BYTE sequenceFlag
    INTEGER*2 packetSequenceCount
    INTEGER*2 packetLength
    INTEGER*4 instrTimeSeconds
    INTEGER*2 instrTimeSubseconds
    BYTE numPacketSegments
```

```
    BYTE spare
    INTEGER*2 RDRversion
    RECORD /L1AGMI_S3_GSDR_TIME/ GSDR_TIME
    RECORD /L1AGMI_S3_SENSOR_INFO/ SENSOR_INFO
    RECORD /L1AGMI_S3_RS_INFO/ RS_INFO
    RECORD /L1AGMI_S3_SYNCH_STAMPS/ SYNCH_STAMPS
    RECORD /L1AGMI_S3_SYNCH_STAMPS2/ SYNCH_STAMPS2
    RECORD /L1AGMI_S3_RSHSK_STATUS/ RSHSK_STATUS
    RECORD /L1AGMI_S3_RSHSK_SAMPL_INFO/ RSHSK_SAMPL_INFO
    RECORD /L1AGMI_S3_RSHSK_GAIN/ RSHSK_GAIN
    RECORD /L1AGMI_S3_RSHSK_TEMP/ RSHSK_TEMP
    RECORD /L1AGMI_S3_IEHSK_TEMP/ IEHSK_TEMP
    RECORD /L1AGMI_S3_IE_TELEMETRY/ IE_TELEMETRY
    RECORD /L1AGMI_S3_MECHANISMS/ MECHANISMS
    RECORD /L1AGMI_S3_SMPL_INFO/ SMPL_INFO
END STRUCTURE

STRUCTURE /L1AGMI_S2_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /L1AGMI_S2_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /L1AGMI_S2/
```

```
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    RECORD /L1AGMI_S2_SCANSTATUS/ scanStatus
    CHARACTER ephemerisUsed(10)
    RECORD /NAVIGATION/ navigation
    RECORD /L1AGMI_S2_SUNDATA/ sunData
    REAL*4 incidenceAngle(221)
    REAL*4 satAzimuthAngle(221)
    REAL*4 solarZenAngle(221)
    REAL*4 solarAzimuthAngle(221)
    REAL*4 sunGlintAngle(221)
    REAL*4 moonVectorInstFrame(3)
    INTEGER*2 earthView(4,221)
    INTEGER*2 hotLoad(4,221)
    INTEGER*2 coldSky(4,221)
END STRUCTURE

STRUCTURE /L1AGMI_S1_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
```

```
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L1AGMI_S1_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1AGMI_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    RECORD /L1AGMI_S1_SCANSTATUS/ scanStatus
    CHARACTER ephemerisUsed(10)
    RECORD /NAVIGATION/ navigation
    RECORD /L1AGMI_S1_SUNDATA/ sunData
    REAL*4 incidenceAngle(221)
    REAL*4 satAzimuthAngle(221)
    REAL*4 solarZenAngle(221)
    REAL*4 solarAzimuthAngle(221)
    REAL*4 sunGlintAngle(221)
```

```
    REAL*4 moonVectorInstFrame(3)
    INTEGER*2 earthView(9,221)
    INTEGER*2 hotLoad(9,221)
    INTEGER*2 coldSky(9,221)
    CHARACTER earthViewBlanking(2,221)
    CHARACTER hotLoadBlanking(2,221)
    CHARACTER coldSkyBlanking(2,221)
END STRUCTURE

STRUCTURE /L1AGMI_SWATHS/
    RECORD /L1AGMI_S1/ S1
    RECORD /L1AGMI_S2/ S2
    RECORD /L1AGMI_S3/ S3
    RECORD /L1AGMI_S4/ S4
    RECORD /L1AGMI_S5/ S5
END STRUCTURE

STRUCTURE /L1AGMI_GMI1AHEADER/
    INTEGER*2 sampleRangeFile(6,7)
END STRUCTURE
```

5.18 1BGMI - GMI Brightness Temperatures

The Level-1B GMI Product, 1BGMI, "GMI Brightness Temperatures," is written as a multi-Swath Structure. Swath S1 has channels 1-9: 10V 10H 19V 19H 23V 37V 37H 89V 89H. Swath S2 has channels 10-13: 166V 166H 183+/-3V 183+/-8V. The following sections describe the structure and contents of the format.

Dimension definitions:

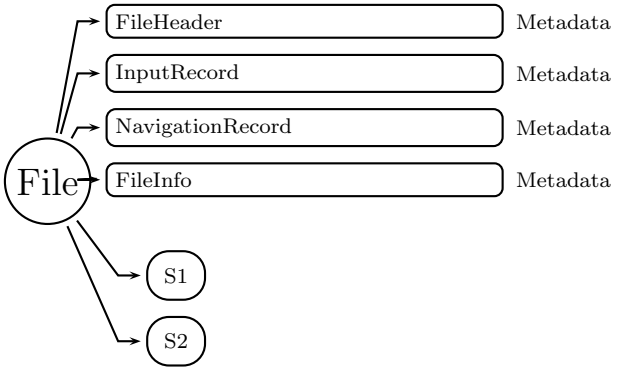


Figure 240: Data Format Structure for 1BGMI, GMI Brightness Temperatures

nscan	var	Number of scans in the granule.
nchan1	9	Number of channels in Swath 1.
nchan2	4	Number of channels in Swath 2.
nfreq1	5	Number of frequencies in Swath 1.
nfreq2	2	Number of frequencies in Swath 2.
npix1	221	Number of pixels in Swath 1.
npix2	221	Number of pixels in Swath 2.
ncolds1	85	Maximum number of cold samples in Swath 1.
ncolds2	85	Maximum number of cold samples in Swath 2.
nhots1	65	Maximum number of hot samples in Swath 1.
nhots2	65	Maximum number of hot samples in Swath 2.
ntherm	11	Number of hot load thermisters.
LNL	2	Linear and non-linear.
nsamt	4	Number of sample types. The types are: total science GSDR, earth-view, hot load, cold sky.
ntach	32	Number of tachometer readings.
GMIxyz	3	x, y, z components in GMI instrument coordinate system.

Figure 240 through Figure 256 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

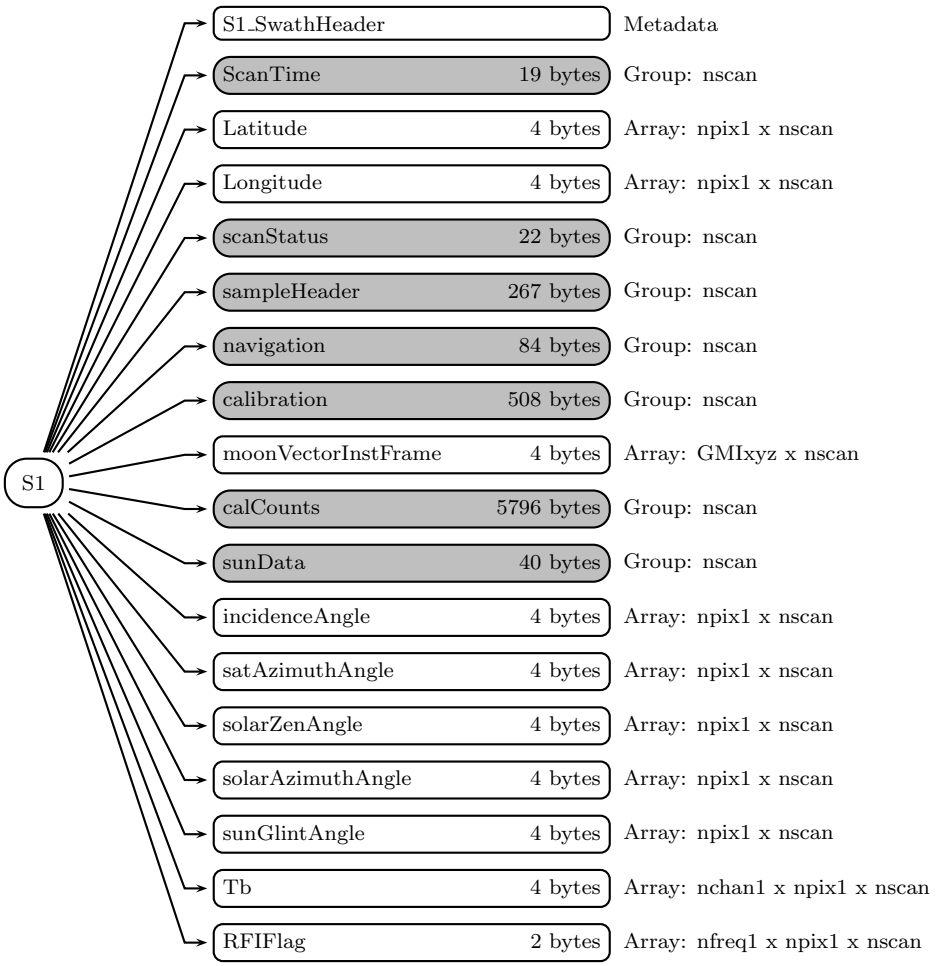


Figure 241: Data Format Structure for 1BGMI, S1

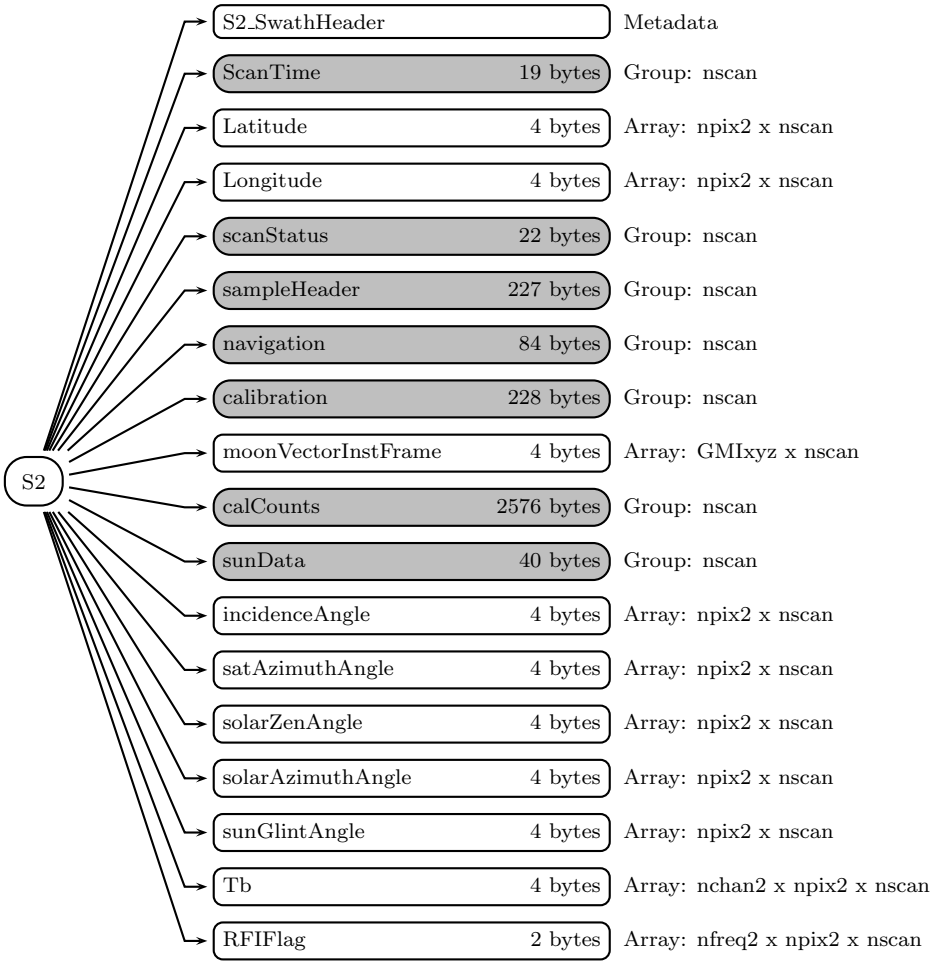


Figure 242: Data Format Structure for 1BGMI, S2

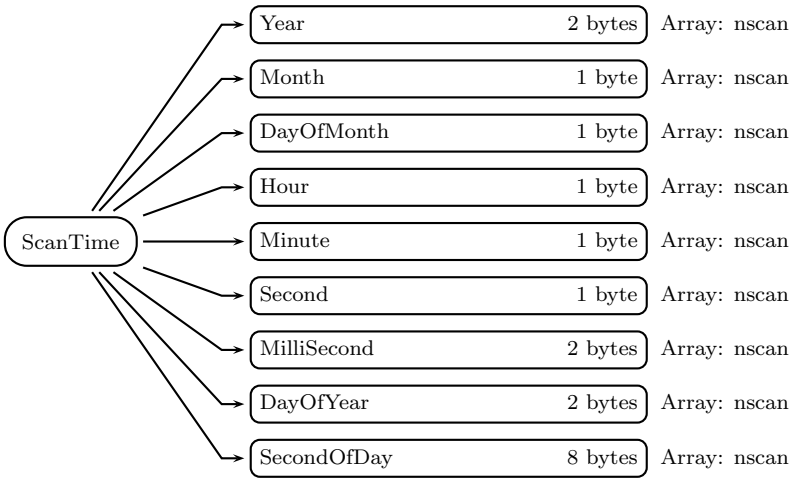


Figure 243: Data Format Structure for 1BGMI, S1, ScanTime

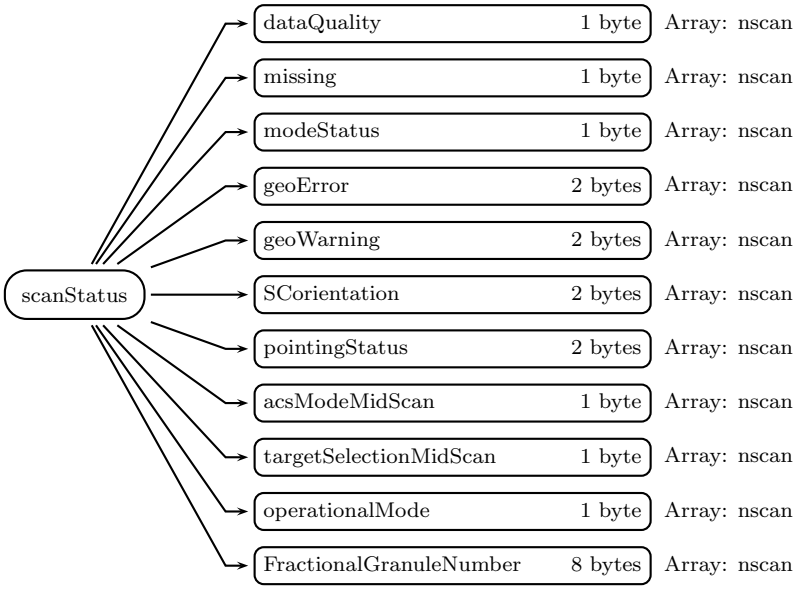


Figure 244: Data Format Structure for 1BGMI, S1, scanStatus

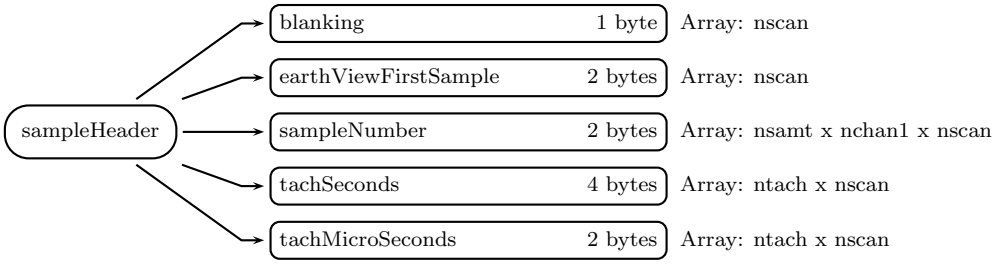


Figure 245: Data Format Structure for 1BGMI, S1, sampleHeader

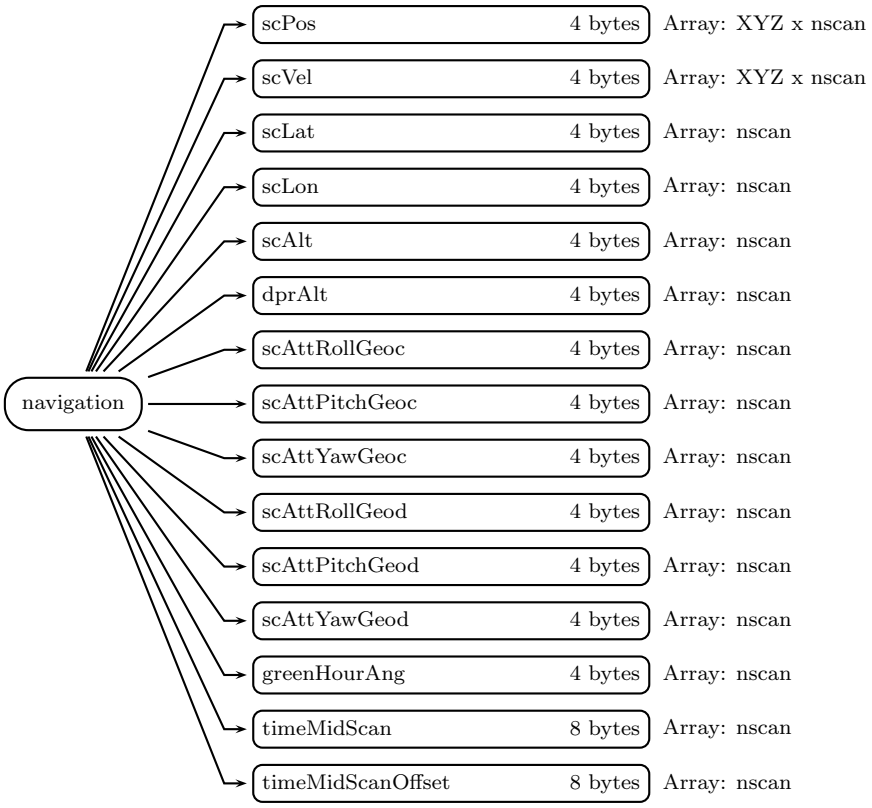


Figure 246: Data Format Structure for 1BGMI, S1, navigation

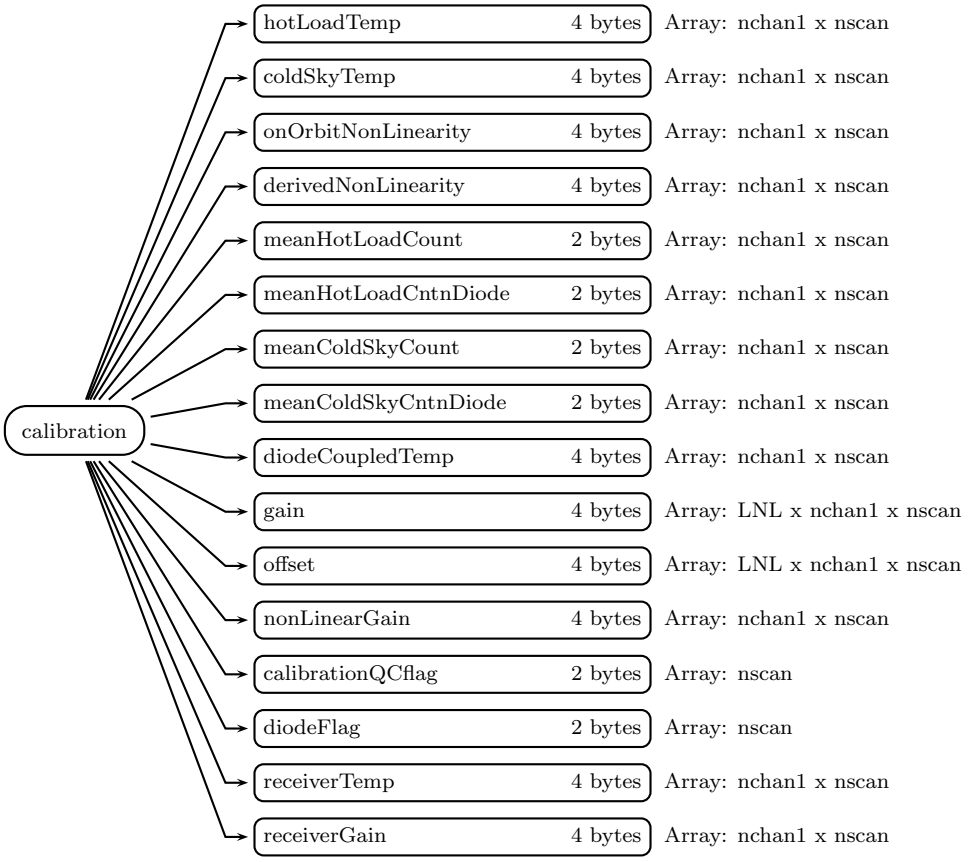


Figure 247: Data Format Structure for 1BGMI, S1, calibration

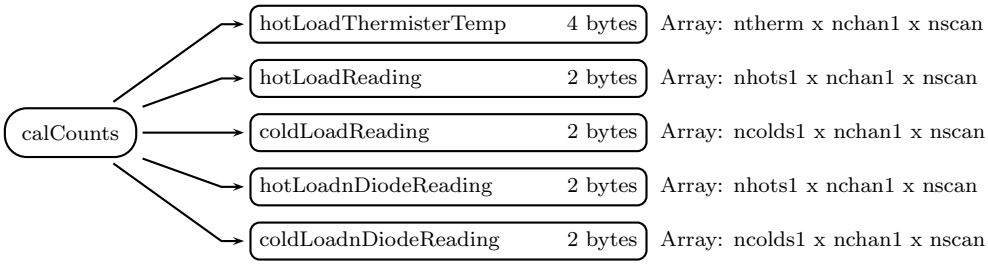


Figure 248: Data Format Structure for 1BGMI, S1, calCounts

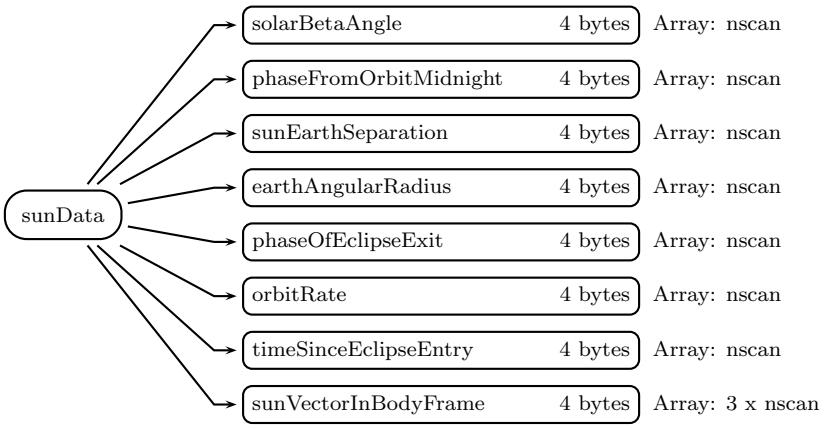


Figure 249: Data Format Structure for 1BGMI, S1, sunData

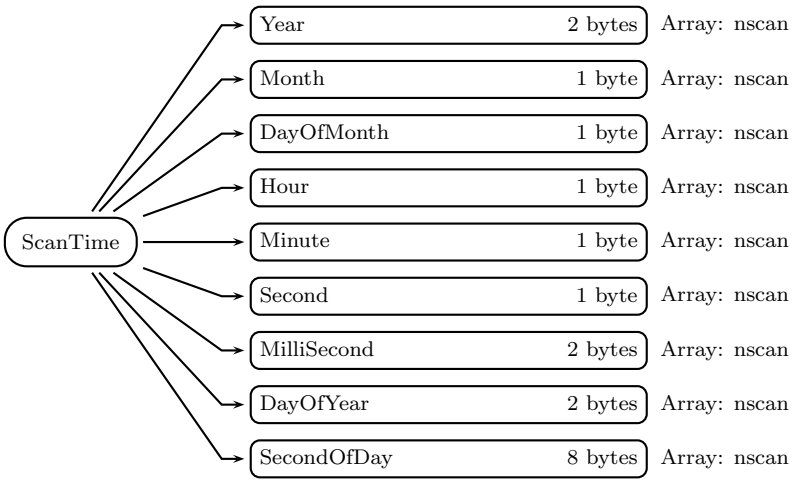


Figure 250: Data Format Structure for 1BGMI, S2, ScanTime

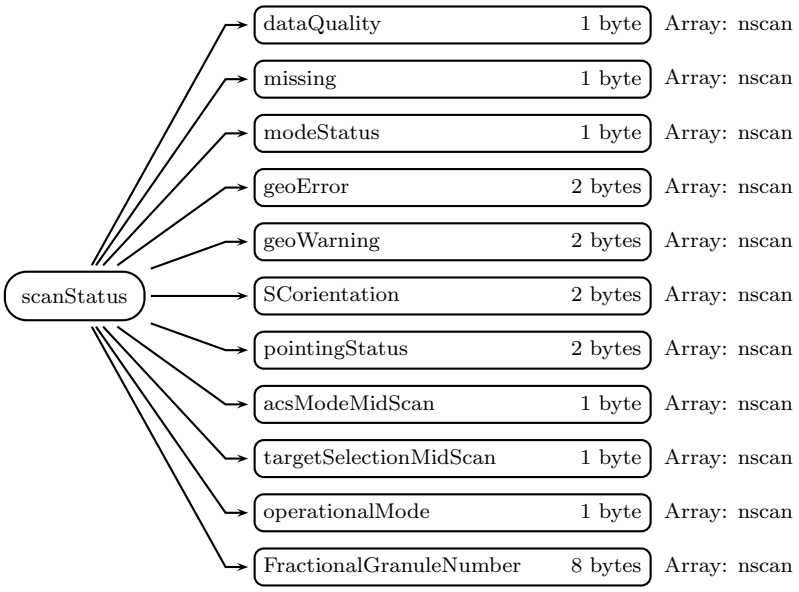


Figure 251: Data Format Structure for 1BGMI, S2, scanStatus

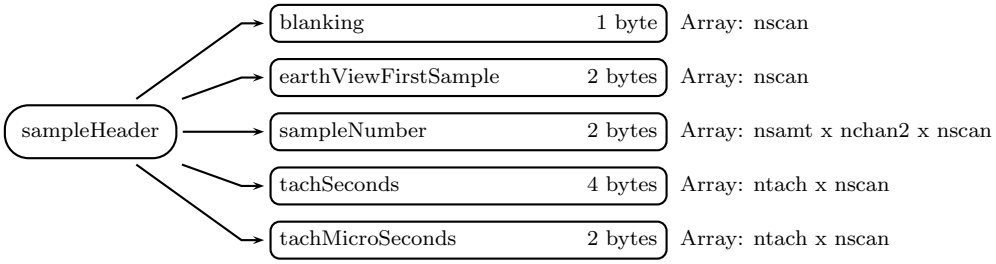


Figure 252: Data Format Structure for 1BGMI, S2, sampleHeader

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

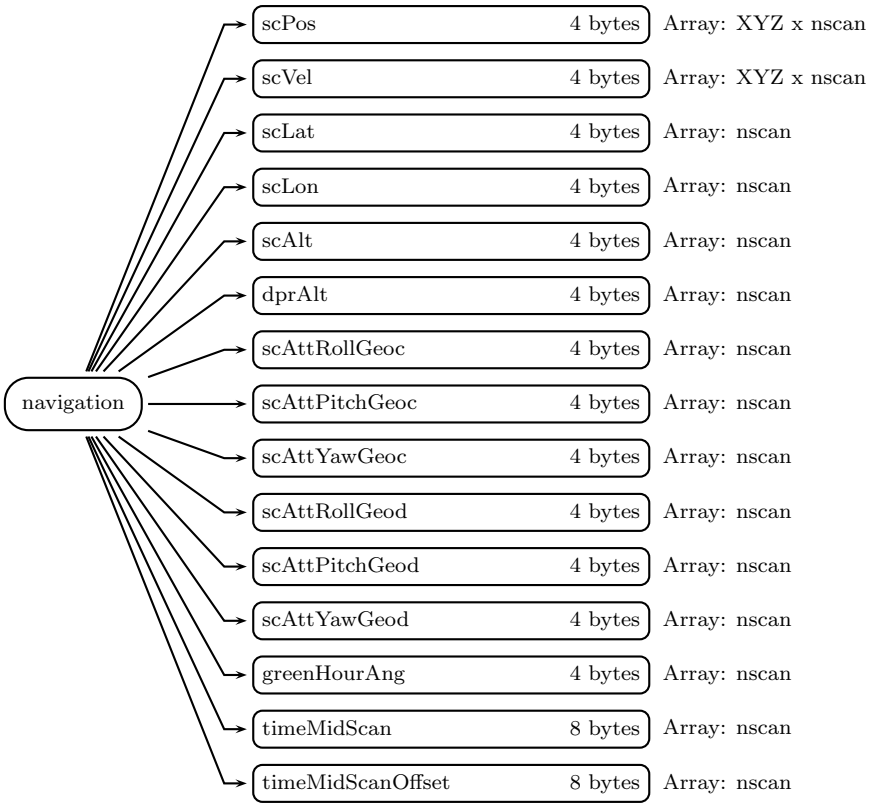


Figure 253: Data Format Structure for 1BGMI, S2, navigation

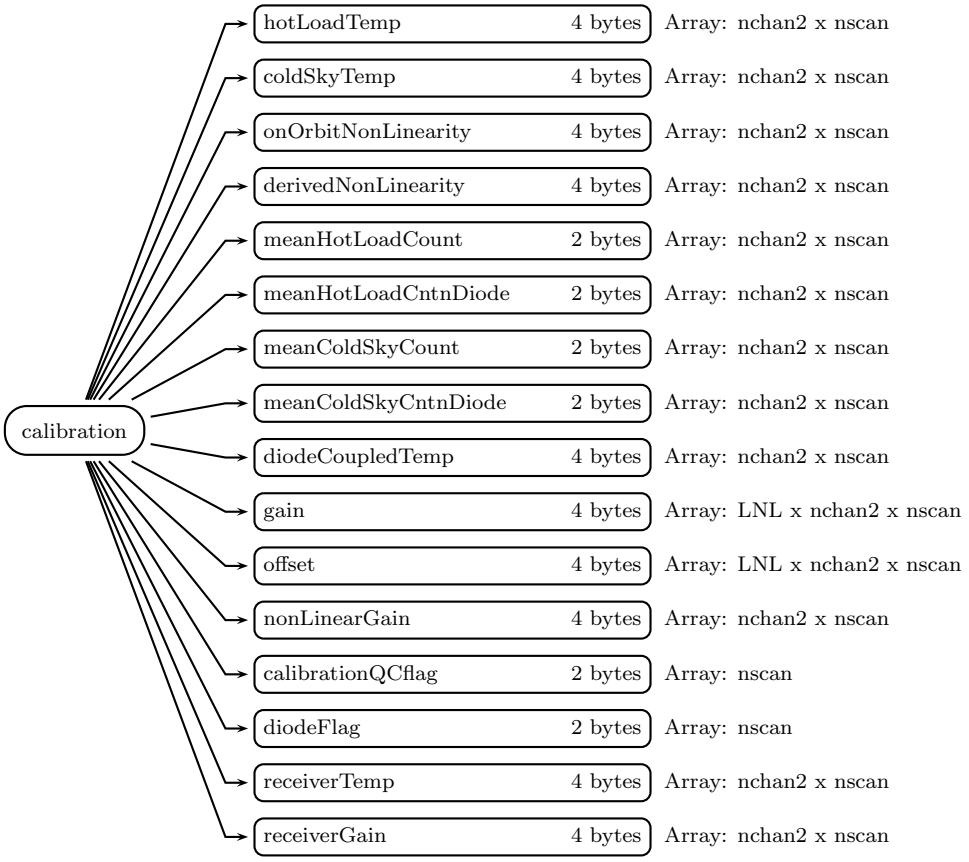


Figure 254: Data Format Structure for 1BGMI, S2, calibration

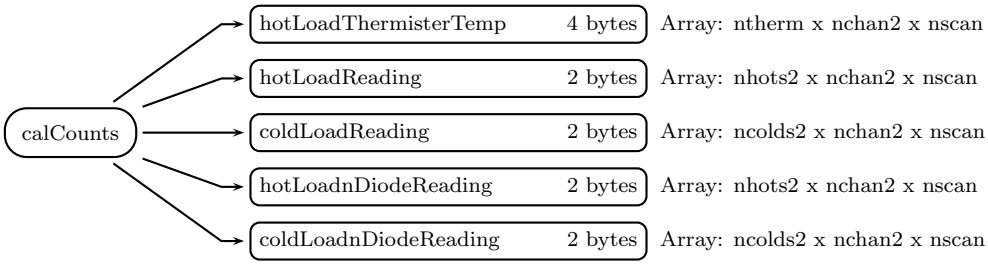


Figure 255: Data Format Structure for 1BGMI, S2, calCounts

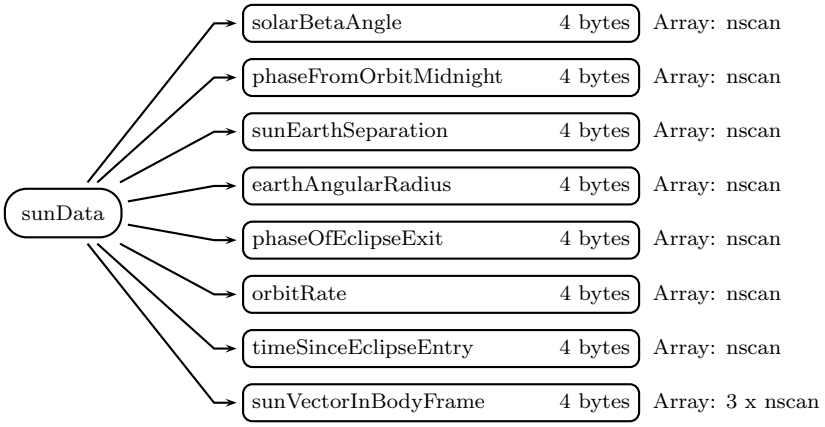


Figure 256: Data Format Structure for 1BGMI, S2, sunData

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix1 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude

is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix1 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S1)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be

useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

sampleHeader (Group in S1)

blanking (1-byte integer, array size: nscan):

```
Value of 0 = Table 0 used for hot and cold samples,
                     No blanking
Value of 1 = Table 1 used for hot and cold samples,
                     Blanking on both sides
Value of 2 = Table 2 used for hot and cold samples,
                     Blanking on begin side
Value of 3 = Table 3 used for hot and cold samples,
                     Blanking on end side
```

earthViewFirstSample (2-byte integer, array size: nscan):
Sample number of the first earth view. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

sampleNumber (2-byte integer, array size: nsamt x nchan1 x nscan):
Number of valid samples in scan. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

tachSeconds (4-byte unsigned integer, array size: ntach x nscan):
Tachometer seconds. Special values are defined as:
0 Missing value

tachMicroSeconds (2-byte unsigned integer, array size: ntach x nscan):
Tachometer microseconds. Special values are defined as:
0 Missing value

navigation (Group in S1)

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

calibration (Group in S1)

hotLoadTemp (4-byte float, array size: nchan1 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan1 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan1 x nscan):
The on Orbit Non-Linearity. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan1 x nscan):
The derived Non-Linearity. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (2-byte unsigned integer, array size: nchan1 x nscan):
The mean Hot Load Count. Values range from 0 to 15. Special values are defined as:
65535 Missing value

meanHotLoadCntnDiode (2-byte unsigned integer, array size: nchan1 x nscan):
The mean Hot Load Count Plus Noise Diode. Values range from 0 to 15. Special values are defined as:
65535 Missing value

meanColdSkyCount (2-byte unsigned integer, array size: nchan1 x nscan):
The mean Cold Sky Count. Values range from 0 to 15. Special values are defined as:
65535 Missing value

meanColdSkyCntnDiode (2-byte unsigned integer, array size: nchan1 x nscan):
The mean Cold Sky Count Plus Noise Diode. Values range from 0 to 15. Special values are defined as:
65535 Missing value

diodeCoupledTemp (4-byte float, array size: nchan1 x nscan):
The diode Coupled Temp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan1 x nscan):
Automatic gain control. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan1 x nscan):
Offset. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

nonLinearGain (4-byte float, array size: nchan1 x nscan):
The nonlinear gain. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):
Diode flag. If diodeFlag = 1, use LoadPlusDiodeReading If diodeFlag = 0, use LoadReading Values range from 0 to 1 counts. Special values are defined as:
-9999 Missing value

receiverTemp (4-byte float, array size: nchan1 x nscan):
The receiver temperature. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan1 x nscan):
The receiver gain. Special values are defined as:
-9999.9 Missing value

moonVectorInstFrame (4-byte float, array size: GMIxyz x nscan):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

calCounts (Group in S1)

hotLoadThermisterTemp (4-byte float, array size: ntherm x nchan1 x nscan):
Hot Load Thermister Temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

hotLoadReading (2-byte unsigned integer, array size: nhots1 x nchan1 x nscan):
Hot Load Reading. Values range from 0 to 15 counts. Special values are defined as:
0 Missing value

coldLoadReading (2-byte unsigned integer, array size: ncolds1 x nchan1 x nscan):
Cold Load Reading. Values range from 0 to 15 counts. Special values are defined as:
0 Missing value

hotLoadnDiodeReading (2-byte unsigned integer, array size: nhots1 x nchan1 x nscan):
Hot Load Plus Diode Reading. Values range from 0 to 15 counts. Special values are defined as:
0 Missing value

coldLoadnDiodeReading (2-byte unsigned integer, array size: ncolds1 x nchan1 x nscan):
Cold Load Plus Diode Reading. Values range from 0 to 15 counts. Special values are defined as:
0 Missing value

sunData (Group in S1)

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: 3 x nscan):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special

values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix1 x nscan):
The angle at the center of the IFOV between the antenna boresight vector and the zenith vector normal to the Earth Ellipsiod. Also known as Satellite Zenith Angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npix1 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npix1 x nscan):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npix1 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npix1 x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

Tb (4-byte float, array size: nchan1 x npix1 x nscan):
Earth view brightness temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

RFIFlag (2-byte integer, array size: nfreq1 x npix1 x nscan):

```
Radio Frequency Interference (RFI) Flag.  The flag is set
to non-zero if the pixel is contaminated by RFI according
to certain filters.  Current values are:

0:     Not affected by RFI.
1:     Affected by RFI with X-cal filter.
```

```
2:     Affected by RFI with RSS filter.
3-7:   Spare
-9999: Missing
```

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix2 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix2 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S2)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
```

```
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is

good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

sampleHeader (Group in S2)

blanking (1-byte integer, array size: nscan):

```
Value of 0 = Table 0 used for hot and cold samples,
                     No blanking
Value of 1 = Table 1 used for hot and cold samples,
                     Blanking on both sides
Value of 2 = Table 2 used for hot and cold samples,
                     Blanking on begin side
Value of 3 = Table 3 used for hot and cold samples,
                     Blanking on end side
```

earthViewFirstSample (2-byte integer, array size: nscan):
Sample number of the first earth view. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

sampleNumber (2-byte integer, array size: nsamt x nchan2 x nscan):
Number of valid samples in scan. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

tachSeconds (4-byte unsigned integer, array size: ntach x nscan):
Tachometer seconds. Special values are defined as:
0 Missing value

tachMicroSeconds (2-byte unsigned integer, array size: ntach x nscan):
Tachometer microseconds. Special values are defined as:
0 Missing value

navigation (Group in S2)

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

calibration (Group in S2)

hotLoadTemp (4-byte float, array size: nchan2 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan2 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan2 x nscan):
The on Orbit Non-Linearity. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan2 x nscan):
The derived Non-Linearity. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (2-byte unsigned integer, array size: nchan2 x nscan):
The mean Hot Load Count. Values range from 0 to 15. Special values are defined as:
65535 Missing value

meanHotLoadCntnDiode (2-byte unsigned integer, array size: nchan2 x nscan):
The mean Hot Load Count Plus Noise Diode. Values range from 0 to 15. Special values are defined as:
65535 Missing value

meanColdSkyCount (2-byte unsigned integer, array size: nchan2 x nscan):
The mean Cold Sky Count. Values range from 0 to 15. Special values are defined as:
65535 Missing value

meanColdSkyCntnDiode (2-byte unsigned integer, array size: nchan2 x nscan):
The mean Cold Sky Count Plus Noise Diode. Values range from 0 to 15. Special values are defined as:
65535 Missing value

diodeCoupledTemp (4-byte float, array size: nchan2 x nscan):
The diode Coupled Temp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan2 x nscan):
Automatic gain control. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan2 x nscan):
Offset. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

nonLinearGain (4-byte float, array size: nchan2 x nscan):
The nonlinear gain. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):
Diode flag. If diodeFlag = 1, use LoadPlusDiodeReading If diodeFlag = 0, use LoadReading Values range from 0 to 1 counts. Special values are defined as:
-9999 Missing value

receiverTemp (4-byte float, array size: nchan2 x nscan):
The receiver temperature. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan2 x nscan):
The receiver gain. Special values are defined as:
-9999.9 Missing value

moonVectorInstFrame (4-byte float, array size: GMIxyz x nscan):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

calCounts (Group in S2)

hotLoadThermisterTemp (4-byte float, array size: ntherm x nchan2 x nscan):
Hot Load Thermister Temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

hotLoadReading (2-byte unsigned integer, array size: nhots2 x nchan2 x nscan):
Hot Load Reading. Values range from 0 to 15 counts. Special values are defined as:
0 Missing value

coldLoadReading (2-byte unsigned integer, array size: ncolds2 x nchan2 x nscan):
Cold Load Reading. Values range from 0 to 15 counts. Special values are defined as:
0 Missing value

hotLoadnDiodeReading (2-byte unsigned integer, array size: nhots2 x nchan2 x nscan):
Hot Load Plus Diode Reading. Values range from 0 to 15 counts. Special values are

defined as:
0 Missing value

coldLoadnDiodeReading (2-byte unsigned integer, array size: ncolds2 x nchan2 x nscan):
Cold Load Plus Diode Reading. Values range from 0 to 15 counts. Special values are defined as:
0 Missing value

sunData (Group in S2)

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):
The instantaneous angular rate of the spacecraft around the orbit. Values range from

0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: 3 x nscan):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix2 x nscan):
The angle at the center of the IFOV between the antenna boresight vector and the zenith vector normal to the Earth Ellipsiod. Also known as Satellite Zenith Angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npix2 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npix2 x nscan):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npix2 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npix2 x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

Tb (4-byte float, array size: nchan2 x npix2 x nscan):
Earth view brightness temperature. Values range from 0 to 400 K. Special values are

defined as:
-9999.9 Missing value

RFIFlag (2-byte integer, array size: nfreq2 x npix2 x nscan):

```
Radio Frequency Interference (RFI) Flag.  The flag is set
to non-zero if the pixel is contaminated by RFI according
to certain filters.  Current values are:

0:     Not affected by RFI.
1:     Affected by RFI with X-cal filter.
2:     Affected by RFI with RSS filter.
3-7:   Spare
-9999: Missing
```

C Structure Header file:

```
#ifndef _TK_1BGMI_H_
#define _TK_1BGMI_H_

#ifndef _L1BGMI_S2_SUNDATA_
#define _L1BGMI_S2_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1BGMI_S2_SUNDATA;

#endif

#ifndef _L1BGMI_S2_CALCOUNTS_
#define _L1BGMI_S2_CALCOUNTS_

typedef struct {
    float hotLoadThermisterTemp[4][11];
    unsigned short hotLoadReading[4][65];
    unsigned short coldLoadReading[4][85];
```

```
    unsigned short hotLoadnDiodeReading[4][65];
    unsigned short coldLoadnDiodeReading[4][85];
} L1BGMI_S2_CALCOUNTS;

#endif

#ifndef _L1BGMI_S2_CALIBRATION_
#define _L1BGMI_S2_CALIBRATION_

typedef struct {
    float hotLoadTemp[4];
    float coldSkyTemp[4];
    float onOrbitNonLinearity[4];
    float derivedNonLinearity[4];
    unsigned short meanHotLoadCount[4];
    unsigned short meanHotLoadCntnDiode[4];
    unsigned short meanColdSkyCount[4];
    unsigned short meanColdSkyCntnDiode[4];
    float diodeCoupledTemp[4];
    float gain[4][2];
    float offset[4][2];
    float nonLinearGain[4];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[4];
    float receiverGain[4];
} L1BGMI_S2_CALIBRATION;

#endif

#ifndef _L1BGMI_S2_SAMPLEHEADER_
#define _L1BGMI_S2_SAMPLEHEADER_

typedef struct {
    signed char blanking;
    short earthViewFirstSample;
    short sampleNumber[4][4];
    unsigned int tachSeconds[32];
    unsigned short tachMicroSeconds[32];
} L1BGMI_S2_SAMPLEHEADER;

#endif
```

```
#ifndef _L1BGMI_S2_SCANSTATUS_
#define _L1BGMI_S2_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} L1BGMI_S2_SCANSTATUS;

#endif

#ifndef _L1BGMI_S2_
#define _L1BGMI_S2_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    L1BGMI_S2_SCANSTATUS scanStatus;
    L1BGMI_S2_SAMPLEHEADER sampleHeader;
    NAVIGATION navigation;
    L1BGMI_S2_CALIBRATION calibration;
    float moonVectorInstFrame[3];
    L1BGMI_S2_CALCOUNTS calCounts;
    L1BGMI_S2_SUNDATA sunData;
    float incidenceAngle[221];
    float satAzimuthAngle[221];
    float solarZenAngle[221];
    float solarAzimuthAngle[221];
    float sunGlintAngle[221];
    float Tb[221][4];
    short RFIFlag[221][2];
} L1BGMI_S2;

#endif
```

```
#ifndef _L1BGMI_S1_SUNDATA_
#define _L1BGMI_S1_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1BGMI_S1_SUNDATA;

#endif

#ifndef _L1BGMI_S1_CALCOUNTS_
#define _L1BGMI_S1_CALCOUNTS_

typedef struct {
    float hotLoadThermisterTemp[9][11];
    unsigned short hotLoadReading[9][65];
    unsigned short coldLoadReading[9][85];
    unsigned short hotLoadnDiodeReading[9][65];
    unsigned short coldLoadnDiodeReading[9][85];
} L1BGMI_S1_CALCOUNTS;

#endif

#ifndef _L1BGMI_S1_CALIBRATION_
#define _L1BGMI_S1_CALIBRATION_

typedef struct {
    float hotLoadTemp[9];
    float coldSkyTemp[9];
    float onOrbitNonLinearity[9];
    float derivedNonLinearity[9];
    unsigned short meanHotLoadCount[9];
    unsigned short meanHotLoadCntnDiode[9];
    unsigned short meanColdSkyCount[9];
    unsigned short meanColdSkyCntnDiode[9];
    float diodeCoupledTemp[9];
```

```
    float gain[9][2];
    float offset[9][2];
    float nonLinearGain[9];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[9];
    float receiverGain[9];
} L1BGMI_S1_CALIBRATION;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _L1BGMI_S1_SAMPLEHEADER_
#define _L1BGMI_S1_SAMPLEHEADER_

typedef struct {
    signed char blanking;
    short earthViewFirstSample;
    short sampleNumber[9][4];
    unsigned int tachSeconds[32];
    unsigned short tachMicroSeconds[32];
```

```
} L1BGMI_S1_SAMPLEHEADER;

#endif

#ifndef _L1BGMI_S1_SCANSTATUS_
#define _L1BGMI_S1_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} L1BGMI_S1_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1BGMI_S1_
#define _L1BGMI_S1_
```

```
typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    L1BGMI_S1_SCANSTATUS scanStatus;
    L1BGMI_S1_SAMPLEHEADER sampleHeader;
    NAVIGATION navigation;
    L1BGMI_S1_CALIBRATION calibration;
    float moonVectorInstFrame[3];
    L1BGMI_S1_CALCOUNTS calCounts;
    L1BGMI_S1_SUNDATA sunData;
    float incidenceAngle[221];
    float satAzimuthAngle[221];
    float solarZenAngle[221];
    float solarAzimuthAngle[221];
    float sunGlintAngle[221];
    float Tb[221][9];
    short RFIFlag[221][5];
} L1BGMI_S1;

#endif

#ifndef _L1BGMI_SWATHS_
#define _L1BGMI_SWATHS_

typedef struct {
    L1BGMI_S1 S1;
    L1BGMI_S2 S2;
} L1BGMI_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1BGMI_S2_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
```

```
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /L1BGMI_S2_CALCOUNTS/
    REAL*4 hotLoadThermisterTemp(11,4)
    INTEGER*2 hotLoadReading(65,4)
    INTEGER*2 coldLoadReading(85,4)
    INTEGER*2 hotLoadnDiodeReading(65,4)
    INTEGER*2 coldLoadnDiodeReading(85,4)
END STRUCTURE

STRUCTURE /L1BGMI_S2_CALIBRATION/
    REAL*4 hotLoadTemp(4)
    REAL*4 coldSkyTemp(4)
    REAL*4 onOrbitNonLinearity(4)
    REAL*4 derivedNonLinearity(4)
    INTEGER*2 meanHotLoadCount(4)
    INTEGER*2 meanHotLoadCntnDiode(4)
    INTEGER*2 meanColdSkyCount(4)
    INTEGER*2 meanColdSkyCntnDiode(4)
    REAL*4 diodeCoupledTemp(4)
    REAL*4 gain(2,4)
    REAL*4 offset(2,4)
    REAL*4 nonLinearGain(4)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(4)
    REAL*4 receiverGain(4)
END STRUCTURE

STRUCTURE /L1BGMI_S2_SAMPLEHEADER/
    BYTE blanking
    INTEGER*2 earthViewFirstSample
    INTEGER*2 sampleNumber(4,4)
    INTEGER*4 tachSeconds(32)
    INTEGER*2 tachMicroSeconds(32)
END STRUCTURE

STRUCTURE /L1BGMI_S2_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
```

```
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /L1BGMI_S2/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    RECORD /L1BGMI_S2_SCANSTATUS/ scanStatus
    RECORD /L1BGMI_S2_SAMPLEHEADER/ sampleHeader
    RECORD /NAVIGATION/ navigation
    RECORD /L1BGMI_S2_CALIBRATION/ calibration
    REAL*4 moonVectorInstFrame(3)
    RECORD /L1BGMI_S2_CALCOUNTS/ calCounts
    RECORD /L1BGMI_S2_SUNDATA/ sunData
    REAL*4 incidenceAngle(221)
    REAL*4 satAzimuthAngle(221)
    REAL*4 solarZenAngle(221)
    REAL*4 solarAzimuthAngle(221)
    REAL*4 sunGlintAngle(221)
    REAL*4 Tb(4,221)
    INTEGER*2 RFIFlag(2,221)
END STRUCTURE

STRUCTURE /L1BGMI_S1_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /L1BGMI_S1_CALCOUNTS/
    REAL*4 hotLoadThermisterTemp(11,9)
```

```
    INTEGER*2 hotLoadReading(65,9)
    INTEGER*2 coldLoadReading(85,9)
    INTEGER*2 hotLoadnDiodeReading(65,9)
    INTEGER*2 coldLoadnDiodeReading(85,9)
END STRUCTURE

STRUCTURE /L1BGMI_S1_CALIBRATION/
    REAL*4 hotLoadTemp(9)
    REAL*4 coldSkyTemp(9)
    REAL*4 onOrbitNonLinearity(9)
    REAL*4 derivedNonLinearity(9)
    INTEGER*2 meanHotLoadCount(9)
    INTEGER*2 meanHotLoadCntnDiode(9)
    INTEGER*2 meanColdSkyCount(9)
    INTEGER*2 meanColdSkyCntnDiode(9)
    REAL*4 diodeCoupledTemp(9)
    REAL*4 gain(2,9)
    REAL*4 offset(2,9)
    REAL*4 nonLinearGain(9)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(9)
    REAL*4 receiverGain(9)
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE
```

```
STRUCTURE /L1BGMI_S1_SAMPLEHEADER/
    BYTE blanking
    INTEGER*2 earthViewFirstSample
    INTEGER*2 sampleNumber(4,9)
    INTEGER*4 tachSeconds(32)
    INTEGER*2 tachMicroSeconds(32)
END STRUCTURE

STRUCTURE /L1BGMI_S1_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1BGMI_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    RECORD /L1BGMI_S1_SCANSTATUS/ scanStatus
    RECORD /L1BGMI_S1_SAMPLEHEADER/ sampleHeader
    RECORD /NAVIGATION/ navigation
    RECORD /L1BGMI_S1_CALIBRATION/ calibration
    REAL*4 moonVectorInstFrame(3)
```

```
    RECORD /L1BGMI_S1_CALCOUNTS/ calCounts
    RECORD /L1BGMI_S1_SUNDATA/ sunData
    REAL*4 incidenceAngle(221)
    REAL*4 satAzimuthAngle(221)
    REAL*4 solarZenAngle(221)
    REAL*4 solarAzimuthAngle(221)
    REAL*4 sunGlintAngle(221)
    REAL*4 Tb(9,221)
    INTEGER*2 RFIFlag(5,221)
END STRUCTURE

STRUCTURE /L1BGMI_SWATHS/
    RECORD /L1BGMI_S1/ S1
    RECORD /L1BGMI_S2/ S2
END STRUCTURE
```

5.19 1BKu - Ku Power

The Ku Level-1B product, 1BKu, "Ku Power," is written as a swath structure. The swath name is "NS", for Normal scan Swath. The Ka Level-1B product, 1BKa, is closely related. The scan times in 1BKa are identical to the scan times in 1BKu. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nray	49	Number of angle bins in each scan.
nbin	260	Number of range bins in each ray.

Figure 257 through Figure 266 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains metadata of general interest. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. See Metadata for GPM Products for details.

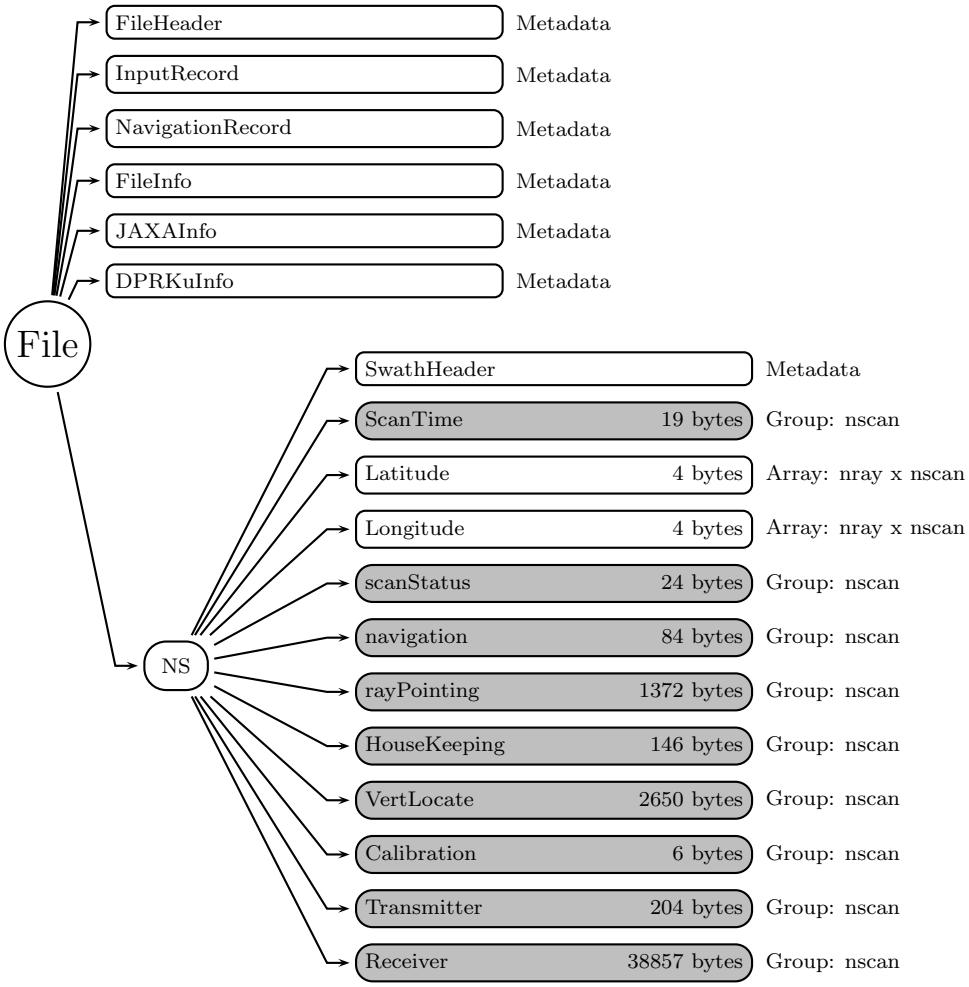


Figure 257: Data Format Structure for 1BKu, Ku Power

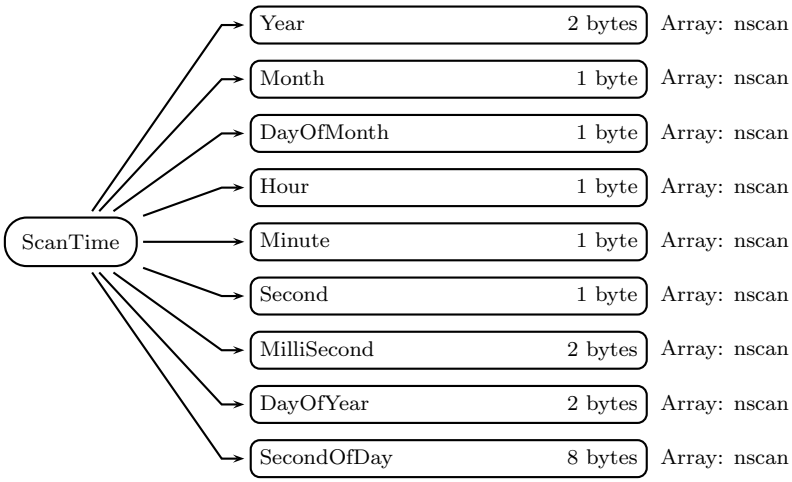


Figure 258: Data Format Structure for 1BKu, ScanTime

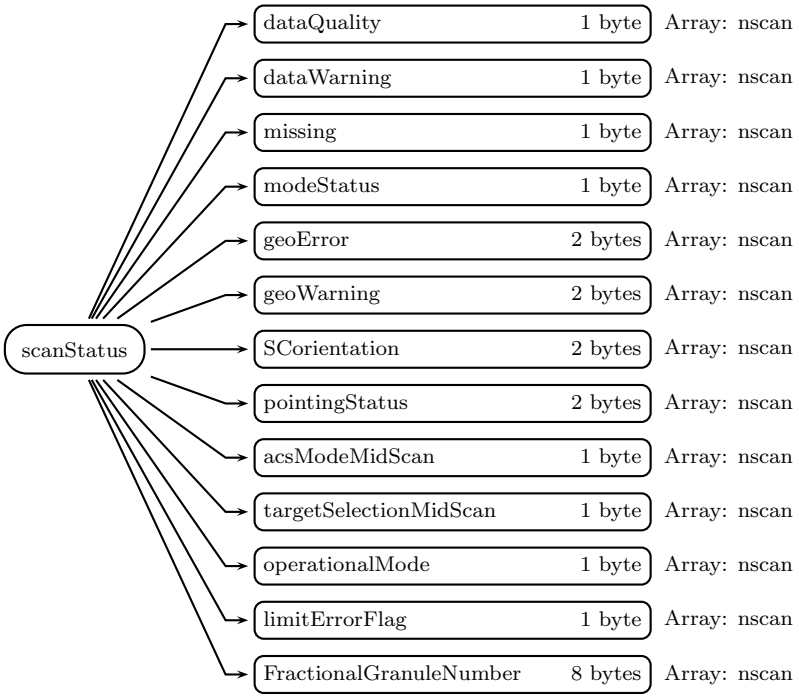


Figure 259: Data Format Structure for 1BKu, scanStatus

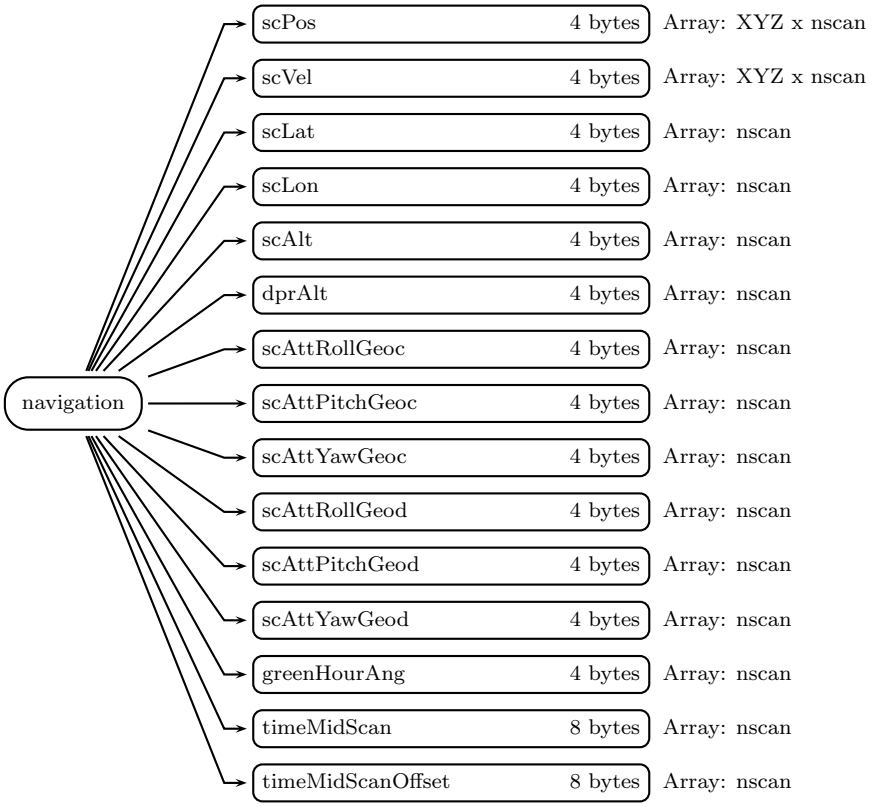


Figure 260: Data Format Structure for 1BKu, navigation

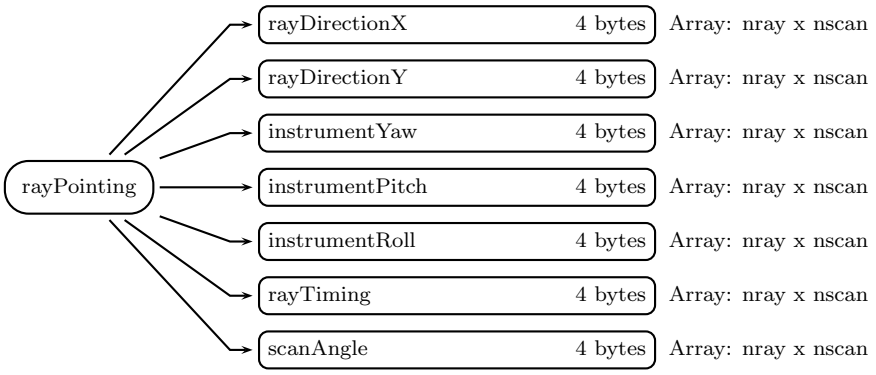


Figure 261: Data Format Structure for 1BKu, rayPointing

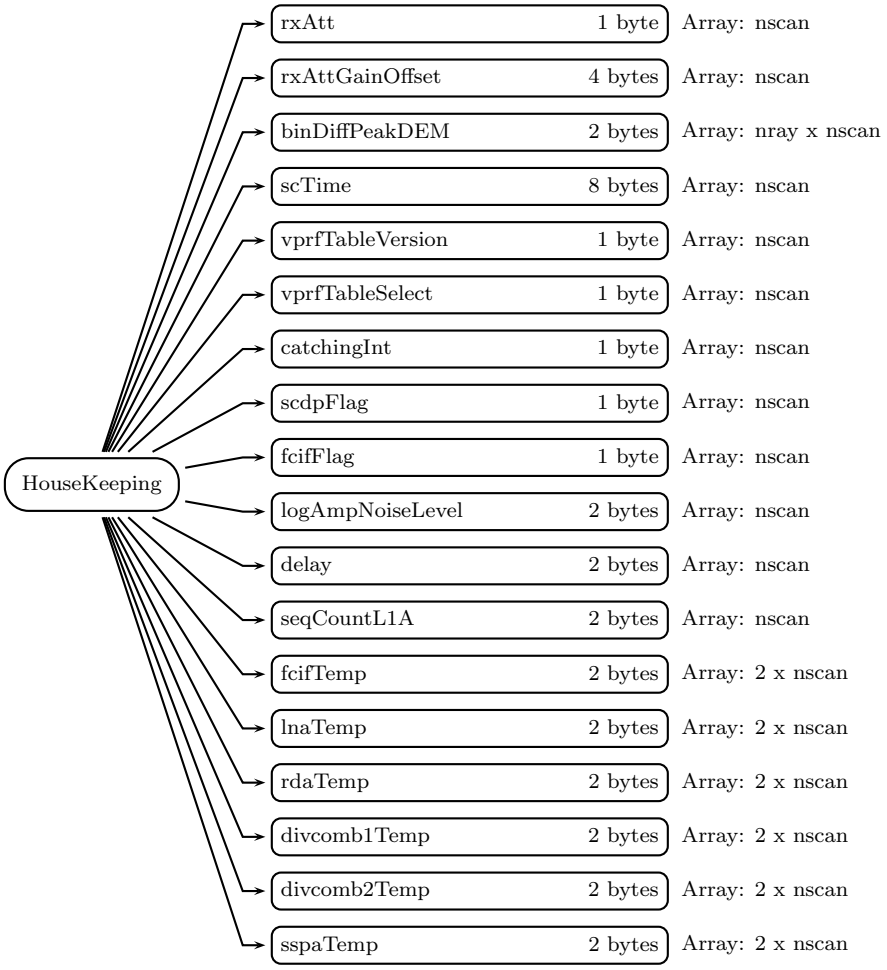


Figure 262: Data Format Structure for 1BKu, HouseKeeping

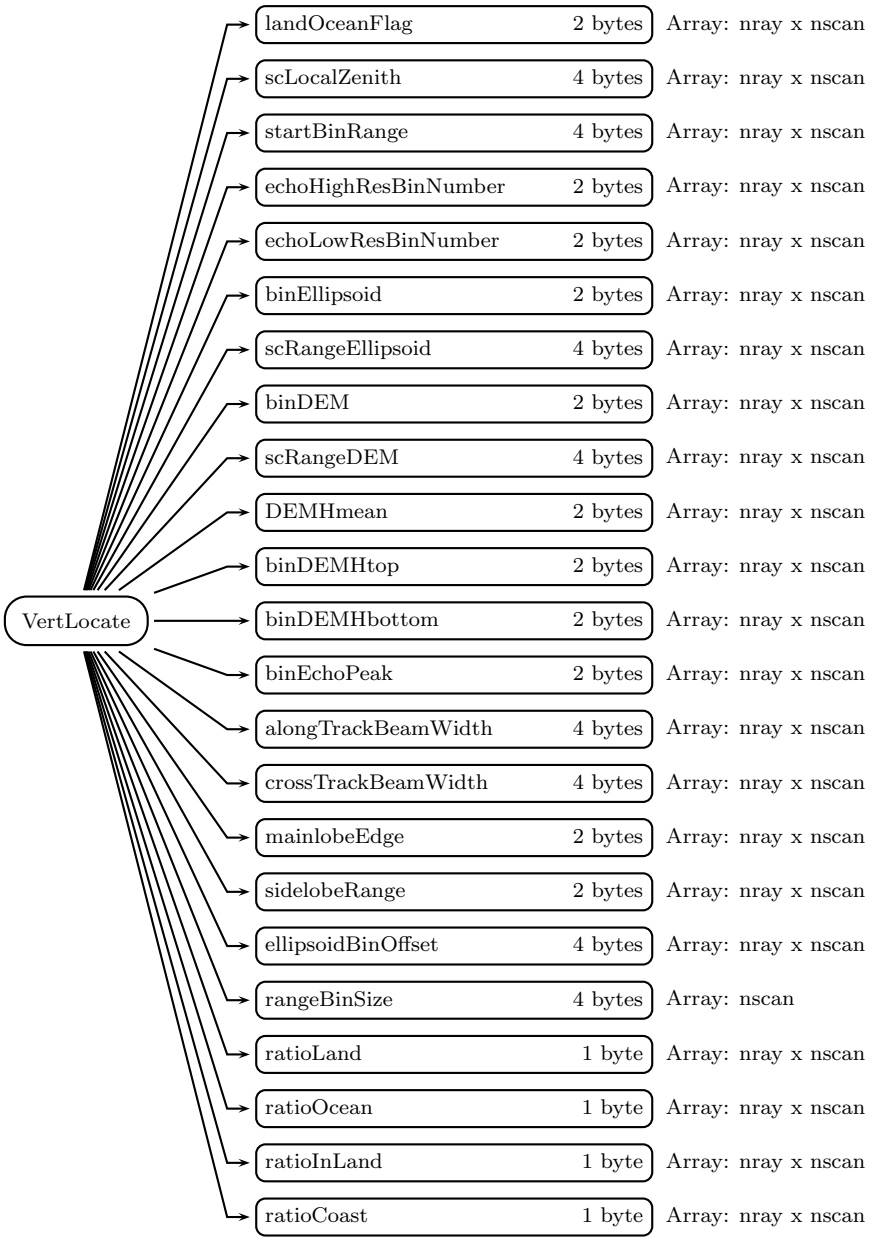


Figure 263: Data Format Structure for 1BKu, VertLocate

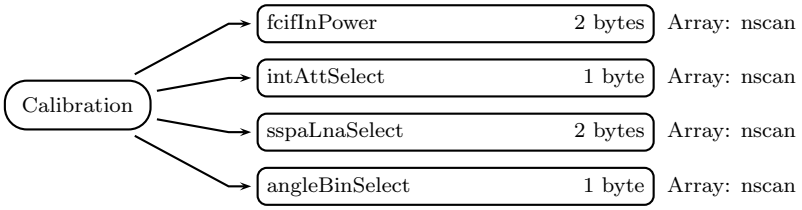


Figure 264: Data Format Structure for 1BKu, Calibration

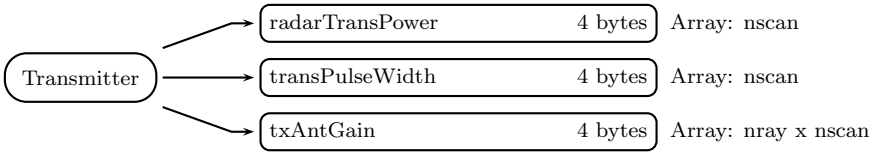


Figure 265: Data Format Structure for 1BKu, Transmitter

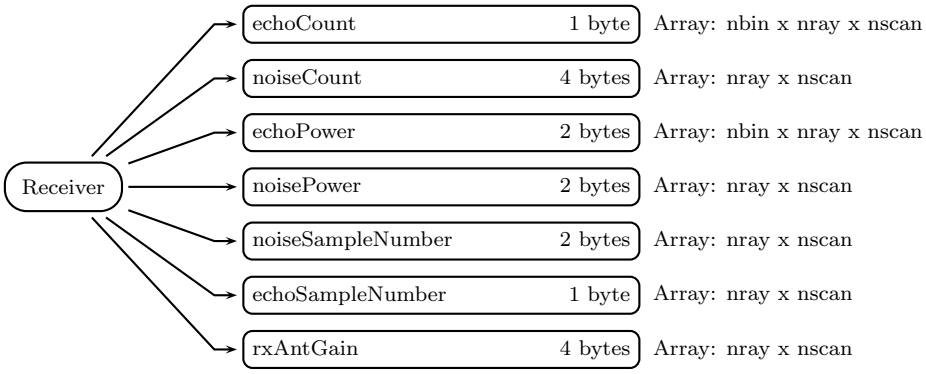


Figure 266: Data Format Structure for 1BKu, Receiver

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

DPRKuInfo (Metadata):
Contains DPR information. See Metadata for GPM Products for details.

NS (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined

as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nray x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nray x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nscan):
Flag of data warning for each scan.

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate

bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
```

```
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):

```
The operational mode of KuPR/KaPR stored in science telemetry.
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
```

```
7     Ku/Ka Standby VPRF Table OUT
8     Ku/Ka Standby Phase Out
9     Ku/Ka Standby Dump Out
10    Ku/Ka Standby (No Science Data)
11    Ku/Ka Independent Observation
12    Ku/Ka Independent External Calibration
13    Ku/Ka Independent Internal Calibration
14    Ku/Ka Independent SSPA Analysis
15    Ku/Ka Independent LNA Analysis
16    Ku/Ka Independent Health-Check
17    Ku/Ka Independent Standby VPRF Table OUT
18    Ku/Ka Independent Standby Phase Out
19    Ku/Ka Independent Standby Dump Out
20    Ku/Ka Independent Standby (No Science Data)
```

limitErrorFlag (1-byte integer, array size: nscan):

```
Bit flags for every ray with information
about echo power limit checks.
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group)

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

rayPointing (Group)

rayDirectionX (4-byte float, array size: nray x nscan):
Unit ray direction x component in mechanical coordinates. Values range from -1.0 to 1.0. Special values are defined as:
-9999.9 Missing value

rayDirectionY (4-byte float, array size: nray x nscan):
Unit ray direction y component in mechanical coordinates. Values range from -1.0 to 1.0. Special values are defined as:
-9999.9 Missing value

instrumentYaw (4-byte float, array size: nray x nscan):
Yaw of mechanical coordinates w.r.t. geodetic coordinates. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

instrumentPitch (4-byte float, array size: nray x nscan):
Pitch of mechanical coordinates w.r.t. geodetic coordinates. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

instrumentRoll (4-byte float, array size: nray x nscan):
Roll of mechanical coordinates w.r.t. geodetic coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

rayTiming (4-byte float, array size: nray x nscan):
The time delay from the secondary header packet time tag to each ray (assumed as mid-time of all radar pulses for the associated rayDirection). Values range from 0 to 1.6 s. Special values are defined as:
-9999.9 Missing value

scanAngle (4-byte float, array size: nray x nscan):
Angle (degrees) of the ray from nominal nadir offset about the mechanical x_axis. The sign of the angle is consistent with the sensor y-axis, i.e., the angle is positive to the right of the direction of travel if the spacecraft is in normal mode. Values range from -18 to 18 degrees. Special values are defined as:
-9999.9 Missing value

HouseKeeping (Group)

rxAtt (1-byte integer, array size: nscan):
The scan number which is determined by the L1A product. Values range from 0 to 12 dB. Special values are defined as:
-99 Missing value

rxAttGainOffset (4-byte float, array size: nscan):
The actual gain of rxAtt considering the temperature dependence. Values are in dB. Special values are defined as:
-9999.9 Missing value

binDiffPeakDEM (2-byte integer, array size: nray x nscan):
The number of range bins between binEchoPeak and binDEM. It is used to ensure that

the VPRF is switched in accordance with the GPM satellite altitude. Values range from -260 to 260 range bin number at NS and MS, from -130 to 130 range bin number at HS respectively. Values range from -260 to 260 range bin number. Special values are defined as:
-9999 Missing value

scTime (8-byte float, array size: nscan):
Scan time expressed as TAI time with and epoch of 0000Z Jan 6, 1980. This time matches the time in ScanTime. Special values are defined as:
-9999.9 Missing value

vprfTableVersion (1-byte integer, array size: nscan):
The version number of VPRF table which is used in L1B process. Values range from 1 to 127 Number. Special values are defined as:
-99 Missing value

vprfTableSelect (1-byte integer, array size: nscan):
The selected number of VPRF table for altitude (h, km) which is used in L1B process. The range is 1 to 25.

```
h LT 396.5 = 1
396.5 LE h LT 397.5 = 2
397.5 LE h LT 398.5 = 3
398.5 LE h LT 399.5 = 4
399.5 LE h LT 400.5 = 5
400.5 LE h LT 401.5 = 6
401.5 LE h LT 402.5 = 7
402.5 LE h LT 403.5 = 8
403.5 LE h LT 404.5 = 9
404.5 LE h LT 405.5 = 10
405.5 LE h LT 406.5 = 11
406.5 LE h LT 407.5 = 12
407.5 LE h LT 408.5 = 13
408.5 LE h LT 409.5 = 14
409.5 LE h LT 410.5 = 15
410.5 LE h LT 411.5 = 16
411.5 LE h LT 412.5 = 17
412.5 LE h LT 413.5 = 18
413.5 LE h LT 414.5 = 19
414.5 LE h LT 415.5 = 20
415.5 LE h LT 416.5 = 21
416.5 LE h LT 417.5 = 22
417.5 LE h LT 418.5 = 23
418.5 LE h LT 419.5 = 24
419.5 LE h = 25
```

```
where
LT mean less than and
LE means less than or equal to
```

catchingInt (1-byte integer, array size: nscan):
The timing that receive window is open for the first reflected TX pulse. If catchingInt is set to 12, then the first TX pulse is received with receive window after the twelfth TX pulse. In the case of nominal operation, catchingInt is set to 12, that is, the VPRF table is used. In other cases, including GPS-status trouble, catchingInt is set 8 and limited PRF is loaded. Values range from 8 to 12 Number. Special values are defined as:
-99 Missing value

scdpFlag (1-byte integer, array size: nscan):
The side of the SCDP system and system table used.

```
Bit Meaning if bit=1
0   B-side is used (if bit=0, then A-side used)
1   Priority is 1 at Basic System Table. Refer to Basic System Table.
2   Priority is 2 at Basic System Table. Refer to HK telemetry.
3   Priority is 2 at Basic System Table. Refer to Basic System Table.
4   (Spare)
5   (Spare)
6   (Spare)
7   (Spare)
```

fcifFlag (1-byte integer, array size: nscan):
The side of FCIF system and the system table used.

```
Bit Meaning if bit=1
0   B-side is used (if bit=0, then A-side used)
1   Priority is 1 at Basic System Table. Refer to Basic System Table.
2   Priority is 2 at Basic System Table. Refer to HK telemetry
3   Priority is 2 at Basic System Table. Refer to Basic System Table
4   (Spare)
5   (Spare)
6   (Spare)
7   (Spare)
```

logAmpNoiseLevel (2-byte integer, array size: nscan):
The Noise Level at Log Amp Termination which is stored in science telemetry. Values are in dBM. Special values are defined as:
-9999 Missing value

delay (2-byte integer, array size: nscan):
The timing offset value from space craft time in NS. In MS and HS, it is defined as offset

time value from the base delay time. They are used to adjust for beam matching of along track direction. Values range from 0 to 3360 counts. Special values are defined as:
-9999 Missing value

seqCountL1A (2-byte integer, array size: nscan):
The scan number which is determined by the L1A product. Values range from 0 to 27000 counts. Special values are defined as:
-9999 Missing value

fcifTemp (2-byte integer, array size: 2 x nscan):
The temperature of FCIF component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

lnaTemp (2-byte integer, array size: 2 x nscan):
The temperature of LNA component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C.

rdaTemp (2-byte integer, array size: 2 x nscan):
he temperature of RDA component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C Attenuator setting levels of Received radar antenna.Values are 0, 3, 6, 9 and 12 in dB. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

divcomb1Temp (2-byte integer, array size: 2 x nscan):
The temperature of divcomb2, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

divcomb2Temp (2-byte integer, array size: 2 x nscan):
The temperature of divcomb2, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

sspaTemp (2-byte integer, array size: 2 x nscan):
The temperature of RDA component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is

-50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

VertLocate (Group)

landOceanFlag (2-byte integer, array size: nray x nscan):
Land or ocean information. The values of the flag are:

```
0 = Water
1 = Land
2 = Coast
3 = Inland Water
```

scLocalZenith (4-byte float, array size: nray x nscan):
The angle, in degrees, between the local zenith and the beam's center line. The local (geodetic) zenith at the intersection of the ray and the earth ellipsoid is used. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

startBinRange (4-byte float, array size: nray x nscan):
The distance from the satellite to the center of the first range bin. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

echoHighResBinNumber (2-byte integer, array size: nray x nscan):
The number of sampling without thinning out (over sampling).. Range of 1-260 for NS and MS and 1-130 at HS. EDIT Values range from 1 to 260 range bin number. Special values are defined as:
-9999 Missing value

```
Meaning in Normal Mode:
0 = Over sampling range bin OR
1 = Normal sampling range bin
2 = Interpolated range bin
-99 = Outrange bin of the observation area
Meaning in internal calibration mode:
0: In internal calibration mode, this value is stored 1- 42 range bin for each
ray.
-99: missing value. In internal calibration mode, this value is stored after 43
range bin for each ray as missing.
```

echoLowResBinNumber (2-byte integer, array size: nray x nscan):
The number of sampling after thinning out the normal sample. From 1 to 260 range bin number at NS and MS while from 1 to 130 at HS. Values range from 0 to 260 range bin

number. Special values are defined as:
-9999 Missing value

binEllipsoid (2-byte integer, array size: nray x nscan):
The range bin number of the earth ellipsoid. Values range from 1 to 260 range bin number. Special values are defined as:
-9999 Missing value

scRangeEllipsoid (4-byte float, array size: nray x nscan):
The distance from instrument to ellipsoid calculated by GeoTK. Values range from 0 to 500000 m. Special values are defined as:
-9999.9 Missing value

binDEM (2-byte integer, array size: nray x nscan):
Range bin number of the average DEM surface elevation in a box centered on the IFOV. Reference width is 5 km x 5 km. Reference number of pixels in the direction of latitude is 7. On the other hand, the number of pixels in the direction of longitude reference is changed to 21-7 by latitude. Values range from 1 to 260 range bin number at NS and MS while from 1 to 130 at HS. Special value is -9999 for missing scan, internal calbration mode, or in case DEM is missing.

scRangeDEM (4-byte float, array size: nray x nscan):
The value is calculted as scRangeEllipsoid - DEMHmean secand(localZenithAngle). Values range from 0 to 500000 m. Special values are defined as:
-9999.9 Missing value

DEMHmean (2-byte integer, array size: nray x nscan):
Averaged DEM height, whose SRTM-30. Values range from 0 to 9000 m. Special values are defined as:
-9999 Missing value

binDEMHtop (2-byte integer, array size: nray x nscan):
The range bin number of the maximum DEM surface elevation in a box centered on the IFOV. Reference width is 5 km x 5 km. Reference number of pixels in the direction of latitude is 7. On the other hand, the number of pixels in the direction of longitude reference is changed to 21-7 by latitude. Values range from 1 to 260 range bin number at NS and MS, from 1 to 130 at HS. Special value is -9999 for missing scan, internal calbration mode, or in case DEM is missing. The first dimension is the box size, with sizes of 5 km x 5 km and 11 km x 11km.

binDEMHbottom (2-byte integer, array size: nray x nscan):
The range bin number of the minimum DEM surface elevation in a box centered on the IFOV. Reference width is 5 km x 5 km. Reference number of pixels in the direction of latitude is 7. On the other hand, the number of pixels in the direction of longitude reference is changed to 21-7 by latitude. Values range from 1 to 260 range bin number at NS and MS, from 1 to 130 at HS. Special value is -9999 for missing scan, internal calbration mode, or in case DEM is missing. The first dimension is the box size, with sizes of 5 km x 5 km and 11 km x 11km.

binEchoPeak (2-byte integer, array size: nray x nscan):
The range bin number which has maximum echoPower in each scan and each angle bin. Values range from 1 to 260 range bin number. Special values are defined as:
-9999 Missing value

alongTrackBeamWidth (4-byte float, array size: nray x nscan):
Radar beamwidth (degrees) at the point transmitted power reaches one half of peak power in the along-track direction.

crossTrackBeamWidth (4-byte float, array size: nray x nscan):
Radar beamwidth (degrees) at the point transmitted power reaches one half of peak power along the cross-track direction.

mainlobeEdge (2-byte integer, array size: nray x nscan):
Absolute value of the difference in Range Bin Numbers between the detected surface and the edge of the clutter from the mainlobe.

sidelobeRange (2-byte integer, array size: nray x nscan):
Absolute value of the difference in Range Bin Numbers between the detected surface and the clutter psition from the sidelobe. A zero means no clutter indicated in this field since less than 3 bins contained significant clutter.

ellipsoidBinOffset (4-byte float, array size: nray x nscan):
The distance between center of binEllipsoid range bin and Ellipsoid position.

rangeBinSize (4-byte float, array size: nscan):
The range bin size. With VPRF, the size for NS and MS is 250.32670 m and for HS 250.32670 m. With limited PRF, the size is 250.32670 m for all three swaths.

ratioLand (1-byte integer, array size: nray x nscan):
Ratio of land area to total area in a footprint.

ratioOcean (1-byte integer, array size: nray x nscan):
Ratio of ocean area to total area in a footprint.

ratioInLand (1-byte integer, array size: nray x nscan):
Ratio of inland water area to total area in a footprint.

ratioCoast (1-byte integer, array size: nray x nscan):
Ratio of coast area to total area in a footprint.

Calibration (Group)

fcifInPower (2-byte integer, array size: nscan):
Input power value of FCIF and is set at internal calibration mode. At another mode, the value of fcifInPower is set as missing. Values are in 0.01 dBm. Special values are defined as:
-32734 Missing value

intAttSelect (1-byte integer, array size: nscan):
The selected number of internal attenuation that is controlled automatically with 32 steps and is set by internal mode. At another mode, the value of fcifInPower is set as missing. Values range from 1 to 32 step. Special values are defined as:
-99 Missing value

sspaLnaSelect (2-byte integer, array size: nscan):
In SSPA mode, sspaLnaSelect stores the number of LNA. In LNA mode, sspaLnaSelect stores the number of SSPA. In other modes, sspaLnaSelect is given the missing value. Values range from 1 to 128 Number. Special values are defined as:
-9999 Missing value

angleBinSelect (1-byte integer, array size: nscan):
In SSPA and LNA mode, angleBinSelect contains the selected beam number. In other operational modes, angleBinSelect is set to missing. Values range from 1 to 49 Number. Special values are defined as:
-99 Missing value

Transmitter (Group)

radarTransPower (4-byte float, array size: nscan):
The total (sum) power of 128 SSPA elements corrected with SSPA temperature in orbit. It is based on ground test temperature data of SSPA transmission power. Special value -9999.9 for missing scan and internal calibration mode.

transPulseWidth (4-byte float, array size: nscan):
Transmitted pulse width corrected with FCIF temperature in orbit, based on temperature test data of FCIF. Values range from 0.0000015 to 0.0000017 s. Special value -9999.9 for missing scan and internal calibration mode.

txAntGain (4-byte float, array size: nray x nscan):
Transmitted radar antenna effectiveness (dB). Special value -9999.9 for missing scan and internal calibration mode.

Receiver (Group)

echoCount (1-byte char, array size: nbin x nray x nscan):
The total signal count at the antenna input that includes both echo and noise power. The signal count is stored on both observation mode and calibration mode. It is basically a copy of science telemetry raw data for sampling range bins. 0 is set to both interpolated range bin and outrange bin of the observation area.

noiseCount (4-byte float, array size: nray x nscan):
An average of the received noise count for each angle bins during suspended 4 pulses. The value -9999.9 means missing scan and inernal calibration mode.

echoPower (2-byte integer, array size: nbin x nray x nscan):
The total signal power at the antenna input that includes both echo and noise power. The numerical value of echoPower is 100 times the power expressed in dBm when the data is valid. Values between -12000 and -2000, which correspond to the power between -120 dBm and -20 dBm, are the valid values. If the echoPower is measured outside the receiving range window that depends on the pulse repetition frequency, -29999 is stored. If the data is not valid for other reasons, -30000 is stored.

```
Special values:
"Count value": internal calibration mode.
-29999 : Outrange bins of the observation area.
-30000 : Missing value
```

noisePower (2-byte integer, array size: nray x nscan):
An average of the received noise power for each angle bins during suspended 4 pulses. Values in dBm are multiplied by 100 and stored in the file as a 2-byte integer. The unit in the file is thus 0.01 dBm. The range is -120 dBm to -20 dBm which corresponds to values in the file from -12000 to -2000. The value -30000 means missing scan and internal calibration mode.

noiseSampleNumber (2-byte integer, array size: nray x nscan):
The number of noise samplings. This value is considered with frequency agility, the number of noise sampling pulse and sampling dependency, so the value is the quadruple of the value defined by the VPRF table. Values range from 0 to 1000 Number. Special value -9999 for missing and internal calibration mode.

echoSampleNumber (1-byte integer, array size: nray x nscan):
The number of received pulse. This value is considered with frequency agility so the value is the double of the value defined by the VHRF table. Values range from 0 to 120 Number. Special values are defined as:

48	Internal Calibration Mode
-99	Missing scan

rxAntGain (4-byte float, array size: nray x nscan):
Received radar antenna effectiveness (dB). Special value -9999.9 for missing scan and internal calibration mode.

C Structure Header file:

```
#ifndef _TK_1BKu_H_
#define _TK_1BKu_H_
```

```
#ifndef _L1BKu_RECEIVER_
#define _L1BKu_RECEIVER_

typedef struct {
    unsigned char echoCount[49][260];
    float noiseCount[49];
    short echoPower[49][260];
    short noisePower[49];
    short noiseSampleNumber[49];
    signed char echoSampleNumber[49];
    float rxAntGain[49];
} L1BKu_RECEIVER;

#endif

#ifndef _L1BKu_TRANSMITTER_
#define _L1BKu_TRANSMITTER_

typedef struct {
    float radarTransPower;
    float transPulseWidth;
    float txAntGain[49];
} L1BKu_TRANSMITTER;

#endif

#ifndef _L1BKu_CALIBRATION_
#define _L1BKu_CALIBRATION_

typedef struct {
    short fcifInPower;
    signed char intAttSelect;
    short sspaLnaSelect;
    signed char angleBinSelect;
} L1BKu_CALIBRATION;

#endif

#ifndef _L1BKu_VERTLOCATE_
#define _L1BKu_VERTLOCATE_

typedef struct {
    short landOceanFlag[49];
```

```
    float scLocalZenith[49];
    float startBinRange[49];
    short echoHighResBinNumber[49];
    short echoLowResBinNumber[49];
    short binEllipsoid[49];
    float scRangeEllipsoid[49];
    short binDEM[49];
    float scRangeDEM[49];
    short DEMHmean[49];
    short binDEMHtop[49];
    short binDEMHbottom[49];
    short binEchoPeak[49];
    float alongTrackBeamWidth[49];
    float crossTrackBeamWidth[49];
    short mainlobeEdge[49];
    short sidelobeRange[49];
    float ellipsoidBinOffset[49];
    float rangeBinSize;
    signed char ratioLand[49];
    signed char ratioOcean[49];
    signed char ratioInLand[49];
    signed char ratioCoast[49];
} L1BKu_VERTLOCATE;

#endif

#ifndef _L1BKu_HOUSEKEEPING_
#define _L1BKu_HOUSEKEEPING_

typedef struct {
    signed char rxAtt;
    float rxAttGainOffset;
    short binDiffPeakDEM[49];
    double scTime;
    signed char vprfTableVersion;
    signed char vprfTableSelect;
    signed char catchingInt;
    signed char scdpFlag;
    signed char fcifFlag;
    short logAmpNoiseLevel;
    short delay;
    short seqCountL1A;
    short fcifTemp[2];
```

```
    short lnaTemp[2];
    short rdaTemp[2];
    short divcomb1Temp[2];
    short divcomb2Temp[2];
    short sspaTemp[2];
} L1BKu_HOUSEKEEPING;

#endif

#ifndef _L1BKu_RAYPOINTING_
#define _L1BKu_RAYPOINTING_

typedef struct {
    float rayDirectionX[49];
    float rayDirectionY[49];
    float instrumentYaw[49];
    float instrumentPitch[49];
    float instrumentRoll[49];
    float rayTiming[49];
    float scanAngle[49];
} L1BKu_RAYPOINTING;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
```

```
} NAVIGATION;

#endif

#ifndef _L1BKu_SCANSTATUS_
#define _L1BKu_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char dataWarning;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    signed char limitErrorFlag;
    double FractionalGranuleNumber;
} L1BKu_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1BKu_NS_
```

```
#define _L1BKu_NS_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[49];
    float Longitude[49];
    L1BKu_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L1BKu_RAYPOINTING rayPointing;
    L1BKu_HOUSEKEEPING HouseKeeping;
    L1BKu_VERTLOCATE VertLocate;
    L1BKu_CALIBRATION Calibration;
    L1BKu_TRANSMITTER Transmitter;
    L1BKu_RECEIVER Receiver;
} L1BKu_NS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1BKu_RECEIVER/
    CHARACTER echoCount(260,49)
    REAL*4 noiseCount(49)
    INTEGER*2 echoPower(260,49)
    INTEGER*2 noisePower(49)
    INTEGER*2 noiseSampleNumber(49)
    BYTE echoSampleNumber(49)
    REAL*4 rxAntGain(49)
END STRUCTURE

STRUCTURE /L1BKu_TRANSMITTER/
    REAL*4 radarTransPower
    REAL*4 transPulseWidth
    REAL*4 txAntGain(49)
END STRUCTURE

STRUCTURE /L1BKu_CALIBRATION/
    INTEGER*2 fcifInPower
    BYTE intAttSelect
    INTEGER*2 sspaLnaSelect
    BYTE angleBinSelect
```

```
END STRUCTURE

STRUCTURE /L1BKu_VERTLOCATE/
    INTEGER*2 landOceanFlag(49)
    REAL*4 scLocalZenith(49)
    REAL*4 startBinRange(49)
    INTEGER*2 echoHighResBinNumber(49)
    INTEGER*2 echoLowResBinNumber(49)
    INTEGER*2 binEllipsoid(49)
    REAL*4 scRangeEllipsoid(49)
    INTEGER*2 binDEM(49)
    REAL*4 scRangeDEM(49)
    INTEGER*2 DEMHmean(49)
    INTEGER*2 binDEMHtop(49)
    INTEGER*2 binDEMHbottom(49)
    INTEGER*2 binEchoPeak(49)
    REAL*4 alongTrackBeamWidth(49)
    REAL*4 crossTrackBeamWidth(49)
    INTEGER*2 mainlobeEdge(49)
    INTEGER*2 sidelobeRange(49)
    REAL*4 ellipsoidBinOffset(49)
    REAL*4 rangeBinSize
    BYTE ratioLand(49)
    BYTE ratioOcean(49)
    BYTE ratioInLand(49)
    BYTE ratioCoast(49)
END STRUCTURE

STRUCTURE /L1BKu_HOUSEKEEPING/
    BYTE rxAtt
    REAL*4 rxAttGainOffset
    INTEGER*2 binDiffPeakDEM(49)
    REAL*8 scTime
    BYTE vprfTableVersion
    BYTE vprfTableSelect
    BYTE catchingInt
    BYTE scdpFlag
    BYTE fcifFlag
    INTEGER*2 logAmpNoiseLevel
    INTEGER*2 delay
    INTEGER*2 seqCountL1A
    INTEGER*2 fcifTemp(2)
    INTEGER*2 lnaTemp(2)
```

```
    INTEGER*2 rdaTemp(2)
    INTEGER*2 divcomb1Temp(2)
    INTEGER*2 divcomb2Temp(2)
    INTEGER*2 sspaTemp(2)
END STRUCTURE

STRUCTURE /L1BKu_RAYPOINTING/
    REAL*4 rayDirectionX(49)
    REAL*4 rayDirectionY(49)
    REAL*4 instrumentYaw(49)
    REAL*4 instrumentPitch(49)
    REAL*4 instrumentRoll(49)
    REAL*4 rayTiming(49)
    REAL*4 scanAngle(49)
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L1BKu_SCANSTATUS/
    BYTE dataQuality
    BYTE dataWarning
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
```

```
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    BYTE limitErrorFlag
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1BKu_NS/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(49)
    REAL*4 Longitude(49)
    RECORD /L1BKu_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L1BKu_RAYPOINTING/ rayPointing
    RECORD /L1BKu_HOUSEKEEPING/ HouseKeeping
    RECORD /L1BKu_VERTLOCATE/ VertLocate
    RECORD /L1BKu_CALIBRATION/ Calibration
    RECORD /L1BKu_TRANSMITTER/ Transmitter
    RECORD /L1BKu_RECEIVER/ Receiver
END STRUCTURE
```

5.20 1BKa - Ka Power

The Ka Level-1B product, 1BKa, "Ka Power," is written as a two-swath structure. The first swath is MS for Matched beam scan Swath. MS contains rays that match the middle 25 1BKu rays in location. The second swath is HS for High sensitivity beam scan Swath. HS contains high sensitivity rays which are close to the middle 25 1BKu rays in location. The Ku Level-1B product, 1BKu, is closely related. The scanTime in 1BKu is identical to the scanTime in 1BKa. The following sections describe the structure and contents of the format.

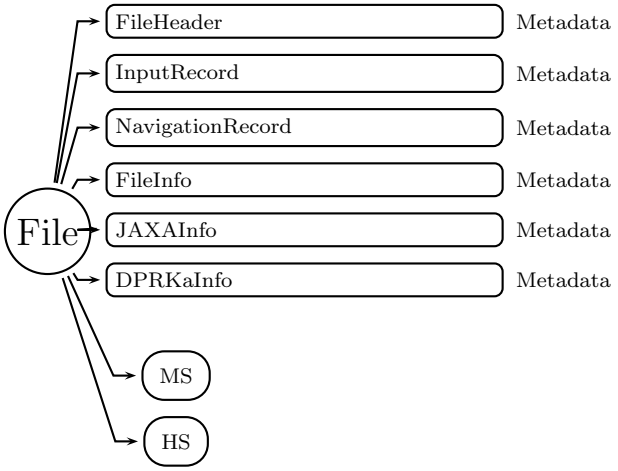


Figure 267: Data Format Structure for 1BKa, Ka Power

Dimension definitions:

nscan	var	Number of scans in the granule.
nrayMS	25	Number of rays (angle bins) in each Matched scan.
nbinMS	260	Number of range bins in each Matched angle bin.
nrayHS	24	Number of rays (angle bins) in each High Sensitivity scan.
nbinHS	130	Number of range bins in each High Sensitivity angle bin.

Figure 267 through Figure 287 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

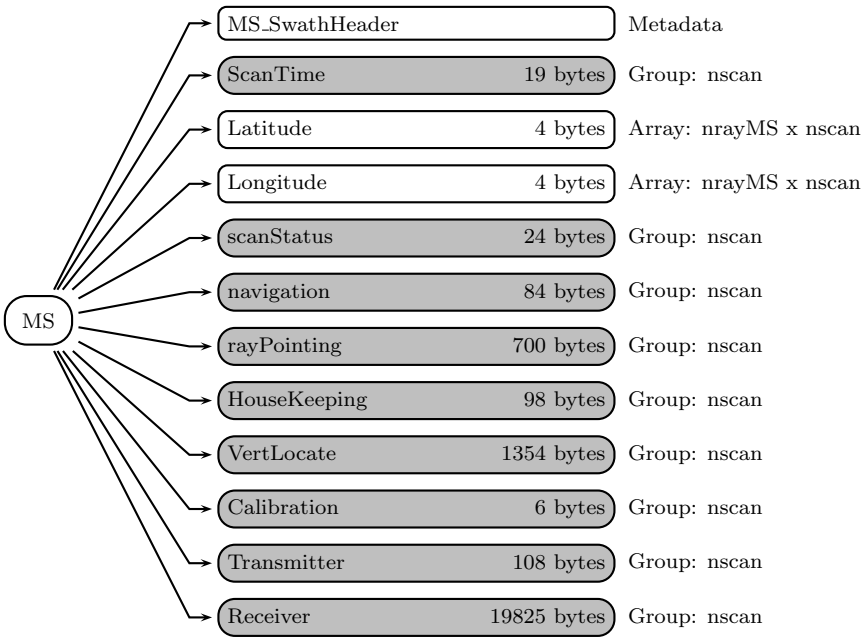


Figure 268: Data Format Structure for 1BKa, MS

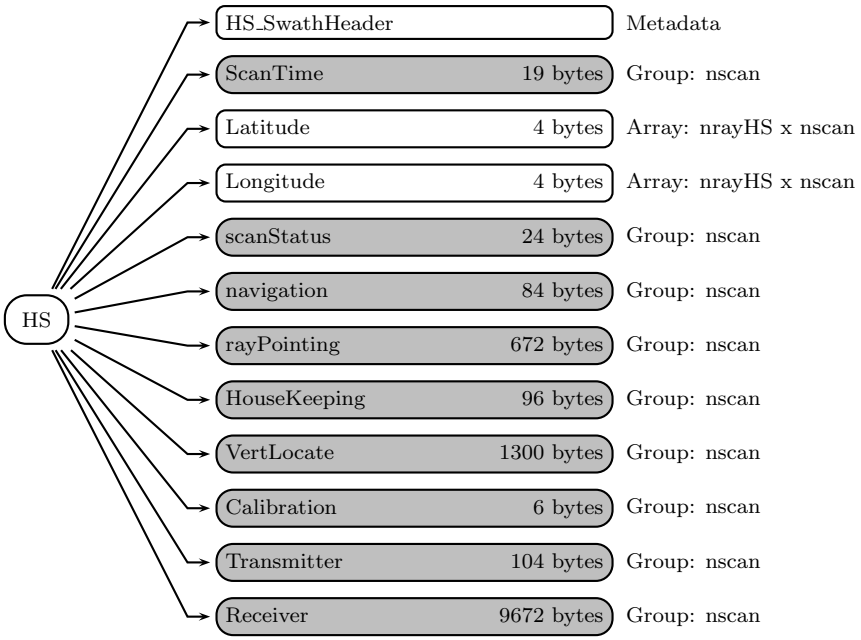


Figure 269: Data Format Structure for 1BKa, HS

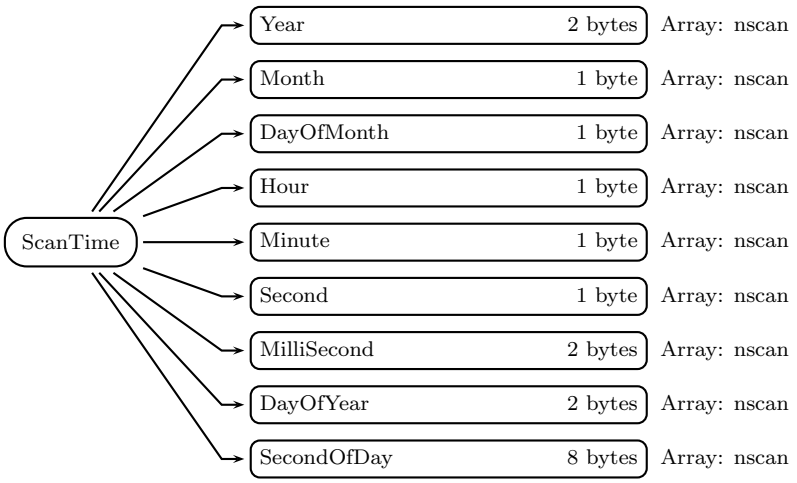


Figure 270: Data Format Structure for 1BKa, MS, ScanTime

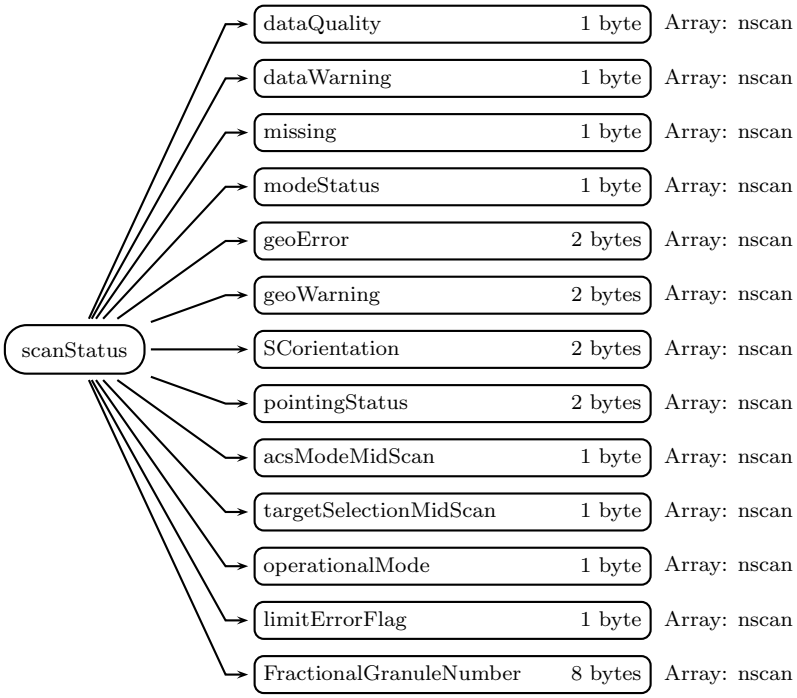


Figure 271: Data Format Structure for 1BKa, MS, scanStatus

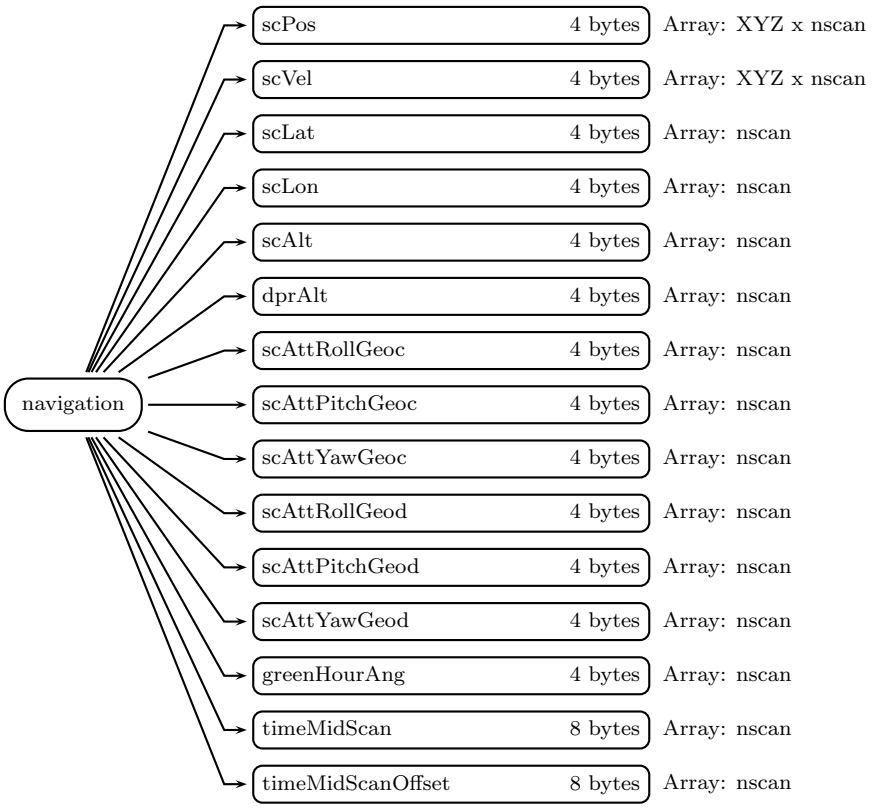


Figure 272: Data Format Structure for 1BKa, MS, navigation

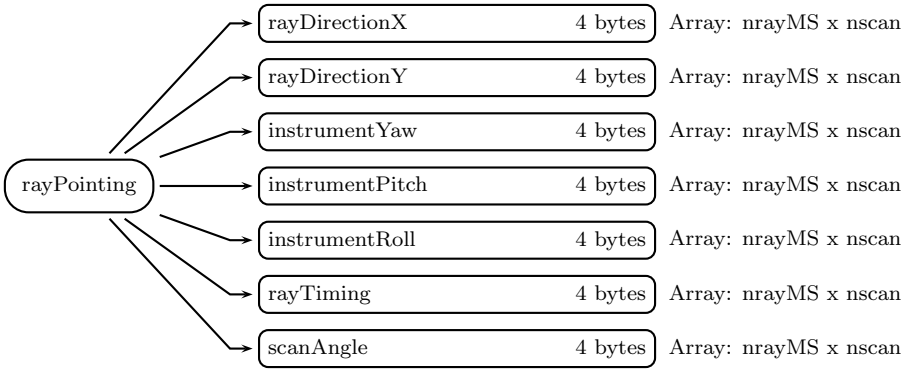


Figure 273: Data Format Structure for 1BKa, MS, rayPointing

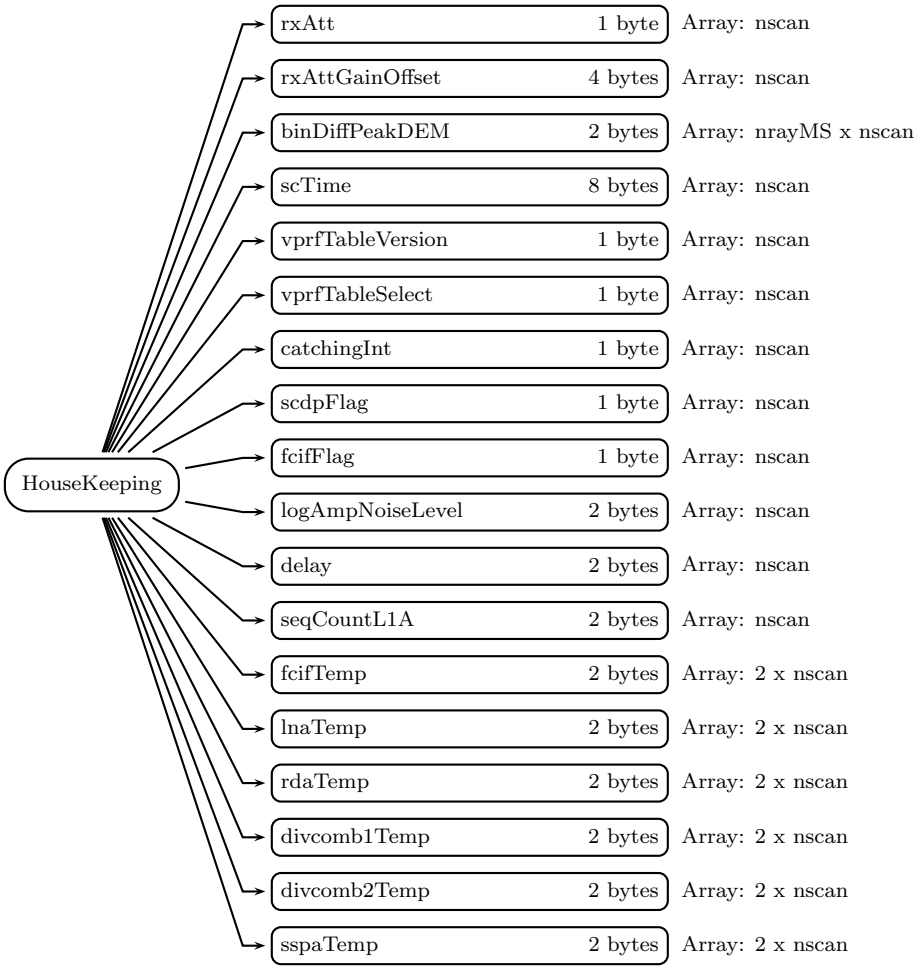


Figure 274: Data Format Structure for 1BKa, MS, HouseKeeping

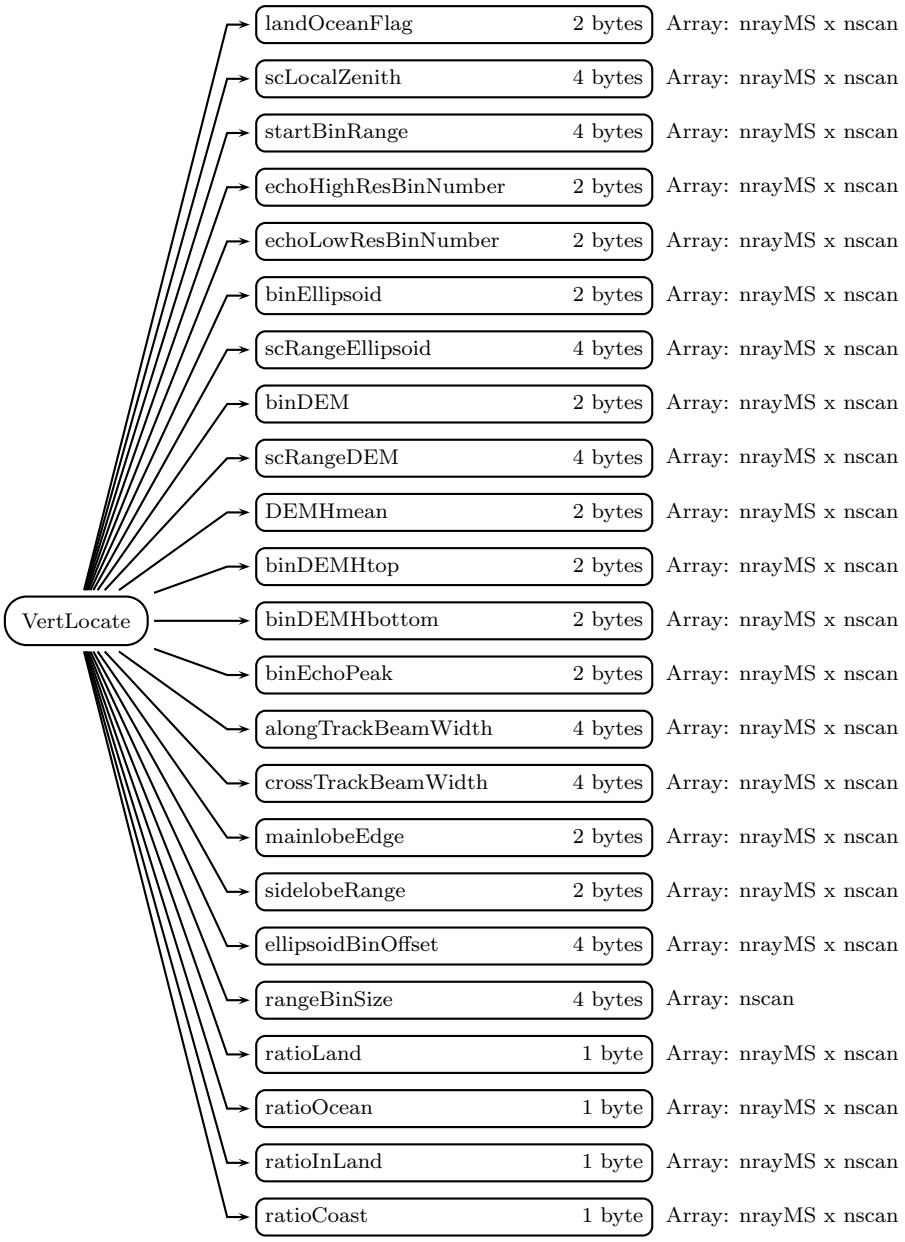


Figure 275: Data Format Structure for 1BKa, MS, VertLocate

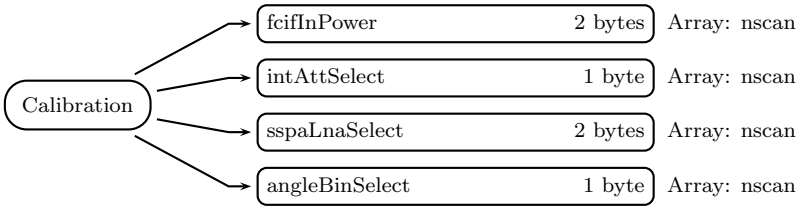


Figure 276: Data Format Structure for 1BKa, MS, Calibration

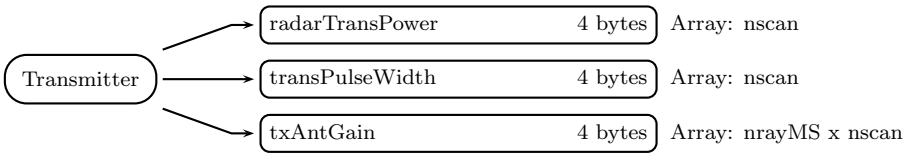


Figure 277: Data Format Structure for 1BKa, MS, Transmitter

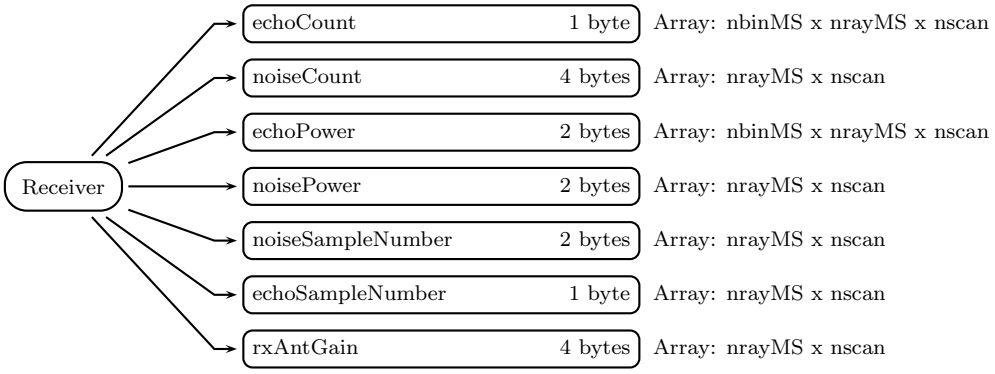


Figure 278: Data Format Structure for 1BKa, MS, Receiver

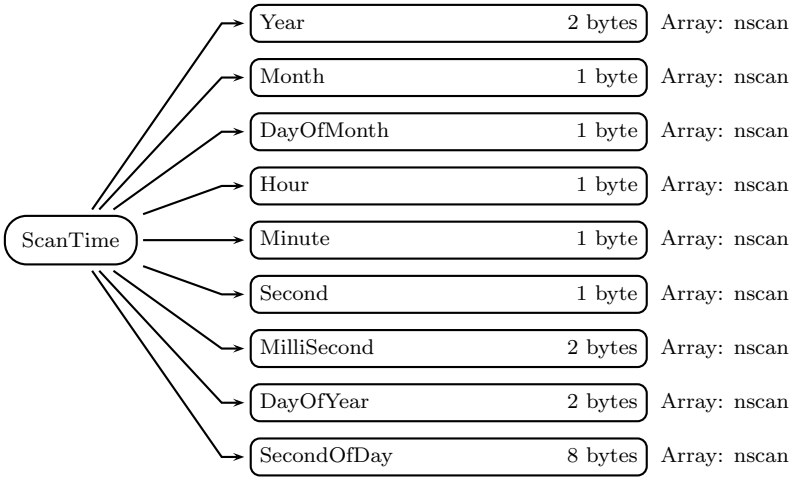


Figure 279: Data Format Structure for 1BKa, HS, ScanTime

FileHeader (Metadata):
FileHeader contains metadata of general interest. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

DPRKaInfo (Metadata):
Contains DPR information. See Metadata for GPM Products for details.

MS (Swath)

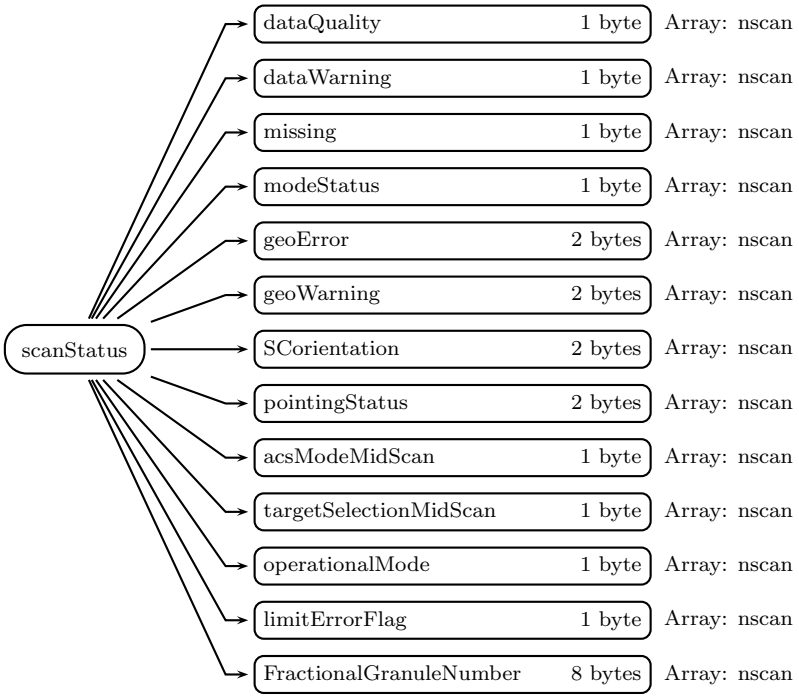


Figure 280: Data Format Structure for 1BKa, HS, scanStatus

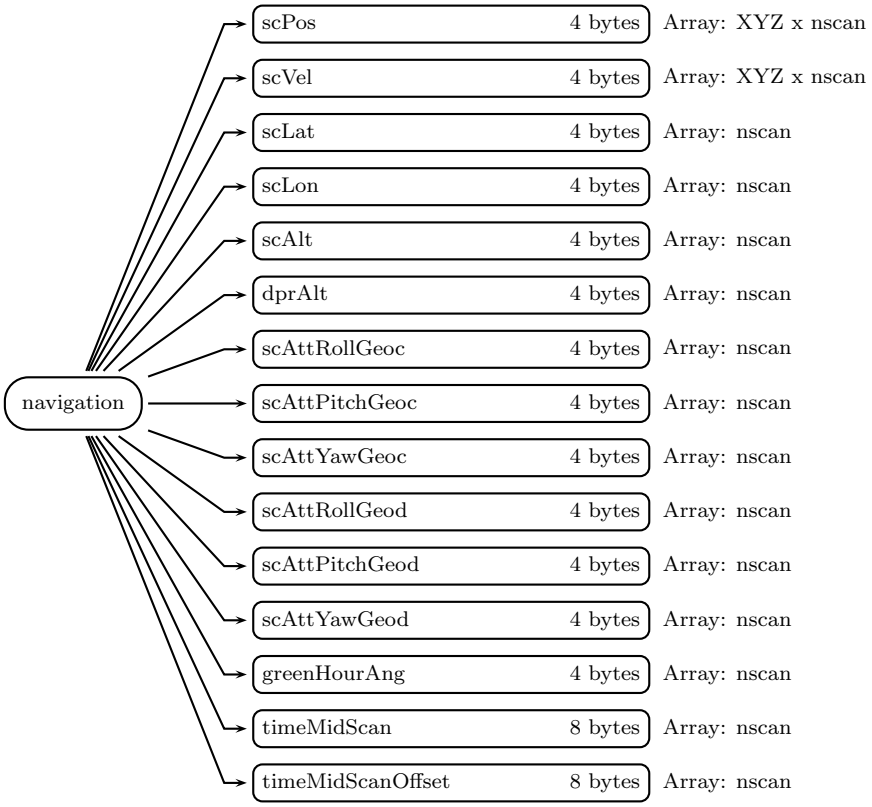


Figure 281: Data Format Structure for 1BKa, HS, navigation

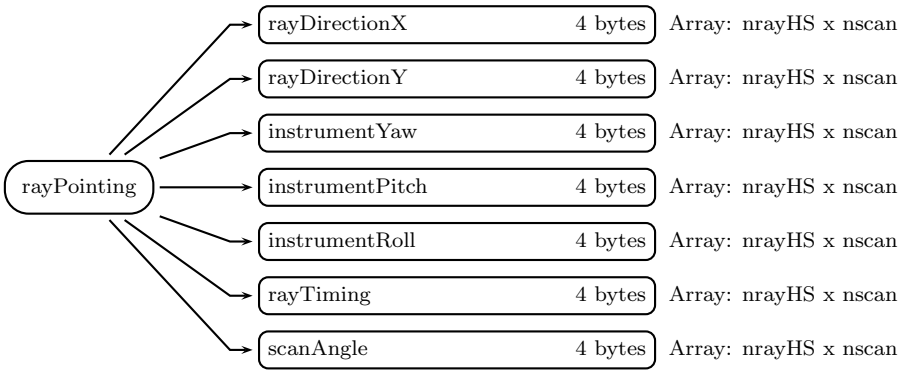


Figure 282: Data Format Structure for 1BKa, HS, rayPointing

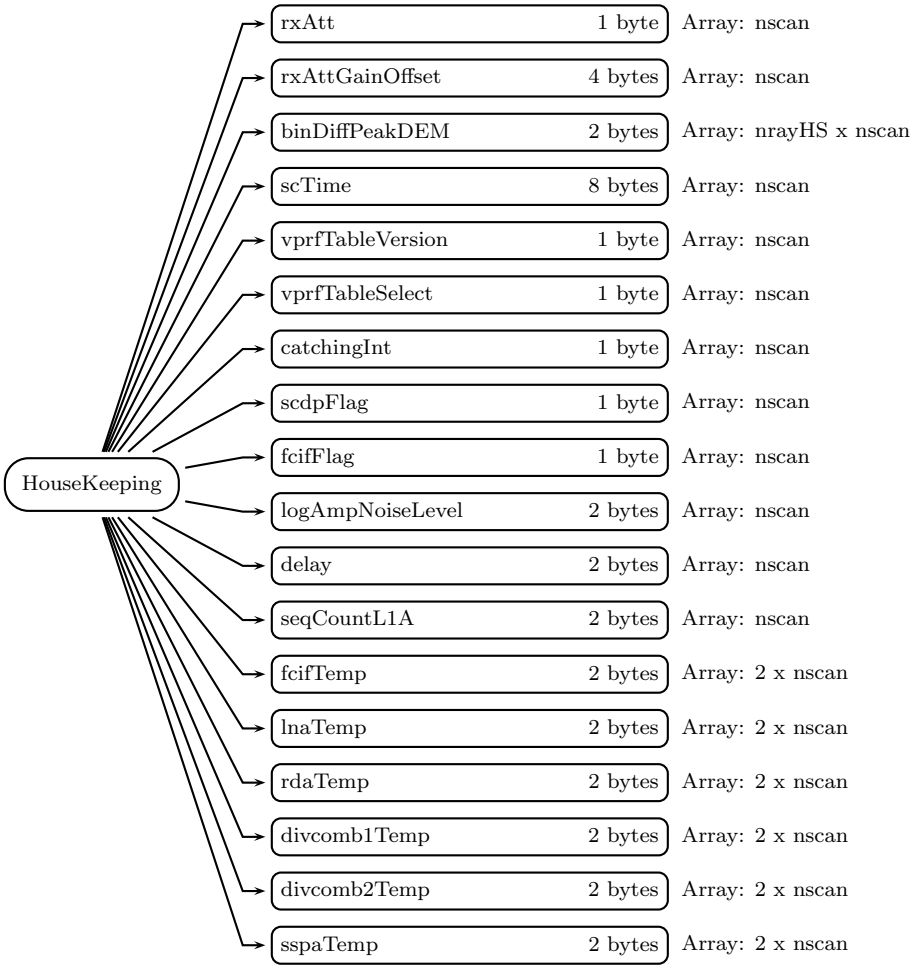


Figure 283: Data Format Structure for 1BKa, HS, HouseKeeping

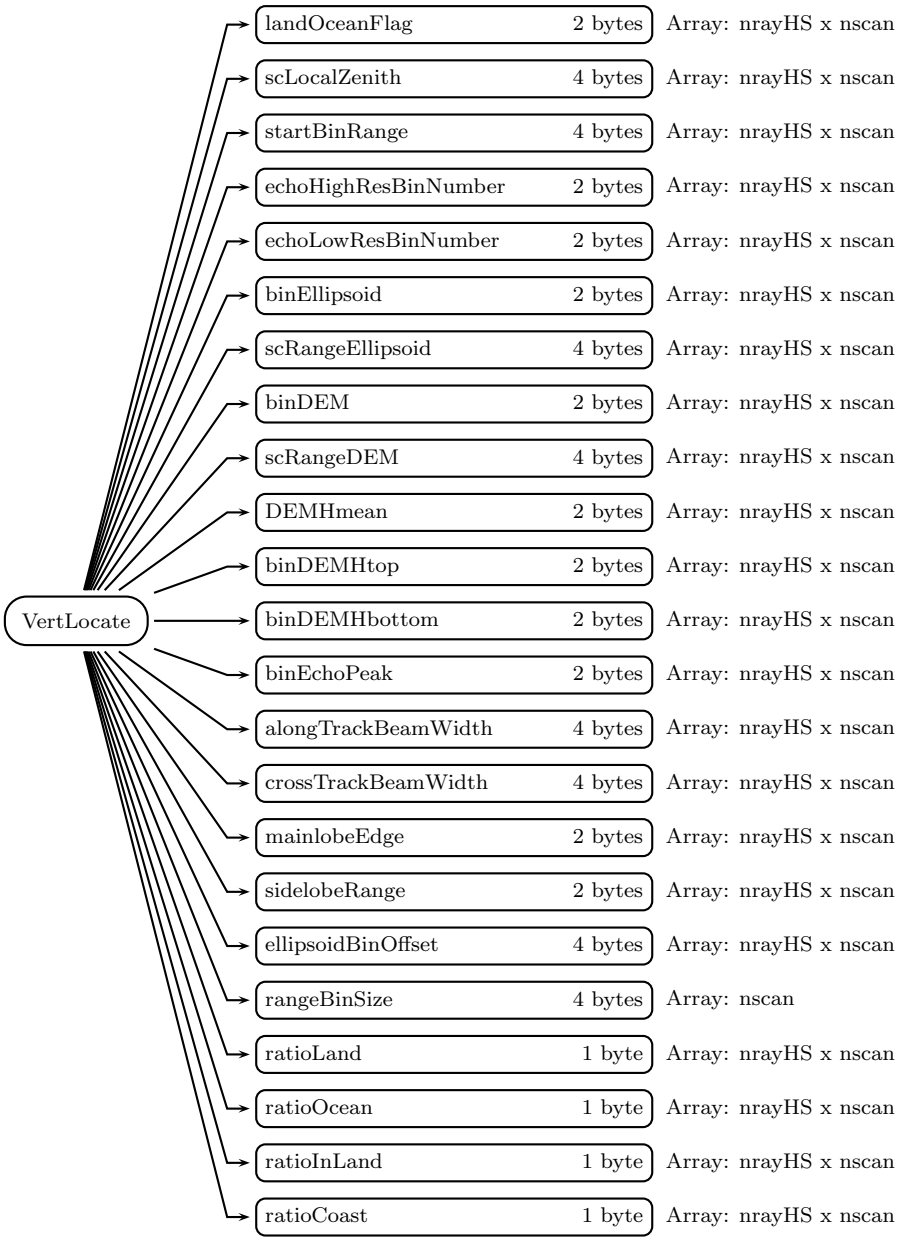


Figure 284: Data Format Structure for 1BKa, HS, VertLocate

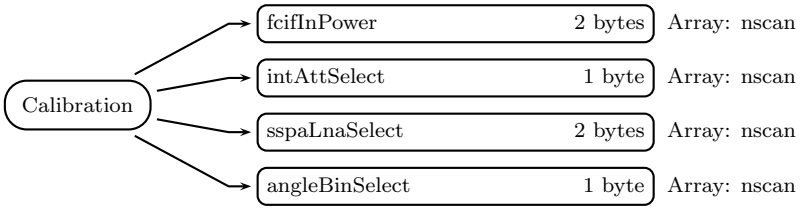


Figure 285: Data Format Structure for 1BKa, HS, Calibration

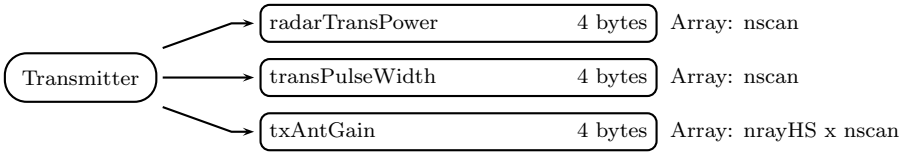


Figure 286: Data Format Structure for 1BKa, HS, Transmitter

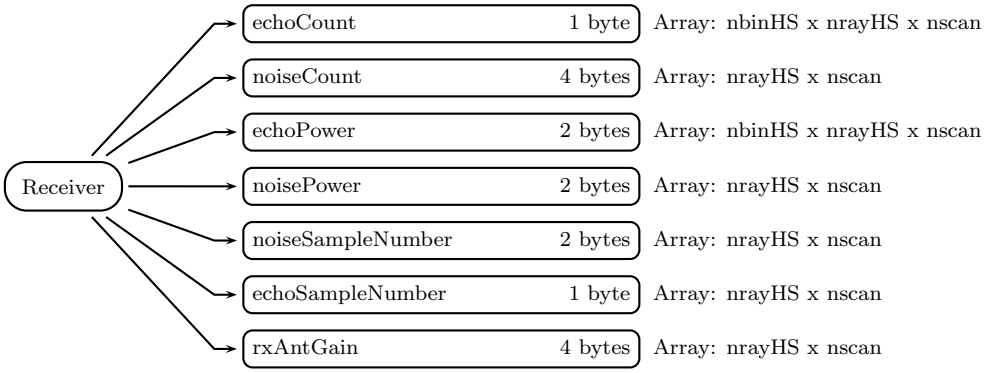


Figure 287: Data Format Structure for 1BKa, HS, Receiver

MS_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in MS)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nrayMS x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nrayMS x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in MS)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nscan):
Flag of data warning for each scan.

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken

down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
```

```
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
```

```
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):

```
The operational mode of KuPR/KaPR stored in science telemetry.
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
7     Ku/Ka Standby VPRF Table OUT
8     Ku/Ka Standby Phase Out
9     Ku/Ka Standby Dump Out
10    Ku/Ka Standby (No Science Data)
11    Ku/Ka Independent Observation
12    Ku/Ka Independent External Calibration
13    Ku/Ka Independent Internal Calibration
14    Ku/Ka Independent SSPA Analysis
15    Ku/Ka Independent LNA Analysis
16    Ku/Ka Independent Health-Check
17    Ku/Ka Independent Standby VPRF Table OUT
18    Ku/Ka Independent Standby Phase Out
19    Ku/Ka Independent Standby Dump Out
20    Ku/Ka Independent Standby (No Science Data)
```

limitErrorFlag (1-byte integer, array size: nscan):

```
Bit flags for every ray with information
about echo power limit checks.
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group in MS)

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from

DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

rayPointing (Group in MS)

rayDirectionX (4-byte float, array size: nrayMS x nscan):
Unit ray direction x component in mechanical coordinates. Values range from -1.0 to 1.0. Special values are defined as:
-9999.9 Missing value

rayDirectionY (4-byte float, array size: nrayMS x nscan):
Unit ray direction y component in mechanical coordinates. Values range from -1.0 to 1.0. Special values are defined as:
-9999.9 Missing value

instrumentYaw (4-byte float, array size: nrayMS x nscan):
Yaw of mechanical coordinates w.r.t. geodetic coordinates. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

instrumentPitch (4-byte float, array size: nrayMS x nscan):
Pitch of mechanical coordinates w.r.t. geodetic coordinates. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

instrumentRoll (4-byte float, array size: nrayMS x nscan):
Roll of mechanical coordinates w.r.t. geodetic coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

rayTiming (4-byte float, array size: nrayMS x nscan):
The time delay from the secondary header packet time tag to each ray (assumed as mid-time of all radar pulses for the associated rayDirection). Values range from 0 to 1.6 s. Special values are defined as:
-9999.9 Missing value

scanAngle (4-byte float, array size: nrayMS x nscan):
Angle (degrees) of the ray from nominal nadir offset about the mechanical x_axis. The sign of the angle is consistent with the sensor y-axis, i.e., the angle is positive to the right of the direction of travel if the spacecraft is in normal mode. Values range from -18 to 18 degrees. Special values are defined as:
-9999.9 Missing value

HouseKeeping (Group in MS)

rxAtt (1-byte integer, array size: nscan):
The scan number which is determined by the L1A product. Values range from 0 to 12 dB. Special values are defined as:
-99 Missing value

rxAttGainOffset (4-byte float, array size: nscan):
The actual gain of rxAtt considering the temperature dependence. Values are in dB. Special values are defined as:
-9999.9 Missing value

binDiffPeakDEM (2-byte integer, array size: nrayMS x nscan):
The number of range bins between binEchoPeak and binDEM. It is used to ensure that the VPRF is switched in accordance with the GPM satellite altitude. Values range from -260 to 260 range bin number at NS and MS, from -130 to 130 range bin number at HS respectively. Values range from -260 to 260 range bin number. Special values are defined as:
-9999 Missing value

scTime (8-byte float, array size: nscan):
Scan time expressed as TAI time with and epoch of 0000Z Jan 6, 1980. This time matches the time in ScanTime. Special values are defined as:
-9999.9 Missing value

vprfTableVersion (1-byte integer, array size: nscan):
The version number of VPRF table which is used in L1B process. Values range from 1 to 127 Number. Special values are defined as:
-99 Missing value

vprfTableSelect (1-byte integer, array size: nscan):
The selected number of VPRF table for altitude (h, km) which is used in L1B process. The range is 1 to 25.

```
h LT 396.5 = 1
396.5 LE h LT 397.5 = 2
397.5 LE h LT 398.5 = 3
398.5 LE h LT 399.5 = 4
399.5 LE h LT 400.5 = 5
400.5 LE h LT 401.5 = 6
401.5 LE h LT 402.5 = 7
402.5 LE h LT 403.5 = 8
403.5 LE h LT 404.5 = 9
404.5 LE h LT 405.5 = 10
405.5 LE h LT 406.5 = 11
406.5 LE h LT 407.5 = 12
407.5 LE h LT 408.5 = 13
408.5 LE h LT 409.5 = 14
409.5 LE h LT 410.5 = 15
410.5 LE h LT 411.5 = 16
411.5 LE h LT 412.5 = 17
412.5 LE h LT 413.5 = 18
413.5 LE h LT 414.5 = 19
414.5 LE h LT 415.5 = 20
415.5 LE h LT 416.5 = 21
416.5 LE h LT 417.5 = 22
417.5 LE h LT 418.5 = 23
418.5 LE h LT 419.5 = 24
419.5 LE h = 25

where
LT mean less than and
LE means less than or equal to
```

catchingInt (1-byte integer, array size: nscan):
The timing that receive window is open for the first reflected TX pulse. If catchingInt is set to 12, then the first TX pulse is received with receive window after the twelfth TX pulse. In the case of nominal operation, catchingInt is set to 12, that is, the VPRF table is used. In other cases, including GPS-status trouble, catchingInt is set 8 and limited PRF is loaded. Values range from 8 to 12 Number. Special values are defined as:
-99 Missing value

scdpFlag (1-byte integer, array size: nscan):
The side of the SCDP system and system table used.

```
Bit Meaning if bit=1
0   B-side is used (if bit=0, then A-side used)
1   Priority is 1 at Basic System Table. Refer to Basic System Table.
```

```
2   Priority is 2 at Basic System Table. Refer to HK telemetry.
3   Priority is 2 at Basic System Table. Refer to Basic System Table.
4   (Spare)
5   (Spare)
6   (Spare)
7   (Spare)
```

fcifFlag (1-byte integer, array size: nscan):
The side of FCIF system and the system table used.

```
Bit Meaning if bit=1
0   B-side is used (if bit=0, then A-side used)
1   Priority is 1 at Basic System Table. Refer to Basic System Table.
2   Priority is 2 at Basic System Table. Refer to HK telemetry
3   Priority is 2 at Basic System Table. Refer to Basic System Table
4   (Spare)
5   (Spare)
6   (Spare)
7   (Spare)
```

logAmpNoiseLevel (2-byte integer, array size: nscan):
The Noise Level at Log Amp Termination which is stored in science telemetry. Values are in dBM. Special values are defined as:
-9999 Missing value

delay (2-byte integer, array size: nscan):
The timing offset value from space craft time in NS. In MS and HS, it is defined as offset time value from the base delay time. They are used to adjust for beam matching of along track direction. Values range from 0 to 3360 counts. Special values are defined as:
-9999 Missing value

seqCountL1A (2-byte integer, array size: nscan):
The scan number which is determined by the L1A product. Values range from 0 to 27000 counts. Special values are defined as:
-9999 Missing value

fcifTemp (2-byte integer, array size: 2 x nscan):
The temperature of FCIF component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

lnaTemp (2-byte integer, array size: 2 x nscan):
The temperature of LNA component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry.

Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C.

rdaTemp (2-byte integer, array size: 2 x nscan):
he temperature of RDA component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C Attenuator setting levels of Received radar antenna.Values are 0, 3, 6, 9 and 12 in dB. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

divcomb1Temp (2-byte integer, array size: 2 x nscan):
The temperature of divcomb2, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

divcomb2Temp (2-byte integer, array size: 2 x nscan):
The temperature of divcomb2, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

sspaTemp (2-byte integer, array size: 2 x nscan):
The temperature of RDA component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

VertLocate (Group in MS)

landOceanFlag (2-byte integer, array size: nrayMS x nscan):
Land or ocean information. The values of the flag are:

```
0 = Water
1 = Land
2 = Coast
3 = Inland Water
```

scLocalZenith (4-byte float, array size: nrayMS x nscan):
The angle, in degrees, between the local zenith and the beam's center line. The local (geodetic) zenith at the intersection of the ray and the earth ellipsoid is used. Values

range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

startBinRange (4-byte float, array size: nrayMS x nscan):
The distance from the satellite to the center of the first range bin. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

echoHighResBinNumber (2-byte integer, array size: nrayMS x nscan):
The number of sampling without thinning out (over sampling).. Range of 1-260 for NS and MS and 1-130 at HS. EDIT Values range from 1 to 260 range bin number. Special values are defined as:
-9999 Missing value

```
Meaning in Normal Mode:
0 = Over sampling range bin OR
1 = Normal sampling range bin
2 = Interpolated range bin
-99 = Outrange bin of the observation area
Meaning in internal calibration mode:
0: In internal calibration mode, this value is stored 1- 42 range bin for each
ray.
-99: missing value. In internal calibration mode, this value is stored after 43
range bin for each ray as missing.
```

echoLowResBinNumber (2-byte integer, array size: nrayMS x nscan):
The number of sampling after thinning out the normal sample. From 1 to 260 range bin number at NS and MS while from 1 to 130 at HS. Values range from 0 to 260 range bin number. Special values are defined as:
-9999 Missing value

binEllipsoid (2-byte integer, array size: nrayMS x nscan):
The range bin number of the earth ellipsoid. Values range from 1 to 260 range bin number. Special values are defined as:
-9999 Missing value

scRangeEllipsoid (4-byte float, array size: nrayMS x nscan):
The distance from instrument to ellipsoid calculated by GeoTK. Values range from 0 to 500000 m. Special values are defined as:
-9999.9 Missing value

binDEM (2-byte integer, array size: nrayMS x nscan):
Range bin number of the average DEM surface elevation in a box centered on the IFOV. Reference width is 5 km x 5 km. Reference number of pixels in the direction of latitude is 7. On the other hand, the number of pixels in the direction of longitude reference is changed to 21-7 by latitude. Values range from 1 to 260 range bin number at NS and MS while from 1 to 130 at HS. Special value is -9999 for missing scan, internal calbration mode, or in case DEM is missing.

scRangeDEM (4-byte float, array size: nrayMS x nscan):
The value is calculted as scRangeEllipsoid - DEMHmean secand(localZenithAngle). Values range from 0 to 500000 m. Special values are defined as:
-9999.9 Missing value

DEMHmean (2-byte integer, array size: nrayMS x nscan):
Averaged DEM height, whose SRTM-30. Values range from 0 to 9000 m. Special values are defined as:
-9999 Missing value

binDEMHtop (2-byte integer, array size: nrayMS x nscan):
The range bin number of the maximum DEM surface elevation in a box centered on the IFOV. Reference width is 5 km x 5 km. Reference number of pixels in the direction of latitude is 7. On the other hand, the number of pixels in the direction of longitude reference is changed to 21-7 by latitude. Values range from 1 to 260 range bin number at NS and MS, from 1 to 130 at HS. Special value is -9999 for missing scan, internal calbration mode, or in case DEM is missing. The first dimension is the box size, with sizes of 5 km x 5 km and 11 km x 11km.

binDEMHbottom (2-byte integer, array size: nrayMS x nscan):
The range bin number of the minimum DEM surface elevation in a box centered on the IFOV. Reference width is 5 km x 5 km. Reference number of pixels in the direction of latitude is 7. On the other hand, the number of pixels in the direction of longitude reference is changed to 21-7 by latitude. Values range from 1 to 260 range bin number at NS and MS, from 1 to 130 at HS. Special value is -9999 for missing scan, internal calbration mode, or in case DEM is missing. The first dimension is the box size, with sizes of 5 km x 5 km and 11 km x 11km.

binEchoPeak (2-byte integer, array size: nrayMS x nscan):
The range bin number which has maximum echoPower in each scan and each angle bin. Values range from 1 to 260 range bin number. Special values are defined as:
-9999 Missing value

alongTrackBeamWidth (4-byte float, array size: nrayMS x nscan):
Radar beamwidth (degrees) at the point transmitted power reaches one half of peak power in the along-track direction.

crossTrackBeamWidth (4-byte float, array size: nrayMS x nscan):
Radar beamwidth (degrees) at the point transmitted power reaches one half of peak power along the cross-track direction.

mainlobeEdge (2-byte integer, array size: nrayMS x nscan):
Absolute value of the difference in Range Bin Numbers between the detected surface and the edge of the clutter from the mainlobe.

sidelobeRange (2-byte integer, array size: nrayMS x nscan):
Absolute value of the difference in Range Bin Numbers between the detected surface and the clutter psition from the sidelobe. A zero means no clutter indicated in this field since less than 3 bins contained significant clutter.

ellipsoidBinOffset (4-byte float, array size: nrayMS x nscan):
The distance between center of binEllipsoid range bin and Ellipsoid position.

rangeBinSize (4-byte float, array size: nscan):
The range bin size. With VPRF, the size for NS and MS is 250.32670 m and for HS 250.32670 m. With limited PRF, the size is 250.32670 m for all three swaths.

ratioLand (1-byte integer, array size: nrayMS x nscan):
Ratio of land area to total area in a footprint.

ratioOcean (1-byte integer, array size: nrayMS x nscan):
Ratio of ocean area to total area in a footprint.

ratioInLand (1-byte integer, array size: nrayMS x nscan):
Ratio of inland water area to total area in a footprint.

ratioCoast (1-byte integer, array size: nrayMS x nscan):
Ratio of coast area to total area in a footprint.

Calibration (Group in MS)

fcifInPower (2-byte integer, array size: nscan):
Input power value of FCIF and is set at internal calibration mode. At another mode, the value of fcifInPower is set as missing. Values are in 0.01 dBm. Special values are defined as:
-32734 Missing value

intAttSelect (1-byte integer, array size: nscan):
The selected number of internal attenuation that is controlled automatically with 32 steps and is set by internal mode. At another mode, the value of fcifInPower is set as missing. Values range from 1 to 32 step. Special values are defined as:
-99 Missing value

sspaLnaSelect (2-byte integer, array size: nscan):
In SSPA mode, sspaLnaSelect stores the number of LNA. In LNA mode, sspaLnaSelect stores the number of SSPA. In other modes, sspaLnaSelect is given the missing value. Values range from 1 to 128 Number. Special values are defined as:
-9999 Missing value

angleBinSelect (1-byte integer, array size: nscan):
In SSPA and LNA mode, angleBinSelect contains the selected beam number. In other operational modes, angleBinSelect is set to missing. Values range from 1 to 49 Number. Special values are defined as:
-99 Missing value

Transmitter (Group in MS)

radarTransPower (4-byte float, array size: nscan):
The total (sum) power of 128 SSPA elements corrected with SSPA temperature in orbit. It is based on ground test temperature data of SSPA transmission power. Special value -9999.9 for missing scan and internal calibration mode.

transPulseWidth (4-byte float, array size: nscan):
Transmitted pulse width corrected with FCIF temperature in orbit, based on temperature test data of FCIF. Values range from 0.0000015 to 0.0000017 s. Special value -9999.9 for missing scan and internal calibration mode.

txAntGain (4-byte float, array size: nrayMS x nscan):
Transmitted radar antenna effectiveness (dB). Special value -9999.9 for missing scan and internal calibration mode.

Receiver (Group in MS)

echoCount (1-byte char, array size: nbinMS x nrayMS x nscan):
The total signal count at the antenna input that includes both echo and noise power. The signal count is stored on both observation mode and calibration mode. It is basically a copy of science telemetry raw data for sampling range bins. 0 is set to both interpolated range bin and outrange bin of the observation area.

noiseCount (4-byte float, array size: nrayMS x nscan):
An average of the received noise count for each angle bins during suspended 4 pulses. The value -9999.9 means missing scan and inernal calibration mode.

echoPower (2-byte integer, array size: nbinMS x nrayMS x nscan):
The total signal power at the antenna input that includes both echo and noise power. The numerical value of echoPower is 100 times the power expressed in dBm when the data is valid. Values between -12000 and -2000, which correspond to the power between -120 dBm and -20 dBm, are the valid values. If the echoPower is measured outside the receiving range window that depends on the pulse repetition frequency, -29999 is stored. If the data is not valid for other reasons, -30000 is stored.

```
Special values:
"Count value": internal calibration mode.
-29999 : Outrange bins of the observation area.
-30000 : Missing value
```

noisePower (2-byte integer, array size: nrayMS x nscan):
An average of the received noise power for each angle bins during suspended 4 pulses. Values in dBm are multiplied by 100 and stored in the file as a 2-byte integer. The unit

in the file is thus 0.01 dBm. The range is -120 dBm to -20 dBm which corresponds to values in the file from -12000 to -2000. The value -30000 means missing scan and internal calibration mode.

noiseSampleNumber (2-byte integer, array size: nrayMS x nscan):
The number of noise samplings. This value is considered with frequency agility, the number of noise sampling pulse and sampling dependency, so the value is the quadruple of the value defined by the VPRF table. Values range from 0 to 1000 Number. Special value -9999 for missing and internal calibration mode.

echoSampleNumber (1-byte integer, array size: nrayMS x nscan):
The number of received pulse. This value is considered with frequency agility so the value is the double of the value defined by the VHRF table. Values range from 0 to 120 Number. Special values are defined as:
48 Internal Calibration Mode
-99 Missing scan

rxAntGain (4-byte float, array size: nrayMS x nscan):
Received radar antenna effectiveness (dB). Special value -9999.9 for missing scan and internal calibration mode.

HS (Swath)

HS_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in HS)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nrayHS x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nrayHS x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in HS)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
```

```
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nscan):
Flag of data warning for each scan.

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
```

```
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
```

```
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):

```
The operational mode of KuPR/KaPR stored in science telemetry.
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
7     Ku/Ka Standby VPRF Table OUT
8     Ku/Ka Standby Phase Out
9     Ku/Ka Standby Dump Out
10    Ku/Ka Standby (No Science Data)
11    Ku/Ka Independent Observation
12    Ku/Ka Independent External Calibration
13    Ku/Ka Independent Internal Calibration
14    Ku/Ka Independent SSPA Analysis
15    Ku/Ka Independent LNA Analysis
16    Ku/Ka Independent Health-Check
```

```
17    Ku/Ka Independent Standby VPRF Table OUT
18    Ku/Ka Independent Standby Phase Out
19    Ku/Ka Independent Standby Dump Out
20    Ku/Ka Independent Standby (No Science Data)
```

limitErrorFlag (1-byte integer, array size: nscan):

```
Bit flags for every ray with information
about echo power limit checks.
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group in HS)

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values

are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

rayPointing (Group in HS)

rayDirectionX (4-byte float, array size: nrayHS x nscan):
Unit ray direction x component in mechanical coordinates. Values range from -1.0 to 1.0. Special values are defined as:
-9999.9 Missing value

rayDirectionY (4-byte float, array size: nrayHS x nscan):
Unit ray direction y component in mechanical coordinates. Values range from -1.0 to 1.0. Special values are defined as:
-9999.9 Missing value

instrumentYaw (4-byte float, array size: nrayHS x nscan):
Yaw of mechanical coordinates w.r.t. geodetic coordinates. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

instrumentPitch (4-byte float, array size: nrayHS x nscan):
Pitch of mechanical coordinates w.r.t. geodetic coordinates. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

instrumentRoll (4-byte float, array size: nrayHS x nscan):
Roll of mechanical coordinates w.r.t. geodetic coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

rayTiming (4-byte float, array size: nrayHS x nscan):
The time delay from the secondary header packet time tag to each ray (assumed as mid-time of all radar pulses for the associated rayDirection). Values range from 0 to 1.6 s. Special values are defined as:
-9999.9 Missing value

scanAngle (4-byte float, array size: nrayHS x nscan):
Angle (degrees) of the ray from nominal nadir offset about the mechanical x_axis. The sign of the angle is consistent with the sensor y-axis, i.e., the angle is positive to the right of the direction of travel if the spacecraft is in normal mode. Values range from -18 to 18 degrees. Special values are defined as:
-9999.9 Missing value

HouseKeeping (Group in HS)

rxAtt (1-byte integer, array size: nscan):
The scan number which is determined by the L1A product. Values range from 0 to 12 dB. Special values are defined as:
-99 Missing value

rxAttGainOffset (4-byte float, array size: nscan):
The actual gain of rxAtt considering the temperature dependence. Values are in dB. Special values are defined as:
-9999.9 Missing value

binDiffPeakDEM (2-byte integer, array size: nrayHS x nscan):
The number of range bins between binEchoPeak and binDEM. It is used to ensure that the VPRF is switched in accordance with the GPM satellite altitude. Values range from -260 to 260 range bin number at NS and MS, from -130 to 130 range bin number at HS respectively. Values range from -260 to 260 range bin number. Special values are defined as:
-9999 Missing value

scTime (8-byte float, array size: nscan):
Scan time expressed as TAI time with and epoch of 0000Z Jan 6, 1980. This time matches

the time in ScanTime. Special values are defined as:
-9999.9 Missing value

vprfTableVersion (1-byte integer, array size: nscan):
The version number of VPRF table which is used in L1B process. Values range from 1 to 127 Number. Special values are defined as:
-99 Missing value

vprfTableSelect (1-byte integer, array size: nscan):
The selected number of VPRF table for altitude (h, km) which is used in L1B process. The range is 1 to 25.

```
h LT 396.5 = 1
396.5 LE h LT 397.5 = 2
397.5 LE h LT 398.5 = 3
398.5 LE h LT 399.5 = 4
399.5 LE h LT 400.5 = 5
400.5 LE h LT 401.5 = 6
401.5 LE h LT 402.5 = 7
402.5 LE h LT 403.5 = 8
403.5 LE h LT 404.5 = 9
404.5 LE h LT 405.5 = 10
405.5 LE h LT 406.5 = 11
406.5 LE h LT 407.5 = 12
407.5 LE h LT 408.5 = 13
408.5 LE h LT 409.5 = 14
409.5 LE h LT 410.5 = 15
410.5 LE h LT 411.5 = 16
411.5 LE h LT 412.5 = 17
412.5 LE h LT 413.5 = 18
413.5 LE h LT 414.5 = 19
414.5 LE h LT 415.5 = 20
415.5 LE h LT 416.5 = 21
416.5 LE h LT 417.5 = 22
417.5 LE h LT 418.5 = 23
418.5 LE h LT 419.5 = 24
419.5 LE h = 25

where
LT mean less than and
LE means less than or equal to
```

catchingInt (1-byte integer, array size: nscan):
The timing that receive window is open for the first reflected TX pulse. If catchingInt is set to 12, then the first TX pulse is received with receive window after the twelfth TX

pulse. In the case of nominal operation, catchingInt is set to 12, that is, the VPRF table is used. In other cases, including GPS-status trouble, catchingInt is set 8 and limited PRF is loaded. Values range from 8 to 12 Number. Special values are defined as:
-99 Missing value

scdpFlag (1-byte integer, array size: nscan):
The side of the SCDP system and system table used.

```
Bit Meaning if bit=1
0   B-side is used (if bit=0, then A-side used)
1   Priority is 1 at Basic System Table. Refer to Basic System Table.
2   Priority is 2 at Basic System Table. Refer to HK telemetry.
3   Priority is 2 at Basic System Table. Refer to Basic System Table.
4   (Spare)
5   (Spare)
6   (Spare)
7   (Spare)
```

fcifFlag (1-byte integer, array size: nscan):
The side of FCIF system and the system table used.

```
Bit Meaning if bit=1
0   B-side is used (if bit=0, then A-side used)
1   Priority is 1 at Basic System Table. Refer to Basic System Table.
2   Priority is 2 at Basic System Table. Refer to HK telemetry
3   Priority is 2 at Basic System Table. Refer to Basic System Table
4   (Spare)
5   (Spare)
6   (Spare)
7   (Spare)
```

logAmpNoiseLevel (2-byte integer, array size: nscan):
The Noise Level at Log Amp Termination which is stored in science telemetry. Values are in dBM. Special values are defined as:
-9999 Missing value

delay (2-byte integer, array size: nscan):
The timing offset value from space craft time in NS. In MS and HS, it is defined as offset time value from the base delay time. They are used to adjust for beam matching of along track direction. Values range from 0 to 3360 counts. Special values are defined as:
-9999 Missing value

seqCountL1A (2-byte integer, array size: nscan):
The scan number which is determined by the L1A product. Values range from 0 to 27000 counts. Special values are defined as:
-9999 Missing value

fcifTemp (2-byte integer, array size: 2 x nscan):
The temperature of FCIF component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

lnaTemp (2-byte integer, array size: 2 x nscan):
The temperature of LNA component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C.

rdaTemp (2-byte integer, array size: 2 x nscan):
he temperature of RDA component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C Attenuator setting levels of Received radar antenna.Values are 0, 3, 6, 9 and 12 in dB. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

divcomb1Temp (2-byte integer, array size: 2 x nscan):
The temperature of divcomb2, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

divcomb2Temp (2-byte integer, array size: 2 x nscan):
The temperature of divcomb2, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

sspaTemp (2-byte integer, array size: 2 x nscan):
The temperature of RDA component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

VertLocate (Group in HS)

landOceanFlag (2-byte integer, array size: nrayHS x nscan):
Land or ocean information. The values of the flag are:

```
0 = Water
1 = Land
2 = Coast
3 = Inland Water
```

scLocalZenith (4-byte float, array size: nrayHS x nscan):
The angle, in degrees, between the local zenith and the beam's center line. The local (geodetic) zenith at the intersection of the ray and the earth ellipsoid is used. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

startBinRange (4-byte float, array size: nrayHS x nscan):
The distance from the satellite to the center of the first range bin. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

echoHighResBinNumber (2-byte integer, array size: nrayHS x nscan):
The number of sampling without thinning out (over sampling).. Range of 1-260 for NS and MS and 1-130 at HS. EDIT Values range from 1 to 260 range bin number. Special values are defined as:
-9999 Missing value

```
Meaning in Normal Mode:
0 = Over sampling range bin OR
1 = Normal sampling range bin
2 = Interpolated range bin
-99 = Outrange bin of the observation area
Meaning in internal calibration mode:
0: In internal calibration mode, this value is stored 1- 42 range bin for each
ray.
-99: missing value. In internal calibration mode, this value is stored after 43
range bin for each ray as missing.
```

echoLowResBinNumber (2-byte integer, array size: nrayHS x nscan):
The number of sampling after thinning out the normal sample. From 1 to 260 range bin number at NS and MS while from 1 to 130 at HS. Values range from 0 to 260 range bin number. Special values are defined as:
-9999 Missing value

binEllipsoid (2-byte integer, array size: nrayHS x nscan):
The range bin number of the earth ellipsoid. Values range from 1 to 260 range bin number. Special values are defined as:
-9999 Missing value

scRangeEllipsoid (4-byte float, array size: nrayHS x nscan):
The distance from instrument to ellipsoid calculated by GeoTK. Values range from 0 to 500000 m. Special values are defined as:
-9999.9 Missing value

binDEM (2-byte integer, array size: nrayHS x nscan):
Range bin number of the average DEM surface elevation in a box centered on the IFOV. Reference width is 5 km x 5 km. Reference number of pixels in the direction of latitude is 7. On the other hand, the number of pixels in the direction of longitude reference is changed to 21-7 by latitude. Values range from 1 to 260 range bin number at NS and MS while from 1 to 130 at HS. Special value is -9999 for missing scan, internal calbration mode, or in case DEM is missing.

scRangeDEM (4-byte float, array size: nrayHS x nscan):
The value is calculted as scRangeEllipsoid - DEMHmean secand(localZenithAngle). Values range from 0 to 500000 m. Special values are defined as:
-9999.9 Missing value

DEMHmean (2-byte integer, array size: nrayHS x nscan):
Averaged DEM height, whose SRTM-30. Values range from 0 to 9000 m. Special values are defined as:
-9999 Missing value

binDEMHtop (2-byte integer, array size: nrayHS x nscan):
The range bin number of the maximum DEM surface elevation in a box centered on the IFOV. Reference width is 5 km x 5 km. Reference number of pixels in the direction of latitude is 7. On the other hand, the number of pixels in the direction of longitude reference is changed to 21-7 by latitude. Values range from 1 to 260 range bin number at NS and MS, from 1 to 130 at HS. Special value is -9999 for missing scan, internal calbration mode, or in case DEM is missing. The first dimension is the box size, with sizes of 5 km x 5 km and 11 km x 11km.

binDEMHbottom (2-byte integer, array size: nrayHS x nscan):
The range bin number of the minimum DEM surface elevation in a box centered on the IFOV. Reference width is 5 km x 5 km. Reference number of pixels in the direction of latitude is 7. On the other hand, the number of pixels in the direction of longitude reference is changed to 21-7 by latitude. Values range from 1 to 260 range bin number at NS and MS, from 1 to 130 at HS. Special value is -9999 for missing scan, internal calbration mode, or in case DEM is missing. The first dimension is the box size, with sizes of 5 km x 5 km and 11 km x 11km.

binEchoPeak (2-byte integer, array size: nrayHS x nscan):
The range bin number which has maximum echoPower in each scan and each angle bin. Values range from 1 to 260 range bin number. Special values are defined as:
-9999 Missing value

alongTrackBeamWidth (4-byte float, array size: nrayHS x nscan):
Radar beamwidth (degrees) at the point transmitted power reaches one half of peak power

in the along-track direction.

crossTrackBeamWidth (4-byte float, array size: nrayHS x nscan):
Radar beamwidth (degrees) at the point transmitted power reaches one half of peak power along the cross-track direction.

mainlobeEdge (2-byte integer, array size: nrayHS x nscan):
Absolute value of the difference in Range Bin Numbers between the detected surface and the edge of the clutter from the mainlobe.

sidelobeRange (2-byte integer, array size: nrayHS x nscan):
Absolute value of the difference in Range Bin Numbers between the detected surface and the clutter psition from the sidelobe. A zero means no clutter indicated in this field since less than 3 bins contained significant clutter.

ellipsoidBinOffset (4-byte float, array size: nrayHS x nscan):
The distance between center of binEllipsoid range bin and Ellipsoid position.

rangeBinSize (4-byte float, array size: nscan):
The range bin size. With VPRF, the size for NS and MS is 250.32670 m and for HS 250.32670 m. With limited PRF, the size is 250.32670 m for all three swaths.

ratioLand (1-byte integer, array size: nrayHS x nscan):
Ratio of land area to total area in a footprint.

ratioOcean (1-byte integer, array size: nrayHS x nscan):
Ratio of ocean area to total area in a footprint.

ratioInLand (1-byte integer, array size: nrayHS x nscan):
Ratio of inland water area to total area in a footprint.

ratioCoast (1-byte integer, array size: nrayHS x nscan):
Ratio of coast area to total area in a footprint.

Calibration (Group in HS)

fcifInPower (2-byte integer, array size: nscan):
Input power value of FCIF and is set at internal calibration mode. At another mode, the value of fcifInPower is set as missing. Values are in 0.01 dBm. Special values are defined as:
-32734 Missing value

intAttSelect (1-byte integer, array size: nscan):
The selected number of internal attenuation that is controlled automatically with 32 steps and is set by internal mode. At another mode, the value of fcifInPower is set as missing. Values range from 1 to 32 step. Special values are defined as:
-99 Missing value

sspaLnaSelect (2-byte integer, array size: nscan):
In SSPA mode, sspaLnaSelect stores the number of LNA. In LNA mode, sspaLnaSelect stores the number of SSPA. In other modes, sspaLnaSelect is given the missing value. Values range from 1 to 128 Number. Special values are defined as:
-9999 Missing value

angleBinSelect (1-byte integer, array size: nscan):
In SSPA and LNA mode, angleBinSelect contains the selected beam number. In other operational modes, angleBinSelect is set to missing. Values range from 1 to 49 Number. Special values are defined as:
-99 Missing value

Transmitter (Group in HS)

radarTransPower (4-byte float, array size: nscan):
The total (sum) power of 128 SSPA elements corrected with SSPA temperature in orbit. It is based on ground test temperature data of SSPA transmission power. Special value -9999.9 for missing scan and internal calibration mode.

transPulseWidth (4-byte float, array size: nscan):
Transmitted pulse width corrected with FCIF temperature in orbit, based on temperature test data of FCIF. Values range from 0.0000015 to 0.0000017 s. Special value -9999.9 for missing scan and internal calibration mode.

txAntGain (4-byte float, array size: nrayHS x nscan):
Transmitted radar antenna effectiveness (dB). Special value -9999.9 for missing scan and internal calibration mode.

Receiver (Group in HS)

echoCount (1-byte char, array size: nbinHS x nrayHS x nscan):
The total signal count at the antenna input that includes both echo and noise power. The signal count is stored on both observation mode and calibration mode. It is basically a copy of science telemetry raw data for sampling range bins. 0 is set to both interpolated range bin and outrange bin of the observation area.

noiseCount (4-byte float, array size: nrayHS x nscan):
An average of the received noise count for each angle bins during suspended 4 pulses. The value -9999.9 means missing scan and inernal calibration mode.

echoPower (2-byte integer, array size: nbinHS x nrayHS x nscan):
The total signal power at the antenna input that includes both echo and noise power. The numerical value of echoPower is 100 times the power expressed in dBm when the

data is valid. Values between -12000 and -2000, which correspond to the power between -120 dBm and -20 dBm, are the valid values. If the echoPower is measured outside the receiving range window that depends on the pulse repetition frequency, -29999 is stored. If the data is not valid for other reasons, -30000 is stored.

```
Special values:
"Count value": internal calibration mode.
-29999 : Outrange bins of the observation area.
-30000 : Missing value
```

noisePower (2-byte integer, array size: nrayHS x nscan):
An average of the received noise power for each angle bins during suspended 4 pulses. Values in dBm are multiplied by 100 and stored in the file as a 2-byte integer. The unit in the file is thus 0.01 dBm. The range is -120 dBm to -20 dBm which corresponds to values in the file from -12000 to -2000. The value -30000 means missing scan and internal calibration mode.

noiseSampleNumber (2-byte integer, array size: nrayHS x nscan):
The number of noise samplings. This value is considered with frequency agility, the number of noise sampling pulse and sampling dependency, so the value is the quadruple of the value defined by the VPRF table. Values range from 0 to 1000 Number. Special value -9999 for missing and internal calibration mode.

echoSampleNumber (1-byte integer, array size: nrayHS x nscan):
The number of received pulse. This value is considered with frequency agility so the value is the double of the value defined by the VHRF table. Values range from 0 to 120 Number. Special values are defined as:

48	Internal Calibration Mode
-99	Missing scan

rxAntGain (4-byte float, array size: nrayHS x nscan):
Received radar antenna effectiveness (dB). Special value -9999.9 for missing scan and internal calibration mode.

C Structure Header file:

```
#ifndef _TK_1BKa_H_
#define _TK_1BKa_H_

#ifndef _L1BKa_HS_RECEIVER_
#define _L1BKa_HS_RECEIVER_

typedef struct {
    unsigned char echoCount[24][130];
    float noiseCount[24];
    short echoPower[24][130];
```

```
    short noisePower[24];
    short noiseSampleNumber[24];
    signed char echoSampleNumber[24];
    float rxAntGain[24];
} L1BKa_HS_RECEIVER;

#endif

#ifndef _L1BKa_HS_TRANSMITTER_
#define _L1BKa_HS_TRANSMITTER_

typedef struct {
    float radarTransPower;
    float transPulseWidth;
    float txAntGain[24];
} L1BKa_HS_TRANSMITTER;

#endif

#ifndef _L1BKa_HS_CALIBRATION_
#define _L1BKa_HS_CALIBRATION_

typedef struct {
    short fcifInPower;
    signed char intAttSelect;
    short sspaLnaSelect;
    signed char angleBinSelect;
} L1BKa_HS_CALIBRATION;

#endif

#ifndef _L1BKa_HS_VERTLOCATE_
#define _L1BKa_HS_VERTLOCATE_

typedef struct {
    short landOceanFlag[24];
    float scLocalZenith[24];
    float startBinRange[24];
    short echoHighResBinNumber[24];
    short echoLowResBinNumber[24];
    short binEllipsoid[24];
    float scRangeEllipsoid[24];
    short binDEM[24];
```

```
    float scRangeDEM[24];
    short DEMHmean[24];
    short binDEMHtop[24];
    short binDEMHbottom[24];
    short binEchoPeak[24];
    float alongTrackBeamWidth[24];
    float crossTrackBeamWidth[24];
    short mainlobeEdge[24];
    short sidelobeRange[24];
    float ellipsoidBinOffset[24];
    float rangeBinSize;
    signed char ratioLand[24];
    signed char ratioOcean[24];
    signed char ratioInLand[24];
    signed char ratioCoast[24];
} L1BKa_HS_VERTLOCATE;

#endif

#ifndef _L1BKa_HS_HOUSEKEEPING_
#define _L1BKa_HS_HOUSEKEEPING_

typedef struct {
    signed char rxAtt;
    float rxAttGainOffset;
    short binDiffPeakDEM[24];
    double scTime;
    signed char vprfTableVersion;
    signed char vprfTableSelect;
    signed char catchingInt;
    signed char scdpFlag;
    signed char fcifFlag;
    short logAmpNoiseLevel;
    short delay;
    short seqCountL1A;
    short fcifTemp[2];
    short lnaTemp[2];
    short rdaTemp[2];
    short divcomb1Temp[2];
    short divcomb2Temp[2];
    short sspaTemp[2];
} L1BKa_HS_HOUSEKEEPING;
```

```
#endif

#ifndef _L1BKa_HS_RAYPOINTING_
#define _L1BKa_HS_RAYPOINTING_

typedef struct {
    float rayDirectionX[24];
    float rayDirectionY[24];
    float instrumentYaw[24];
    float instrumentPitch[24];
    float instrumentRoll[24];
    float rayTiming[24];
    float scanAngle[24];
} L1BKa_HS_RAYPOINTING;

#endif

#ifndef _L1BKa_HS_SCANSTATUS_
#define _L1BKa_HS_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char dataWarning;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    signed char limitErrorFlag;
    double FractionalGranuleNumber;
} L1BKa_HS_SCANSTATUS;

#endif

#ifndef _L1BKa_HS_
#define _L1BKa_HS_

typedef struct {
    SCANTIME ScanTime;
```

```
    float Latitude[24];
    float Longitude[24];
    L1BKa_HS_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L1BKa_HS_RAYPOINTING rayPointing;
    L1BKa_HS_HOUSEKEEPING HouseKeeping;
    L1BKa_HS_VERTLOCATE VertLocate;
    L1BKa_HS_CALIBRATION Calibration;
    L1BKa_HS_TRANSMITTER Transmitter;
    L1BKa_HS_RECEIVER Receiver;
} L1BKa_HS;

#endif

#ifndef _L1BKa_MS_RECEIVER_
#define _L1BKa_MS_RECEIVER_

typedef struct {
    unsigned char echoCount[25][260];
    float noiseCount[25];
    short echoPower[25][260];
    short noisePower[25];
    short noiseSampleNumber[25];
    signed char echoSampleNumber[25];
    float rxAntGain[25];
} L1BKa_MS_RECEIVER;

#endif

#ifndef _L1BKa_MS_TRANSMITTER_
#define _L1BKa_MS_TRANSMITTER_

typedef struct {
    float radarTransPower;
    float transPulseWidth;
    float txAntGain[25];
} L1BKa_MS_TRANSMITTER;

#endif

#ifndef _L1BKa_MS_CALIBRATION_
#define _L1BKa_MS_CALIBRATION_
```

```
typedef struct {
    short fcifInPower;
    signed char intAttSelect;
    short sspaLnaSelect;
    signed char angleBinSelect;
} L1BKa_MS_CALIBRATION;

#endif

#ifndef _L1BKa_MS_VERTLOCATE_
#define _L1BKa_MS_VERTLOCATE_

typedef struct {
    short landOceanFlag[25];
    float scLocalZenith[25];
    float startBinRange[25];
    short echoHighResBinNumber[25];
    short echoLowResBinNumber[25];
    short binEllipsoid[25];
    float scRangeEllipsoid[25];
    short binDEM[25];
    float scRangeDEM[25];
    short DEMHmean[25];
    short binDEMHtop[25];
    short binDEMHbottom[25];
    short binEchoPeak[25];
    float alongTrackBeamWidth[25];
    float crossTrackBeamWidth[25];
    short mainlobeEdge[25];
    short sidelobeRange[25];
    float ellipsoidBinOffset[25];
    float rangeBinSize;
    signed char ratioLand[25];
    signed char ratioOcean[25];
    signed char ratioInLand[25];
    signed char ratioCoast[25];
} L1BKa_MS_VERTLOCATE;

#endif

#ifndef _L1BKa_MS_HOUSEKEEPING_
#define _L1BKa_MS_HOUSEKEEPING_
```

```
typedef struct {
    signed char rxAtt;
    float rxAttGainOffset;
    short binDiffPeakDEM[25];
    double scTime;
    signed char vprfTableVersion;
    signed char vprfTableSelect;
    signed char catchingInt;
    signed char scdpFlag;
    signed char fcifFlag;
    short logAmpNoiseLevel;
    short delay;
    short seqCountL1A;
    short fcifTemp[2];
    short lnaTemp[2];
    short rdaTemp[2];
    short divcomb1Temp[2];
    short divcomb2Temp[2];
    short sspaTemp[2];
} L1BKa_MS_HOUSEKEEPING;

#endif

#ifndef _L1BKa_MS_RAYPOINTING_
#define _L1BKa_MS_RAYPOINTING_

typedef struct {
    float rayDirectionX[25];
    float rayDirectionY[25];
    float instrumentYaw[25];
    float instrumentPitch[25];
    float instrumentRoll[25];
    float rayTiming[25];
    float scanAngle[25];
} L1BKa_MS_RAYPOINTING;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scPos[3];
```

```
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _L1BKa_MS_SCANSTATUS_
#define _L1BKa_MS_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char dataWarning;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    signed char limitErrorFlag;
    double FractionalGranuleNumber;
} L1BKa_MS_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
```

```
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1BKa_MS_
#define _L1BKa_MS_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[25];
    float Longitude[25];
    L1BKa_MS_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L1BKa_MS_RAYPOINTING rayPointing;
    L1BKa_MS_HOUSEKEEPING HouseKeeping;
    L1BKa_MS_VERTLOCATE VertLocate;
    L1BKa_MS_CALIBRATION Calibration;
    L1BKa_MS_TRANSMITTER Transmitter;
    L1BKa_MS_RECEIVER Receiver;
} L1BKa_MS;

#endif

#ifndef _L1BKa_SWATHS_
#define _L1BKa_SWATHS_

typedef struct {
    L1BKa_MS MS;
    L1BKa_HS HS;
} L1BKa_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1BKa_HS_RECEIVER/
    CHARACTER echoCount(130,24)
    REAL*4 noiseCount(24)
    INTEGER*2 echoPower(130,24)
    INTEGER*2 noisePower(24)
    INTEGER*2 noiseSampleNumber(24)
    BYTE echoSampleNumber(24)
    REAL*4 rxAntGain(24)
END STRUCTURE

STRUCTURE /L1BKa_HS_TRANSMITTER/
    REAL*4 radarTransPower
    REAL*4 transPulseWidth
    REAL*4 txAntGain(24)
END STRUCTURE

STRUCTURE /L1BKa_HS_CALIBRATION/
    INTEGER*2 fcifInPower
    BYTE intAttSelect
    INTEGER*2 sspaLnaSelect
    BYTE angleBinSelect
END STRUCTURE

STRUCTURE /L1BKa_HS_VERTLOCATE/
    INTEGER*2 landOceanFlag(24)
    REAL*4 scLocalZenith(24)
    REAL*4 startBinRange(24)
    INTEGER*2 echoHighResBinNumber(24)
    INTEGER*2 echoLowResBinNumber(24)
    INTEGER*2 binEllipsoid(24)
    REAL*4 scRangeEllipsoid(24)
    INTEGER*2 binDEM(24)
    REAL*4 scRangeDEM(24)
    INTEGER*2 DEMHmean(24)
    INTEGER*2 binDEMHtop(24)
    INTEGER*2 binDEMHbottom(24)
    INTEGER*2 binEchoPeak(24)
    REAL*4 alongTrackBeamWidth(24)
    REAL*4 crossTrackBeamWidth(24)
    INTEGER*2 mainlobeEdge(24)
    INTEGER*2 sidelobeRange(24)
```

```
    REAL*4 ellipsoidBinOffset(24)
    REAL*4 rangeBinSize
    BYTE ratioLand(24)
    BYTE ratioOcean(24)
    BYTE ratioInLand(24)
    BYTE ratioCoast(24)
END STRUCTURE

STRUCTURE /L1BKa_HS_HOUSEKEEPING/
    BYTE rxAtt
    REAL*4 rxAttGainOffset
    INTEGER*2 binDiffPeakDEM(24)
    REAL*8 scTime
    BYTE vprfTableVersion
    BYTE vprfTableSelect
    BYTE catchingInt
    BYTE scdpFlag
    BYTE fcifFlag
    INTEGER*2 logAmpNoiseLevel
    INTEGER*2 delay
    INTEGER*2 seqCountL1A
    INTEGER*2 fcifTemp(2)
    INTEGER*2 lnaTemp(2)
    INTEGER*2 rdaTemp(2)
    INTEGER*2 divcomb1Temp(2)
    INTEGER*2 divcomb2Temp(2)
    INTEGER*2 sspaTemp(2)
END STRUCTURE

STRUCTURE /L1BKa_HS_RAYPOINTING/
    REAL*4 rayDirectionX(24)
    REAL*4 rayDirectionY(24)
    REAL*4 instrumentYaw(24)
    REAL*4 instrumentPitch(24)
    REAL*4 instrumentRoll(24)
    REAL*4 rayTiming(24)
    REAL*4 scanAngle(24)
END STRUCTURE

STRUCTURE /L1BKa_HS_SCANSTATUS/
    BYTE dataQuality
    BYTE dataWarning
    BYTE missing
```

```
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    BYTE limitErrorFlag
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /L1BKa_HS/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(24)
    REAL*4 Longitude(24)
    RECORD /L1BKa_HS_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L1BKa_HS_RAYPOINTING/ rayPointing
    RECORD /L1BKa_HS_HOUSEKEEPING/ HouseKeeping
    RECORD /L1BKa_HS_VERTLOCATE/ VertLocate
    RECORD /L1BKa_HS_CALIBRATION/ Calibration
    RECORD /L1BKa_HS_TRANSMITTER/ Transmitter
    RECORD /L1BKa_HS_RECEIVER/ Receiver
END STRUCTURE

STRUCTURE /L1BKa_MS_RECEIVER/
    CHARACTER echoCount(260,25)
    REAL*4 noiseCount(25)
    INTEGER*2 echoPower(260,25)
    INTEGER*2 noisePower(25)
    INTEGER*2 noiseSampleNumber(25)
    BYTE echoSampleNumber(25)
    REAL*4 rxAntGain(25)
END STRUCTURE

STRUCTURE /L1BKa_MS_TRANSMITTER/
    REAL*4 radarTransPower
    REAL*4 transPulseWidth
    REAL*4 txAntGain(25)
END STRUCTURE

STRUCTURE /L1BKa_MS_CALIBRATION/
```

```
    INTEGER*2 fcifInPower
    BYTE intAttSelect
    INTEGER*2 sspaLnaSelect
    BYTE angleBinSelect
END STRUCTURE

STRUCTURE /L1BKa_MS_VERTLOCATE/
    INTEGER*2 landOceanFlag(25)
    REAL*4 scLocalZenith(25)
    REAL*4 startBinRange(25)
    INTEGER*2 echoHighResBinNumber(25)
    INTEGER*2 echoLowResBinNumber(25)
    INTEGER*2 binEllipsoid(25)
    REAL*4 scRangeEllipsoid(25)
    INTEGER*2 binDEM(25)
    REAL*4 scRangeDEM(25)
    INTEGER*2 DEMHmean(25)
    INTEGER*2 binDEMHtop(25)
    INTEGER*2 binDEMHbottom(25)
    INTEGER*2 binEchoPeak(25)
    REAL*4 alongTrackBeamWidth(25)
    REAL*4 crossTrackBeamWidth(25)
    INTEGER*2 mainlobeEdge(25)
    INTEGER*2 sidelobeRange(25)
    REAL*4 ellipsoidBinOffset(25)
    REAL*4 rangeBinSize
    BYTE ratioLand(25)
    BYTE ratioOcean(25)
    BYTE ratioInLand(25)
    BYTE ratioCoast(25)
END STRUCTURE

STRUCTURE /L1BKa_MS_HOUSEKEEPING/
    BYTE rxAtt
    REAL*4 rxAttGainOffset
    INTEGER*2 binDiffPeakDEM(25)
    REAL*8 scTime
    BYTE vprfTableVersion
    BYTE vprfTableSelect
    BYTE catchingInt
    BYTE scdpFlag
    BYTE fcifFlag
    INTEGER*2 logAmpNoiseLevel
```

```
    INTEGER*2 delay
    INTEGER*2 seqCountL1A
    INTEGER*2 fcifTemp(2)
    INTEGER*2 lnaTemp(2)
    INTEGER*2 rdaTemp(2)
    INTEGER*2 divcomb1Temp(2)
    INTEGER*2 divcomb2Temp(2)
    INTEGER*2 sspaTemp(2)
END STRUCTURE

STRUCTURE /L1BKa_MS_RAYPOINTING/
    REAL*4 rayDirectionX(25)
    REAL*4 rayDirectionY(25)
    REAL*4 instrumentYaw(25)
    REAL*4 instrumentPitch(25)
    REAL*4 instrumentRoll(25)
    REAL*4 rayTiming(25)
    REAL*4 scanAngle(25)
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L1BKa_MS_SCANSTATUS/
    BYTE dataQuality
    BYTE dataWarning
    BYTE missing
    BYTE modeStatus
```

```
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    BYTE limitErrorFlag
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1BKa_MS/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(25)
    REAL*4 Longitude(25)
    RECORD /L1BKa_MS_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L1BKa_MS_RAYPOINTING/ rayPointing
    RECORD /L1BKa_MS_HOUSEKEEPING/ HouseKeeping
    RECORD /L1BKa_MS_VERTLOCATE/ VertLocate
    RECORD /L1BKa_MS_CALIBRATION/ Calibration
    RECORD /L1BKa_MS_TRANSMITTER/ Transmitter
    RECORD /L1BKa_MS_RECEIVER/ Receiver
END STRUCTURE

STRUCTURE /L1BKa_SWATHS/
    RECORD /L1BKa_MS/ MS
    RECORD /L1BKa_HS/ HS
END STRUCTURE
```

5.21 2AGPROFTMI - Radiometer Profiling

2AGPROFTMI, "Radiometer Profiling", generates surface rainfall and vertical hydrometeor profiles on a pixel by pixel basis from radiometer brightness temperature data using the Goddard Profiling algorithm GPROF2014. Because the vertical information comes from a radiometer, it is not written out in independent vertical layers like the TRMM Precipitation Radar. Instead, the output is referenced to one of 100 typical structures for each hydrometeor or heating profile. These vertical structures are referenced to as profiles in the output structure. Vertical hydrometeor profiles can be reconstructed to 28 layers by knowing the profile number (i.e. shape) of the profile and a scale factor that is written for each pixel.

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel	208	Number of pixels in each scan.
nspecies	5	Number of hydrometeor species. Species are defined in speciesDescription in the DataHeader group.
sddim	12	Number of characters in each species description.
ntemps	21	Number of profile temperature indeces. Indeces are defined in temperatureDescriptions in the DataHeader group.
nlyrs	28	Number of profiling layers. The top height of each layer is defined in hgtTopLayer in the DataHeader group.
nprf	100	Number of unique profiles for each species and 2 meter Temperature index.

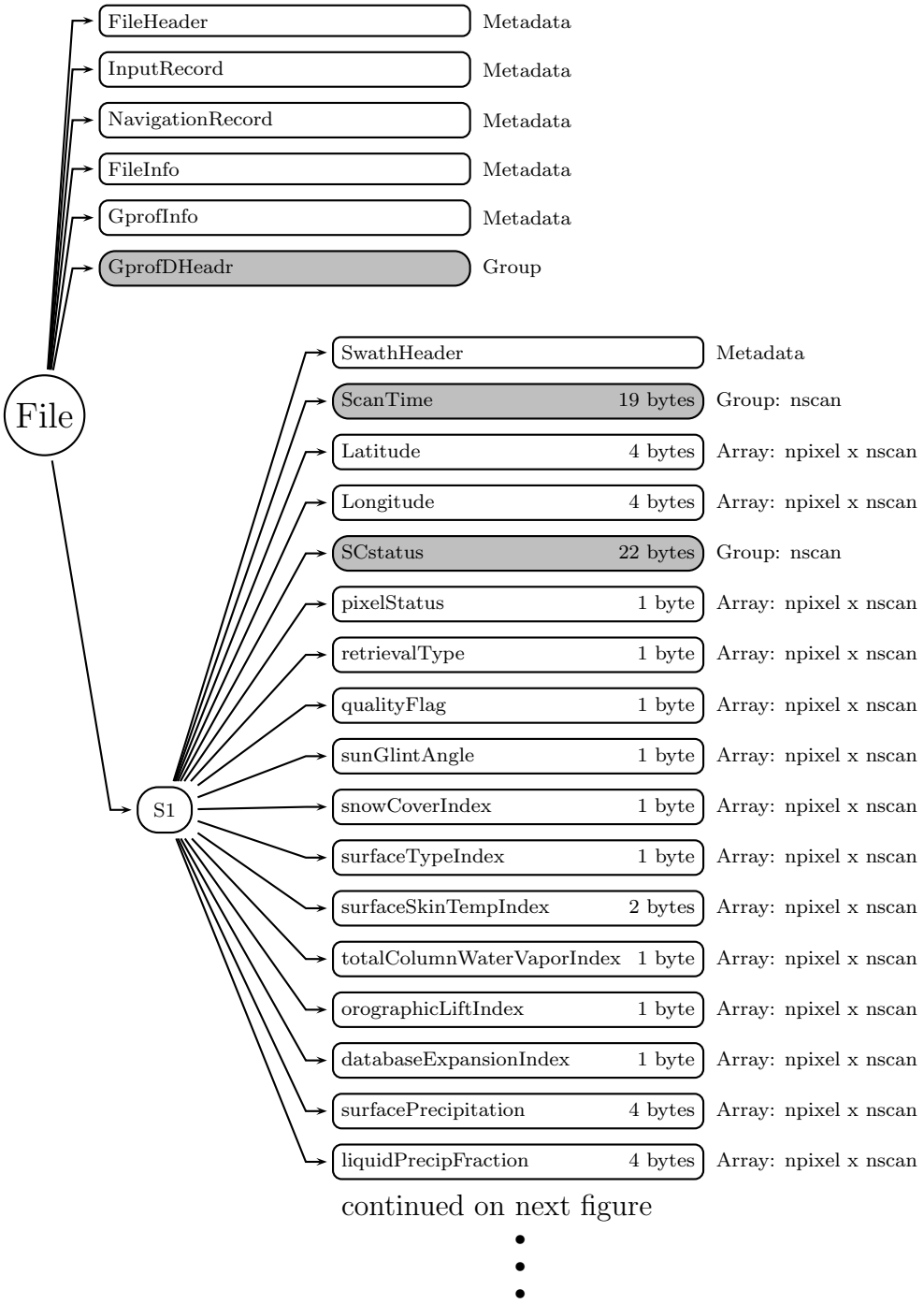
Figure 288 through Figure 292 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.



continued on next figure

Figure 288: Data Format Structure for 2AGPROFTMI, Radiometer Profiling

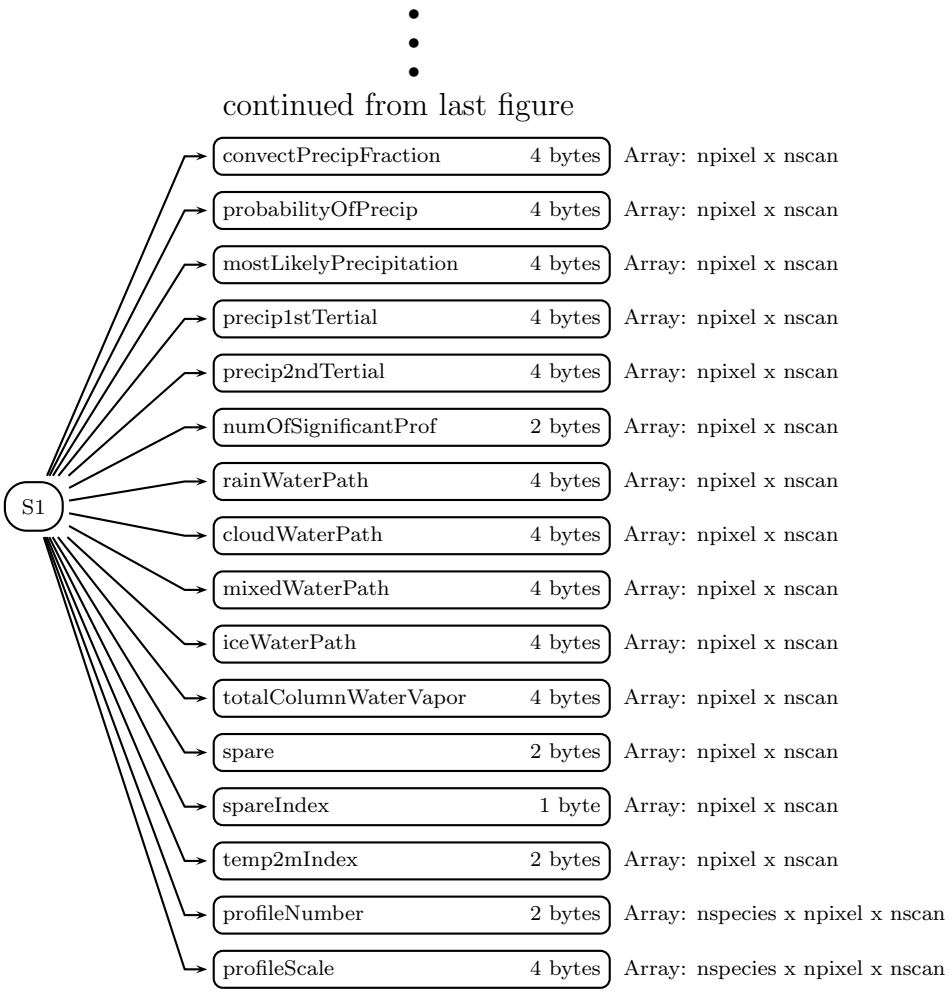


Figure 289: Data Format Structure for 2AGPROFTMI, Radiometer Profiling

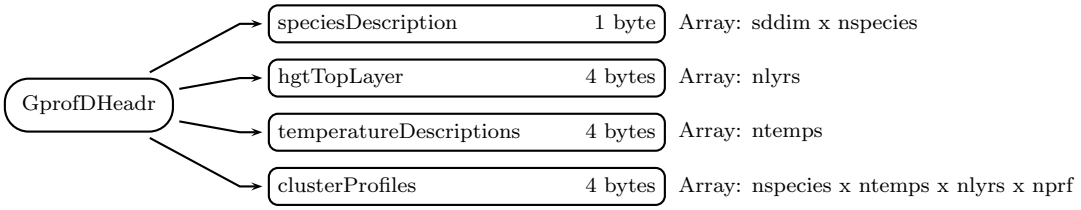


Figure 290: Data Format Structure for 2AGPROFTMI, GprofDHeadr

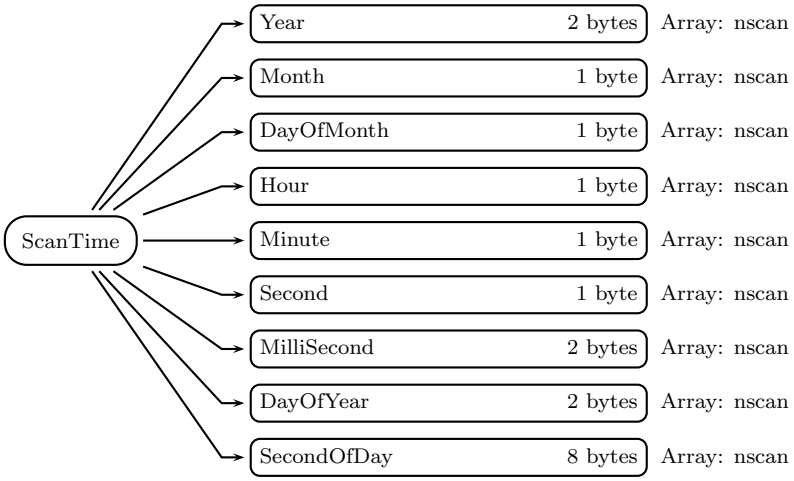


Figure 291: Data Format Structure for 2AGPROFTMI, ScanTime

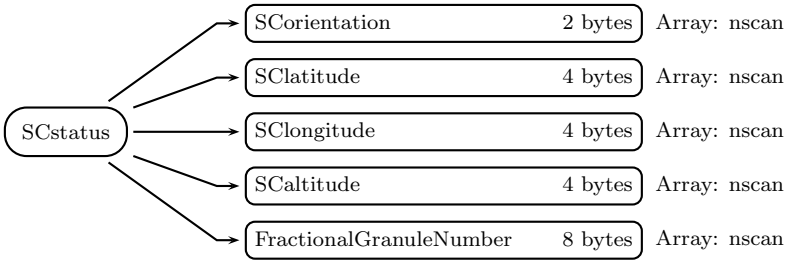


Figure 292: Data Format Structure for 2AGPROFTMI, SCstatus

GprofInfo (Metadata):
GprofInfo contains metadata required by Gprof. Used by 2A12 only. See Metadata for GPM Products for details.

GprofDHeadr (Group)

speciesDescription (1-byte char, array size: sddim x nspecies):
Description of each species. Special values are defined as:
255 Missing value

hgtTopLayer (4-byte float, array size: nlyrs):
Height of the top of each of 28 atmospheric layers in the clusterProfiles. The tops are every 0.5 km up to 10 km, then every km after that up to 18.0 km. Values are: 0.5, 1.0, ... 9.5, 10.0, 11.0, ... 18.0. Values range from 0 to 18.0 km. Special values are defined as:
-9999.9 Missing value

temperatureDescriptions (4-byte float, array size: ntemps):
Temperature of 2 meter temperature indeces of clusterProfiles. Values are in C. Special values are defined as:
-9999.9 Missing value

clusterProfiles (4-byte float, array size: nspecies x ntemps x nlyrs x nprf):
Standard GPM profile structures. Dimensions are hydrometeor/heating species (4); 2 meter temperature index (21); vertical layers (28); and profile number (100). To recover values in a profile see the description below in the variable profileScale.

Special values are defined as:
-9999.9 Missing value

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCstatus (Group)

SCorientation (2-byte integer, array size: nscan):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

pixelStatus (1-byte integer, array size: npixel x nscan):
If there is no retrieval at a given pixel, pixelStatus explains the reason (Range 0 - 99).

```
  0 : Valid pixel
  1 : Boundary error in landmask
  2 : Boundary error in sea-ice check
  3 : Boundary error in sea surface temperature
  4 : Invalid time
  5 : Invalid latitude/longitude
  6 : Invalid brightness temperature
  7 : Invalid sea surface temperature
-99 : Missing value
```

retrievalType (1-byte integer, array size: npixel x nscan):
Specifies that for this pixel, the rain retrieval was made with the S0, S1, or S2 (values are 0,1,2).

qualityFlag (1-byte integer, array size: npixel x nscan):
qualityFlag indicates a generalized quality of the retrieved pixel (Range 0 - 99).

```
      High:    Good retrieval using the GPM derived profile databases
      Medium:  Retrieval using the GPM derived profile databases.
               over coastal areas or in areas of oceanic sunglint.
      Low:     Retrievals using at-launch databases.
  Valid values include:
      0 : High quality (retrieval is good, use it)
      1 : Medium quality (use with caution)
      2 : Low quality (recommended qualitative use only)
    -99 : Missing value
```

sunGlintAngle (1-byte integer, array size: npixel x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. sunGlintAngle is the angular separation between the reflected satellite view vector and the sun vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. If this angle is less than ten degrees, the pixel is affected by sunglint and qualityFlag for the pixel is lowered. Values range from 0 to 180 degrees. Special values are defined as:
-99 Missing value

snowCoverIndex (1-byte integer, array size: npixel x nscan):
An index based on snow depth. Not currently implemented. Values range from 0 to 5. Special values are defined as:
-99 Missing value

surfaceTypeIndex (1-byte integer, array size: npixel x nscan):
Indicates the type of surface (Range 0 - 99).

```
 Codes include
 1  : Ocean
 2  : Sea-Ice
 (3-12 are 'land classification')
 3  : Maximum Vegetation
 4  : High Vegetation
 5  : Moderate Vegetation
 6  : Low Vegetation
 7  : Minimal Vegetation
 8  : Maximum Snow
 9  : Moderate Snow
 10 : Low Snow
 11 : Minimal Snow
 12 : Standing Water and Rivers
 13 : Water/Land Coast Boundary
 14 : Water/Ice Boundary
 15 : Land/Ice Boundary
-99 : Missing value
```

surfaceSkinTempIndex (2-byte integer, array size: npixel x nscan):
Surface temperature from the model, used to select the correct database profiles.

totalColumnWaterVaporIndex (1-byte integer, array size: npixel x nscan):
Liquid equivalent of the total water vapor column used to select the correct database profiles. Values range from 0 to 75 mm. Special values are defined as:
-99 Missing value

orographicLiftIndex (1-byte integer, array size: npixel x nscan):
Index of potential orographic enhancement to precipitation based on vertical motion, atmospheric moisture profile, wind direction, and terrain slope. Not currently implemented. Special values are defined as:
-99 Missing value

databaseExpansionIndex (1-byte integer, array size: npixel x nscan):
Expansion factor of the profile search radius in the profile database beyond the search nominal range. If there are fewer than the minimum number of profiles in the selected database boundaries, then the search radius is expanded. Values range from 0 to 255.

surfacePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous precipitation rate at the surface for each pixel. Check pixelStatus for a valid retrieval. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

liquidPrecipFraction (4-byte float, array size: npixel x nscan):
Fraction of surface precipitation that is liquid. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

convectPrecipFraction (4-byte float, array size: npixel x nscan):
Fraction of surface precipitation that is convective. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

probabilityOfPrecip (4-byte float, array size: npixel x nscan):
A diagnostic variable, in percent, defining the fraction of raining vs. non-raining Database profiles that make up the final solution. Values range from 0 to 100 percent. Special values are defined as:
-9999.9 Missing value

mostLikelyPrecipitation (4-byte float, array size: npixel x nscan):
The surface precipitation value with the highest occurrence within the Bayesian retrieval. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip1stTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 1st tertiary of the precipitation distribution. Values

are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip2ndTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 2nd tertiary of the precipitation distribution. Special values are defined as:
-9999.9 Missing value

numOfSignificantProf (2-byte integer, array size: npixel x nscan):
Number of profiles used in the Bayesian average above 2 sigma. Profiles below this threshold are still used in the average, but are not included in this 'significant' profiles parameter. Special values are defined as:
-9999 Missing value

rainWaterPath (4-byte float, array size: npixel x nscan):
Total integrated rain water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

cloudWaterPath (4-byte float, array size: npixel x nscan):
Total integrated cloud liquid water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

mixedWaterPath (4-byte float, array size: npixel x nscan):
Total integrated mixed phase water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

iceWaterPath (4-byte float, array size: npixel x nscan):
Total integrated cloud ice water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

totalColumnWaterVapor (4-byte float, array size: npixel x nscan):
Total integrated water vapor in the vertical atmospheric column, also known as total precipitable water (TPW). Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

spare (2-byte integer, array size: npixel x nscan):
Spare variable. Special values are defined as:
-9999 Missing value

spareIndex (1-byte integer, array size: npixel x nscan):
Spare index variable. Special values are defined as:
-99 Missing value

temp2mIndex (2-byte integer, array size: npixel x nscan):
Temperature 2 meter height Index in the clusterProfiles array. See profileScale description

below. Values range from 1 to 21. Special values are defined as:
-9999 Missing value

profileNumber (2-byte integer, array size: nspecies x npixel x nscan):
Profile Number in the clusterProfiles array for each species. See profileScale description below. Values range from 1 to 100. Special values are defined as:
-9999 Missing value

profileScale (4-byte float, array size: nspecies x npixel x nscan):
profileScale is used to scale the values of the clusterProfiles array.

```
In order to recover a value of a single pixel,
select your species, layer, and temp2mindex,
then use profileNumber and profileScale
to obtain the value:

Where:
  S = species (1-5)
    Species defined in speciesDescription
  T = temp2mIndex (1-21)
    Temperatures defined in temperatureDescriptions
  L = profile layer (1-28) Top of each layer
    specified in hgtTopLayer
  P = profileNumber (1-100) for species S

In a Fortran program,
  P = profileNumber(S)
  Pixel Value = profileScale(S) * clusterProfiles(S,T,L,P)

In a C program,
  P = profileNumber[S-1]
  Pixel Value = profileScale[S] * clusterProfiles[P-1][L-1][T-1][S-1]
```

C Structure Header file:

```
#ifndef _TK_2AGPROFTMI_H_
#define _TK_2AGPROFTMI_H_

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
```

```
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2AGPROFTMI_S1_
#define _L2AGPROFTMI_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[208];
    float Longitude[208];
    SCSTATUS SCstatus;
    signed char pixelStatus[208];
    signed char retrievalType[208];
    signed char qualityFlag[208];
    signed char sunGlintAngle[208];
    signed char snowCoverIndex[208];
    signed char surfaceTypeIndex[208];
    short surfaceSkinTempIndex[208];
    signed char totalColumnWaterVaporIndex[208];
    signed char orographicLiftIndex[208];
    signed char databaseExpansionIndex[208];
    float surfacePrecipitation[208];
```

```
    float liquidPrecipFraction[208];
    float convectPrecipFraction[208];
    float probabilityOfPrecip[208];
    float mostLikelyPrecipitation[208];
    float precip1stTertial[208];
    float precip2ndTertial[208];
    short numOfSignificantProf[208];
    float rainWaterPath[208];
    float cloudWaterPath[208];
    float mixedWaterPath[208];
    float iceWaterPath[208];
    float totalColumnWaterVapor[208];
    short spare[208];
    signed char spareIndex[208];
    short temp2mIndex[208];
    short profileNumber[208][5];
    float profileScale[208][5];
} L2AGPROFTMI_S1;

#endif

#ifndef _GPROFDHEADR_
#define _GPROFDHEADR_

typedef struct {
    unsigned char speciesDescription[5][12];
    float hgtTopLayer[28];
    float temperatureDescriptions[21];
    float clusterProfiles[100][28][21][5];
} GPROFDHEADR;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
```

```
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2AGPROFTMI_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(208)
    REAL*4 Longitude(208)
    RECORD /SCSTATUS/ SCstatus
    BYTE pixelStatus(208)
    BYTE retrievalType(208)
    BYTE qualityFlag(208)
    BYTE sunGlintAngle(208)
    BYTE snowCoverIndex(208)
    BYTE surfaceTypeIndex(208)
    INTEGER*2 surfaceSkinTempIndex(208)
    BYTE totalColumnWaterVaporIndex(208)
    BYTE orographicLiftIndex(208)
    BYTE databaseExpansionIndex(208)
    REAL*4 surfacePrecipitation(208)
    REAL*4 liquidPrecipFraction(208)
    REAL*4 convectPrecipFraction(208)
    REAL*4 probabilityOfPrecip(208)
    REAL*4 mostLikelyPrecipitation(208)
    REAL*4 precip1stTertial(208)
    REAL*4 precip2ndTertial(208)
    INTEGER*2 numOfSignificantProf(208)
    REAL*4 rainWaterPath(208)
    REAL*4 cloudWaterPath(208)
    REAL*4 mixedWaterPath(208)
    REAL*4 iceWaterPath(208)
    REAL*4 totalColumnWaterVapor(208)
    INTEGER*2 spare(208)
```

```
    BYTE spareIndex(208)
    INTEGER*2 temp2mIndex(208)
    INTEGER*2 profileNumber(5,208)
    REAL*4 profileScale(5,208)
END STRUCTURE

STRUCTURE /GPROFDHEADR/
    CHARACTER speciesDescription(12,5)
    REAL*4 hgtTopLayer(28)
    REAL*4 temperatureDescriptions(21)
    REAL*4 clusterProfiles(5,21,28,100)
END STRUCTURE
```

5.22 2AGPROFGMI - Radiometer Profiling

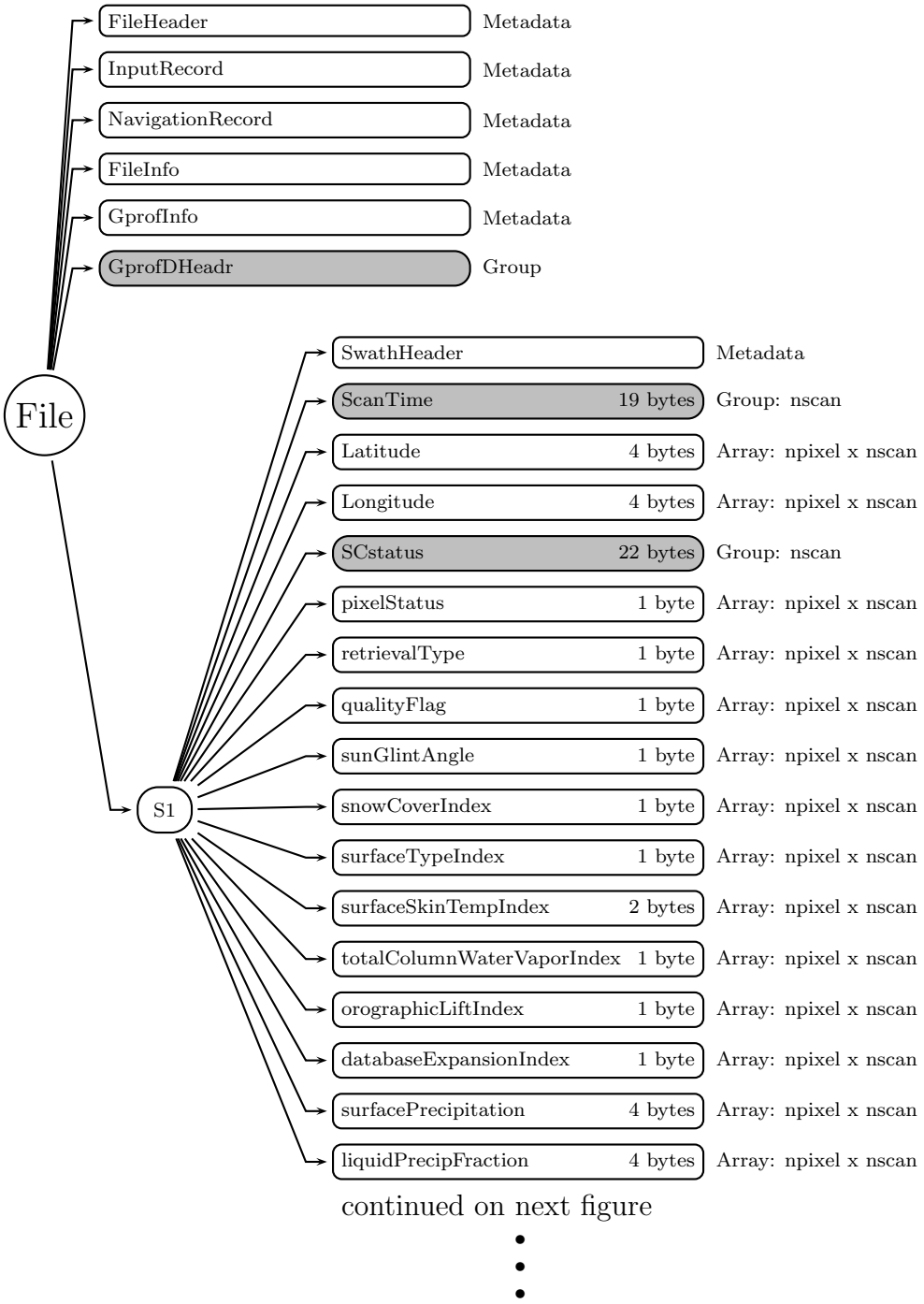
2AGPROFGMI, "Radiometer Profiling", generates surface rainfall and vertical hydrometeor profiles on a pixel by pixel basis from radiometer brightness temperature data using the Goddard Profiling algorithm GPROF2014. Because the vertical information comes from a radiometer, it is not written out in independent vertical layers like the TRMM Precipitation Radar. Instead, the output is referenced to one of 100 typical structures for each hydrometeor or heating profile. These vertical structures are referenced to as profiles in the output structure. Vertical hydrometeor profiles can be reconstructed to 28 layers by knowing the profile number (i.e. shape) of the profile and a scale factor that is written for each pixel.

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel	221	Number of pixels in each scan.
nspecies	5	Number of hydrometeor species. Species are defined in speciesDescription in the DataHeader group.
sddim	12	Number of characters in each species description.
ntemps	21	Number of profile temperature indeces. Indeces are defined in temperatureDescriptions in the DataHeader group.
nlyrs	28	Number of profiling layers. The top height of each layer is defined in hgtTopLayer in the DataHeader group.
nprf	100	Number of unique profiles for each species and 2 meter Temperature index.

Figure 293 through Figure 297 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See



continued on next figure

Figure 293: Data Format Structure for 2AGPROFGMI, Radiometer Profiling

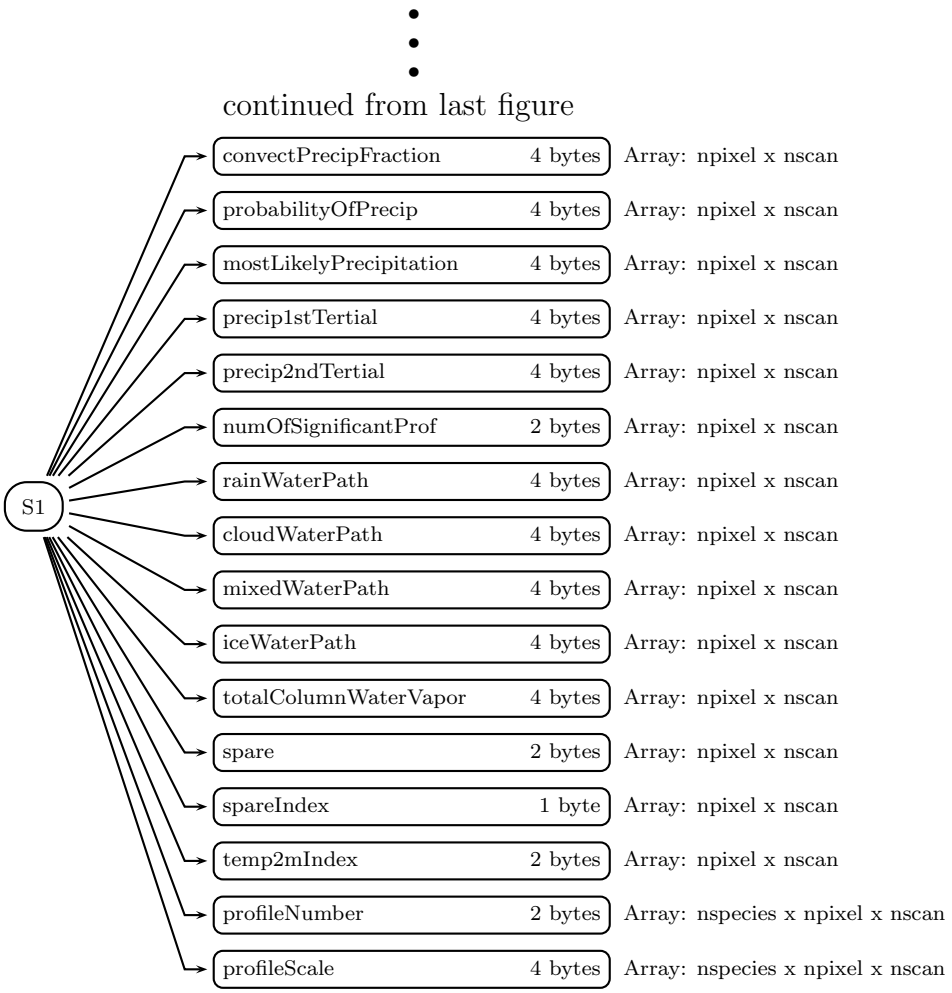


Figure 294: Data Format Structure for 2AGPROFGMI, Radiometer Profiling

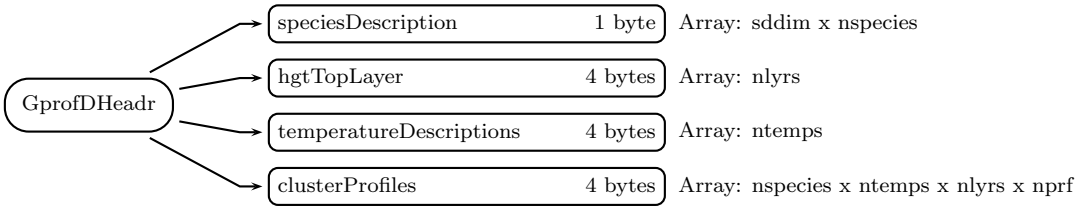


Figure 295: Data Format Structure for 2AGPROFGMI, GprofDHeadr

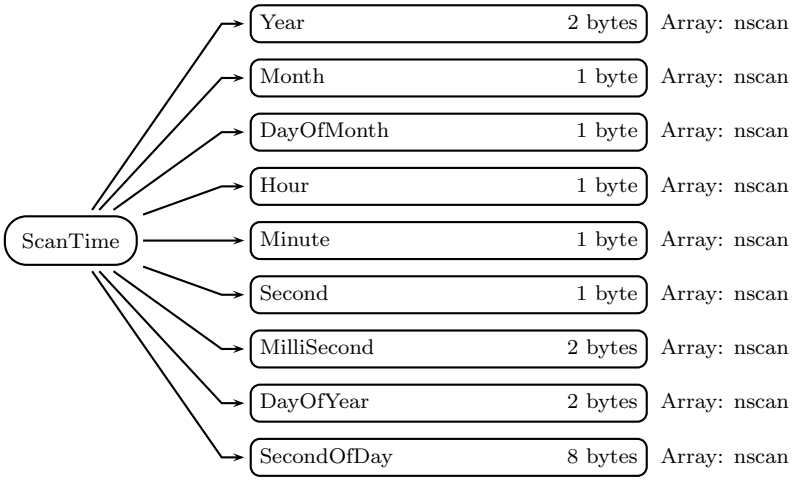


Figure 296: Data Format Structure for 2AGPROFGMI, ScanTime

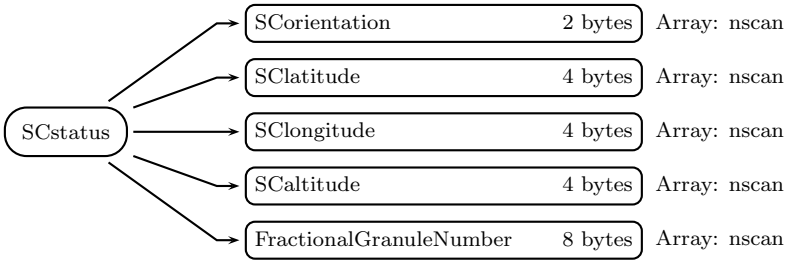


Figure 297: Data Format Structure for 2AGPROFGMI, SCstatus

Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

GprofInfo (Metadata):
GprofInfo contains metadata required by Gprof. Used by 2A12 only. See Metadata for GPM Products for details.

GprofDHeadr (Group)

speciesDescription (1-byte char, array size: sddim x nspecies):
Description of each species. Special values are defined as:
255 Missing value

hgtTopLayer (4-byte float, array size: nlyrs):
Height of the top of each of 28 atmospheric layers in the clusterProfiles. The tops are every 0.5 km up to 10 km, then every km after that up to 18.0 km. Values are: 0.5, 1.0, ... 9.5, 10.0, 11.0, ... 18.0. Values range from 0 to 18.0 km. Special values are defined as:
-9999.9 Missing value

temperatureDescriptions (4-byte float, array size: ntemps):
Temperature of 2 meter temperature indeces of clusterProfiles. Values are in C. Special values are defined as:
-9999.9 Missing value

clusterProfiles (4-byte float, array size: nspecies x ntemps x nlyrs x nprf):
Standard GPM profile structures. Dimensions are hydrometeor/heating species (4); 2 meter temperature index (21); vertical layers (28); and profile number (100). To recover values in a profile see the description below in the variable profileScale.

Special values are defined as:
-9999.9 Missing value

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude

is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCstatus (Group)

SCorientation (2-byte integer, array size: nscan):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

pixelStatus (1-byte integer, array size: npixel x nscan):
If there is no retrieval at a given pixel, pixelStatus explains the reason (Range 0 - 99).

```
0 : Valid pixel
1 : Boundary error in landmask
2 : Boundary error in sea-ice check
3 : Boundary error in sea surface temperature
4 : Invalid time
```

```
   5 : Invalid latitude/longitude
   6 : Invalid brightness temperature
   7 : Invalid sea surface temperature
 -99 : Missing value
```

retrievalType (1-byte integer, array size: npixel x nscan):
Specifies that for this pixel, the rain retrieval was made with the S0, S1, or S2 (values are 0,1,2).

qualityFlag (1-byte integer, array size: npixel x nscan):
qualityFlag indicates a generalized quality of the retrieved pixel (Range 0 - 99).

```
       High:    Good retrieval using the GPM derived profile databases
       Medium:  Retrieval using the GPM derived profile databases.
                over coastal areas or in areas of oceanic sunglint.
       Low:     Retrievals using at-launch databases.
   Valid values include:
       0 : High quality (retrieval is good, use it)
       1 : Medium quality (use with caution)
       2 : Low quality (recommended qualitative use only)
     -99 : Missing value
```

sunGlintAngle (1-byte integer, array size: npixel x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. sunGlintAngle is the angular separation between the reflected satellite view vector and the sun vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. If this angle is less than ten degrees, the pixel is affected by sunglint and qualityFlag for the pixel is lowered. Values range from 0 to 180 degrees. Special values are defined as:
-99 Missing value

snowCoverIndex (1-byte integer, array size: npixel x nscan):
An index based on snow depth. Not currently implemented. Values range from 0 to 5. Special values are defined as:
-99 Missing value

surfaceTypeIndex (1-byte integer, array size: npixel x nscan):
Indicates the type of surface (Range 0 - 99).

```
  Codes include
  1  : Ocean
  2  : Sea-Ice
  (3-12 are 'land classification')
```

```
  3  : Maximum Vegetation
  4  : High Vegetation
  5  : Moderate Vegetation
  6  : Low Vegetation
  7  : Minimal Vegetation
  8  : Maximum Snow
  9  : Moderate Snow
  10 : Low Snow
  11 : Minimal Snow
  12 : Standing Water and Rivers
  13 : Water/Land Coast Boundary
  14 : Water/Ice Boundary
  15 : Land/Ice Boundary
 -99 : Missing value
```

surfaceSkinTempIndex (2-byte integer, array size: npixel x nscan):
Surface temperature from the model, used to select the correct database profiles.

totalColumnWaterVaporIndex (1-byte integer, array size: npixel x nscan):
Liquid equivalent of the total water vapor column used to select the correct database profiles. Values range from 0 to 75 mm. Special values are defined as:
-99 Missing value

orographicLiftIndex (1-byte integer, array size: npixel x nscan):
Index of potential orographic enhancement to precipitation based on vertical motion, atmospheric moisture profile, wind direction, and terrain slope. Not currently implemented. Special values are defined as:
-99 Missing value

databaseExpansionIndex (1-byte integer, array size: npixel x nscan):
Expansion factor of the profile search radius in the profile database beyond the search nominal range. If there are fewer than the minimum number of profiles in the selected database boundaries, then the search radius is expanded. Values range from 0 to 255.

surfacePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous precipitation rate at the surface for each pixel. Check pixelStatus for a valid retrieval. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

liquidPrecipFraction (4-byte float, array size: npixel x nscan):
Fraction of surface precipitation that is liquid. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

convectPrecipFraction (4-byte float, array size: npixel x nscan):
Fraction of surface precipitation that is convective. Values range from 0 to 1. Special

values are defined as:
-9999.9 Missing value

probabilityOfPrecip (4-byte float, array size: npixel x nscan):
A diagnostic variable, in percent, defining the fraction of raining vs. non-raining Database profiles that make up the final solution. Values range from 0 to 100 percent. Special values are defined as:
-9999.9 Missing value

mostLikelyPrecipitation (4-byte float, array size: npixel x nscan):
The surface precipitation value with the highest occurrence within the Bayesian retrieval. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip1stTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 1st tertiary of the precipitation distribution. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip2ndTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 2nd tertiary of the precipitation distribution. Special values are defined as:
-9999.9 Missing value

numOfSignificantProf (2-byte integer, array size: npixel x nscan):
Number of profiles used in the Bayesian average above 2 sigma. Profiles below this threshold are still used in the average, but are not included in this 'significant' profiles parameter. Special values are defined as:
-9999 Missing value

rainWaterPath (4-byte float, array size: npixel x nscan):
Total integrated rain water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

cloudWaterPath (4-byte float, array size: npixel x nscan):
Total integrated cloud liquid water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

mixedWaterPath (4-byte float, array size: npixel x nscan):
Total integrated mixed phase water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

iceWaterPath (4-byte float, array size: npixel x nscan):
Total integrated cloud ice water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

totalColumnWaterVapor (4-byte float, array size: npixel x nscan):
Total integrated water vapor in the vertical atmospheric column, also known as total precipitable water (TPW). Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

spare (2-byte integer, array size: npixel x nscan):
Spare variable. Special values are defined as:
-9999 Missing value

spareIndex (1-byte integer, array size: npixel x nscan):
Spare index variable. Special values are defined as:
-99 Missing value

temp2mIndex (2-byte integer, array size: npixel x nscan):
Temperature 2 meter height Index in the clusterProfiles array. See profileScale description below. Values range from 1 to 21. Special values are defined as:
-9999 Missing value

profileNumber (2-byte integer, array size: nspecies x npixel x nscan):
Profile Number in the clusterProfiles array for each species. See profileScale description below. Values range from 1 to 100. Special values are defined as:
-9999 Missing value

profileScale (4-byte float, array size: nspecies x npixel x nscan):
profileScale is used to scale the values of the clusterProfiles array.

```
In order to recover a value of a single pixel,
select your species, layer, and temp2mindex,
then use profileNumber and profileScale
to obtain the value:

Where:
  S = species (1-5)
    Species defined in speciesDescription
  T = temp2mIndex (1-21)
    Temperatures defined in temperatureDescriptions
  L = profile layer (1-28) Top of each layer
    specified in hgtTopLayer
  P = profileNumber (1-100) for species S

In a Fortran program,
  P = profileNumber(S)
  Pixel Value = profileScale(S) * clusterProfiles(S,T,L,P)

In a C program,
  P = profileNumber[S-1]
```

```
  Pixel Value = profileScale[S] * clusterProfiles[P-1][L-1][T-1][S-1]
```

C Structure Header file:

```
#ifndef _TK_2AGPROFGMI_H_
#define _TK_2AGPROFGMI_H_

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2AGPROFGMI_S1_
#define _L2AGPROFGMI_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
```

```
    float Longitude[221];
    SCSTATUS SCstatus;
    signed char pixelStatus[221];
    signed char retrievalType[221];
    signed char qualityFlag[221];
    signed char sunGlintAngle[221];
    signed char snowCoverIndex[221];
    signed char surfaceTypeIndex[221];
    short surfaceSkinTempIndex[221];
    signed char totalColumnWaterVaporIndex[221];
    signed char orographicLiftIndex[221];
    signed char databaseExpansionIndex[221];
    float surfacePrecipitation[221];
    float liquidPrecipFraction[221];
    float convectPrecipFraction[221];
    float probabilityOfPrecip[221];
    float mostLikelyPrecipitation[221];
    float precip1stTertial[221];
    float precip2ndTertial[221];
    short numOfSignificantProf[221];
    float rainWaterPath[221];
    float cloudWaterPath[221];
    float mixedWaterPath[221];
    float iceWaterPath[221];
    float totalColumnWaterVapor[221];
    short spare[221];
    signed char spareIndex[221];
    short temp2mIndex[221];
    short profileNumber[221][5];
    float profileScale[221][5];
} L2AGPROFGMI_S1;

#endif

#ifndef _GPROFDHEADR_
#define _GPROFDHEADR_

typedef struct {
    unsigned char speciesDescription[5][12];
    float hgtTopLayer[28];
    float temperatureDescriptions[21];
    float clusterProfiles[100][28][21][5];
} GPROFDHEADR;
```

```
#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2AGPROFGMI_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    RECORD /SCSTATUS/ SCstatus
    BYTE pixelStatus(221)
    BYTE retrievalType(221)
    BYTE qualityFlag(221)
    BYTE sunGlintAngle(221)
    BYTE snowCoverIndex(221)
    BYTE surfaceTypeIndex(221)
    INTEGER*2 surfaceSkinTempIndex(221)
    BYTE totalColumnWaterVaporIndex(221)
    BYTE orographicLiftIndex(221)
    BYTE databaseExpansionIndex(221)
    REAL*4 surfacePrecipitation(221)
```

```
    REAL*4 liquidPrecipFraction(221)
    REAL*4 convectPrecipFraction(221)
    REAL*4 probabilityOfPrecip(221)
    REAL*4 mostLikelyPrecipitation(221)
    REAL*4 precip1stTertial(221)
    REAL*4 precip2ndTertial(221)
    INTEGER*2 numOfSignificantProf(221)
    REAL*4 rainWaterPath(221)
    REAL*4 cloudWaterPath(221)
    REAL*4 mixedWaterPath(221)
    REAL*4 iceWaterPath(221)
    REAL*4 totalColumnWaterVapor(221)
    INTEGER*2 spare(221)
    BYTE spareIndex(221)
    INTEGER*2 temp2mIndex(221)
    INTEGER*2 profileNumber(5,221)
    REAL*4 profileScale(5,221)
END STRUCTURE

STRUCTURE /GPROFDHEADR/
    CHARACTER speciesDescription(12,5)
    REAL*4 hgtTopLayer(28)
    REAL*4 temperatureDescriptions(21)
    REAL*4 clusterProfiles(5,21,28,100)
END STRUCTURE
```

5.23 2AGPROFSSMIS - Radiometer Profiling

2AGPROFSSMIS, "Radiometer Profiling", generates surface rainfall and vertical hydrometeor profiles on a pixel by pixel basis from radiometer brightness temperature data using the Goddard Profiling algorithm GPROF2014. Because the vertical information comes from a radiometer, it is not written out in independent vertical layers like the TRMM Precipitation Radar. Instead, the output is referenced to one of 100 typical structures for each hydrometeor or heating profile. These vertical structures are referenced to as profiles in the output structure. Vertical hydrometeor profiles can be reconstructed to 28 layers by knowing the profile number (i.e. shape) of the profile and a scale factor that is written for each pixel.

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel	180	Number of pixels in each scan.
nspecies	5	Number of hydrometeor species. Species are defined in speciesDescription in the DataHeader group.
sddim	12	Number of characters in each species description.
ntemps	21	Number of profile temperature indeces. Indeces are defined in temperatureDescriptions in the DataHeader group.
nlyrs	28	Number of profiling layers. The top height of each layer is defined in hgtTopLayer in the DataHeader group.
nprf	100	Number of unique profiles for each species and 2 meter Temperature index.

Figure 298 through Figure 302 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

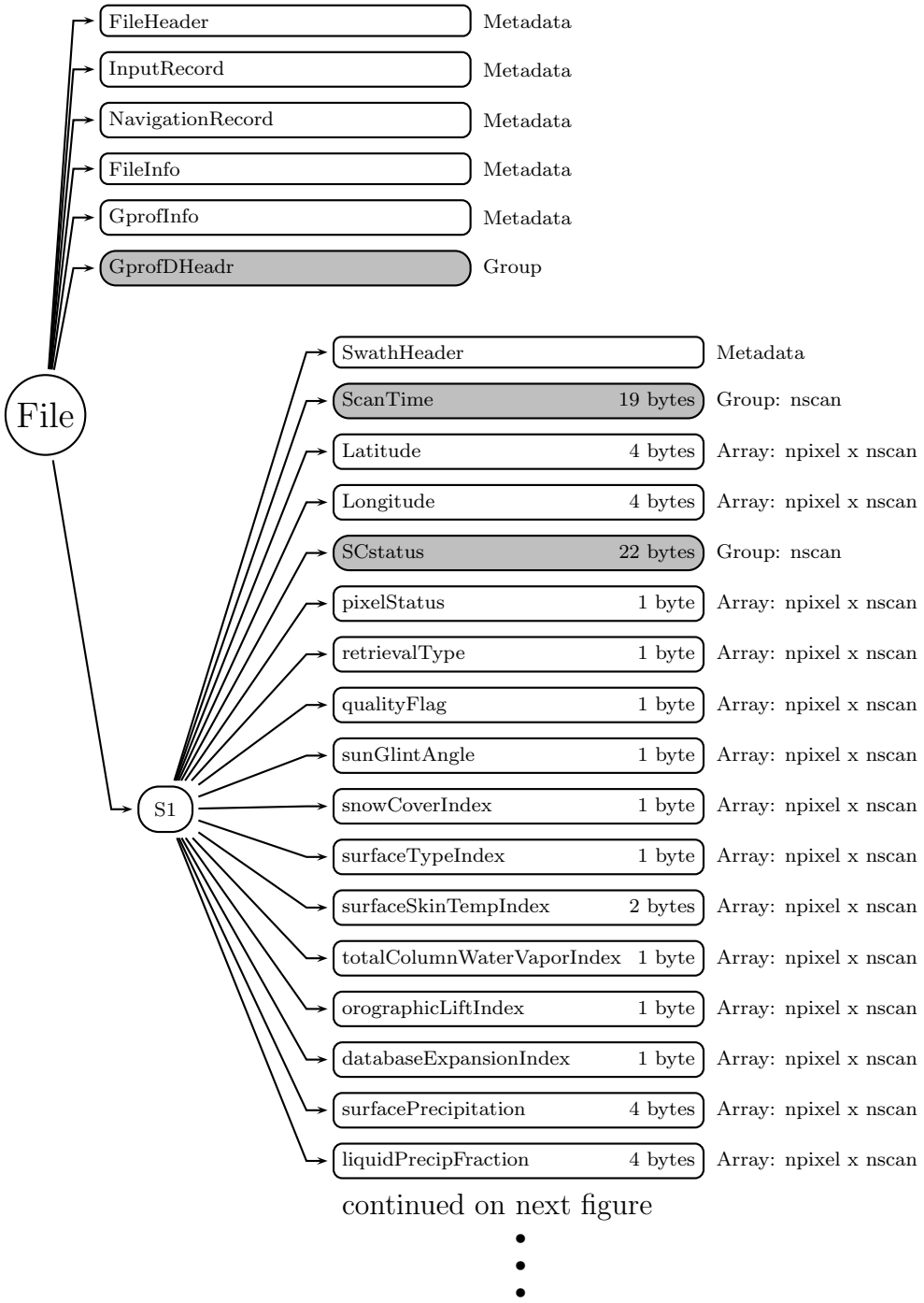
FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

GprofInfo (Metadata):
GprofInfo contains metadata required by Gprof. Used by 2A12 only. See Metadata for GPM Products for details.

GprofDHeadr (Group)

speciesDescription (1-byte char, array size: sddim x nspecies):
Description of each species. Special values are defined as:
255 Missing value

hgtTopLayer (4-byte float, array size: nlyrs):
Height of the top of each of 28 atmospheric layers in the clusterProfiles. The tops are every 0.5 km up to 10 km, then every km after that up to 18.0 km. Values are: 0.5, 1.0,



continued on next figure

Figure 298: Data Format Structure for 2AGPROFSSMIS, Radiometer Profiling

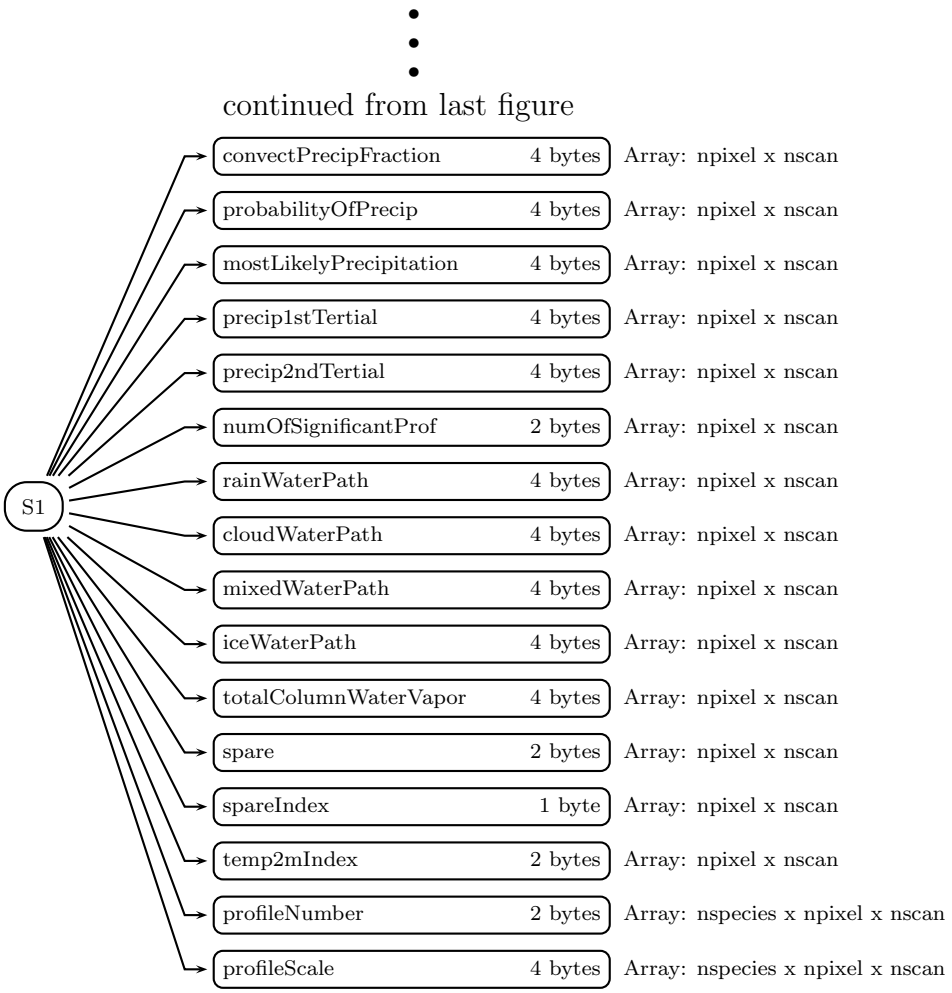


Figure 299: Data Format Structure for 2AGPROFSSMIS, Radiometer Profiling

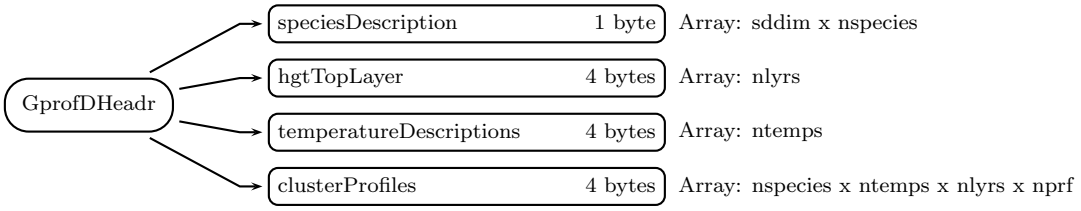


Figure 300: Data Format Structure for 2AGPROFSSMIS, GprofDHeadr

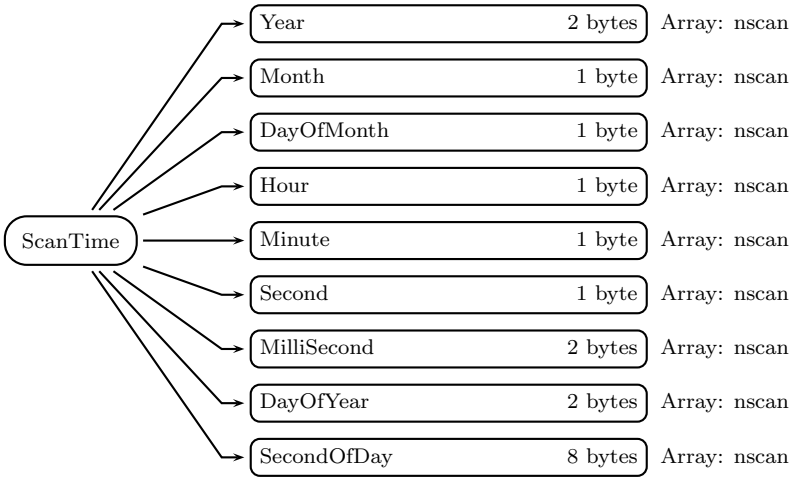


Figure 301: Data Format Structure for 2AGPROFSSMIS, ScanTime

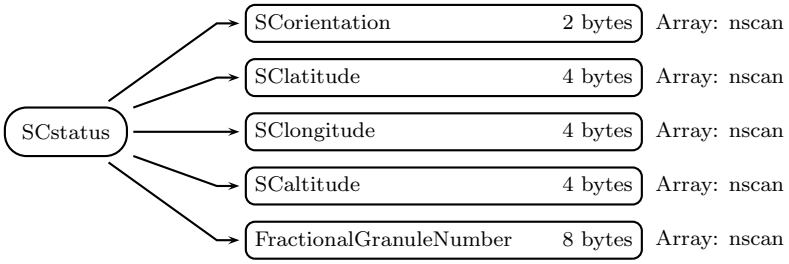


Figure 302: Data Format Structure for 2AGPROFSSMIS, SCstatus

... 9.5, 10.0, 11.0, ... 18.0. Values range from 0 to 18.0 km. Special values are defined as:
-9999.9 Missing value

temperatureDescriptions (4-byte float, array size: ntemps):
Temperature of 2 meter temperature indeces of clusterProfiles. Values are in C. Special values are defined as:
-9999.9 Missing value

clusterProfiles (4-byte float, array size: nspecies x ntemps x nlyrs x nprf):
Standard GPM profile structures. Dimensions are hydrometeor/heating species (4); 2 meter temperature index (21); vertical layers (28); and profile number (100). To recover values in a profile see the description below in the variable profileScale.

Special values are defined as:
-9999.9 Missing value

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCstatus (Group)

SCorientation (2-byte integer, array size: nscan):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

pixelStatus (1-byte integer, array size: npixel x nscan):
If there is no retrieval at a given pixel, pixelStatus explains the reason (Range 0 - 99).

```
  0 : Valid pixel
  1 : Boundary error in landmask
  2 : Boundary error in sea-ice check
  3 : Boundary error in sea surface temperature
  4 : Invalid time
  5 : Invalid latitude/longitude
  6 : Invalid brightness temperature
  7 : Invalid sea surface temperature
-99 : Missing value
```

retrievalType (1-byte integer, array size: npixel x nscan):
Specifies that for this pixel, the rain retrieval was made with the S0, S1, or S2 (values are 0,1,2).

qualityFlag (1-byte integer, array size: npixel x nscan):
qualityFlag indicates a generalized quality of the retrieved pixel (Range 0 - 99).

```
      High:    Good retrieval using the GPM derived profile databases
      Medium:  Retrieval using the GPM derived profile databases.
               over coastal areas or in areas of oceanic sunglint.
      Low:     Retrievals using at-launch databases.
  Valid values include:
      0 : High quality (retrieval is good, use it)
      1 : Medium quality (use with caution)
      2 : Low quality (recommended qualitative use only)
    -99 : Missing value
```

sunGlintAngle (1-byte integer, array size: npixel x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected

off the Earth's surface. sunGlintAngle is the angular separation between the reflected satellite view vector and the sun vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. If this angle is less than ten degrees, the pixel is affected by sunglint and qualityFlag for the pixel is lowered. Values range from 0 to 180 degrees. Special values are defined as:
-99 Missing value

snowCoverIndex (1-byte integer, array size: npixel x nscan):
An index based on snow depth. Not currently implemented. Values range from 0 to 5. Special values are defined as:
-99 Missing value

surfaceTypeIndex (1-byte integer, array size: npixel x nscan):
Indicates the type of surface (Range 0 - 99).

```
  Codes include
  1  : Ocean
  2  : Sea-Ice
  (3-12 are 'land classification')
  3  : Maximum Vegetation
  4  : High Vegetation
  5  : Moderate Vegetation
  6  : Low Vegetation
  7  : Minimal Vegetation
  8  : Maximum Snow
  9  : Moderate Snow
  10 : Low Snow
  11 : Minimal Snow
  12 : Standing Water and Rivers
  13 : Water/Land Coast Boundary
  14 : Water/Ice Boundary
  15 : Land/Ice Boundary
 -99 : Missing value
```

surfaceSkinTempIndex (2-byte integer, array size: npixel x nscan):
Surface temperature from the model, used to select the correct database profiles.

totalColumnWaterVaporIndex (1-byte integer, array size: npixel x nscan):
Liquid equivalent of the total water vapor column used to select the correct database profiles. Values range from 0 to 75 mm. Special values are defined as:
-99 Missing value

orographicLiftIndex (1-byte integer, array size: npixel x nscan):
Index of potential orographic enhancement to precipitation based on vertical motion, atmospheric moisture profile, wind direction, and terrain slope. Not currently implemented. Special values are defined as:
-99 Missing value

databaseExpansionIndex (1-byte integer, array size: npixel x nscan):
Expansion factor of the profile search radius in the profile database beyond the search nominal range. If there are fewer than the minimum number of profiles in the selected database boundaries, then the search radius is expanded. Values range from 0 to 255.

surfacePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous precipitation rate at the surface for each pixel. Check pixelStatus for a valid retrieval. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

liquidPrecipFraction (4-byte float, array size: npixel x nscan):
Fraction of surface precipitation that is liquid. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

convectPrecipFraction (4-byte float, array size: npixel x nscan):
Fraction of surface precipitation that is convective. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

probabilityOfPrecip (4-byte float, array size: npixel x nscan):
A diagnostic variable, in percent, defining the fraction of raining vs. non-raining Database profiles that make up the final solution. Values range from 0 to 100 percent. Special values are defined as:
-9999.9 Missing value

mostLikelyPrecipitation (4-byte float, array size: npixel x nscan):
The surface precipitation value with the highest occurrence within the Bayesian retrieval. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip1stTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 1st tertiary of the precipitation distribution. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip2ndTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 2nd tertiary of the precipitation distribution. Special values are defined as:
-9999.9 Missing value

numOfSignificantProf (2-byte integer, array size: npixel x nscan):
Number of profiles used in the Bayesian average above 2 sigma. Profiles below this threshold are still used in the average, but are not included in this 'significant' profiles parameter. Special values are defined as:
-9999 Missing value

rainWaterPath (4-byte float, array size: npixel x nscan):
Total integrated rain water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

cloudWaterPath (4-byte float, array size: npixel x nscan):
Total integrated cloud liquid water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

mixedWaterPath (4-byte float, array size: npixel x nscan):
Total integrated mixed phase water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

iceWaterPath (4-byte float, array size: npixel x nscan):
Total integrated cloud ice water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

totalColumnWaterVapor (4-byte float, array size: npixel x nscan):
Total integrated water vapor in the vertical atmospheric column, also known as total precipitable water (TPW). Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

spare (2-byte integer, array size: npixel x nscan):
Spare variable. Special values are defined as:
-9999 Missing value

spareIndex (1-byte integer, array size: npixel x nscan):
Spare index variable. Special values are defined as:
-99 Missing value

temp2mIndex (2-byte integer, array size: npixel x nscan):
Temperature 2 meter height Index in the clusterProfiles array. See profileScale description below. Values range from 1 to 21. Special values are defined as:
-9999 Missing value

profileNumber (2-byte integer, array size: nspecies x npixel x nscan):
Profile Number in the clusterProfiles array for each species. See profileScale description below. Values range from 1 to 100. Special values are defined as:
-9999 Missing value

profileScale (4-byte float, array size: nspecies x npixel x nscan):
profileScale is used to scale the values of the clusterProfiles array.

```
In order to recover a value of a single pixel,
select your species, layer, and temp2mindex,
then use profileNumber and profileScale
```

```
to obtain the value:

Where:
  S = species (1-5)
    Species defined in speciesDescription
  T = temp2mIndex (1-21)
    Temperatures defined in temperatureDescriptions
  L = profile layer (1-28) Top of each layer
    specified in hgtTopLayer
  P = profileNumber (1-100) for species S

In a Fortran program,
  P = profileNumber(S)
  Pixel Value = profileScale(S) * clusterProfiles(S,T,L,P)

In a C program,
  P = profileNumber[S-1]
  Pixel Value = profileScale[S] * clusterProfiles[P-1][L-1][T-1][S-1]
```

C Structure Header file:

```
#ifndef _TK_2AGPROFSSMIS_H_
#define _TK_2AGPROFSSMIS_H_

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
```

```
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2AGPROFSSMIS_S1_
#define _L2AGPROFSSMIS_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[180];
    float Longitude[180];
    SCSTATUS SCstatus;
    signed char pixelStatus[180];
    signed char retrievalType[180];
    signed char qualityFlag[180];
    signed char sunGlintAngle[180];
    signed char snowCoverIndex[180];
    signed char surfaceTypeIndex[180];
    short surfaceSkinTempIndex[180];
    signed char totalColumnWaterVaporIndex[180];
    signed char orographicLiftIndex[180];
    signed char databaseExpansionIndex[180];
    float surfacePrecipitation[180];
    float liquidPrecipFraction[180];
    float convectPrecipFraction[180];
    float probabilityOfPrecip[180];
    float mostLikelyPrecipitation[180];
    float precip1stTertial[180];
    float precip2ndTertial[180];
    short numOfSignificantProf[180];
    float rainWaterPath[180];
    float cloudWaterPath[180];
    float mixedWaterPath[180];
    float iceWaterPath[180];
    float totalColumnWaterVapor[180];
    short spare[180];
```

```
    signed char spareIndex[180];
    short temp2mIndex[180];
    short profileNumber[180][5];
    float profileScale[180][5];
} L2AGPROFSSMIS_S1;

#endif

#ifndef _GPROFDHEADR_
#define _GPROFDHEADR_

typedef struct {
    unsigned char speciesDescription[5][12];
    float hgtTopLayer[28];
    float temperatureDescriptions[21];
    float clusterProfiles[100][28][21][5];
} GPROFDHEADR;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE
```

```
STRUCTURE /L2AGPROFSSMIS_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(180)
    REAL*4 Longitude(180)
    RECORD /SCSTATUS/ SCstatus
    BYTE pixelStatus(180)
    BYTE retrievalType(180)
    BYTE qualityFlag(180)
    BYTE sunGlintAngle(180)
    BYTE snowCoverIndex(180)
    BYTE surfaceTypeIndex(180)
    INTEGER*2 surfaceSkinTempIndex(180)
    BYTE totalColumnWaterVaporIndex(180)
    BYTE orographicLiftIndex(180)
    BYTE databaseExpansionIndex(180)
    REAL*4 surfacePrecipitation(180)
    REAL*4 liquidPrecipFraction(180)
    REAL*4 convectPrecipFraction(180)
    REAL*4 probabilityOfPrecip(180)
    REAL*4 mostLikelyPrecipitation(180)
    REAL*4 precip1stTertial(180)
    REAL*4 precip2ndTertial(180)
    INTEGER*2 numOfSignificantProf(180)
    REAL*4 rainWaterPath(180)
    REAL*4 cloudWaterPath(180)
    REAL*4 mixedWaterPath(180)
    REAL*4 iceWaterPath(180)
    REAL*4 totalColumnWaterVapor(180)
    INTEGER*2 spare(180)
    BYTE spareIndex(180)
    INTEGER*2 temp2mIndex(180)
    INTEGER*2 profileNumber(5,180)
    REAL*4 profileScale(5,180)
END STRUCTURE

STRUCTURE /GPROFDHEADR/
    CHARACTER speciesDescription(12,5)
    REAL*4 hgtTopLayer(28)
    REAL*4 temperatureDescriptions(21)
    REAL*4 clusterProfiles(5,21,28,100)
END STRUCTURE
```

5.24 2AGPROFAMSR2 - Radiometer Profiling

2AGPROFAMSR2, "Radiometer Profiling", generates surface rainfall and vertical hydrometeor profiles on a pixel by pixel basis from radiometer brightness temperature data using the Goddard Profiling algorithm GPROF2014. Because the vertical information comes from a radiometer, it is not written out in independent vertical layers like the TRMM Precipitation Radar. Instead, the output is referenced to one of 100 typical structures for each hydrometeor or heating profile. These vertical structures are referenced to as profiles in the output structure. Vertical hydrometeor profiles can be reconstructed to 28 layers by knowing the profile number (i.e. shape) of the profile and a scale factor that is written for each pixel.

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel	486	Number of pixels in each scan.
nspecies	5	Number of hydrometeor species. Species are defined in speciesDescription in the DataHeader group.
sddim	12	Number of characters in each species description.
ntemps	21	Number of profile temperature indeces. Indeces are defined in temperatureDescriptions in the DataHeader group.
nlyrs	28	Number of profiling layers. The top height of each layer is defined in hgtTopLayer in the DataHeader group.
nprf	100	Number of unique profiles for each species and 2 meter Temperature index.

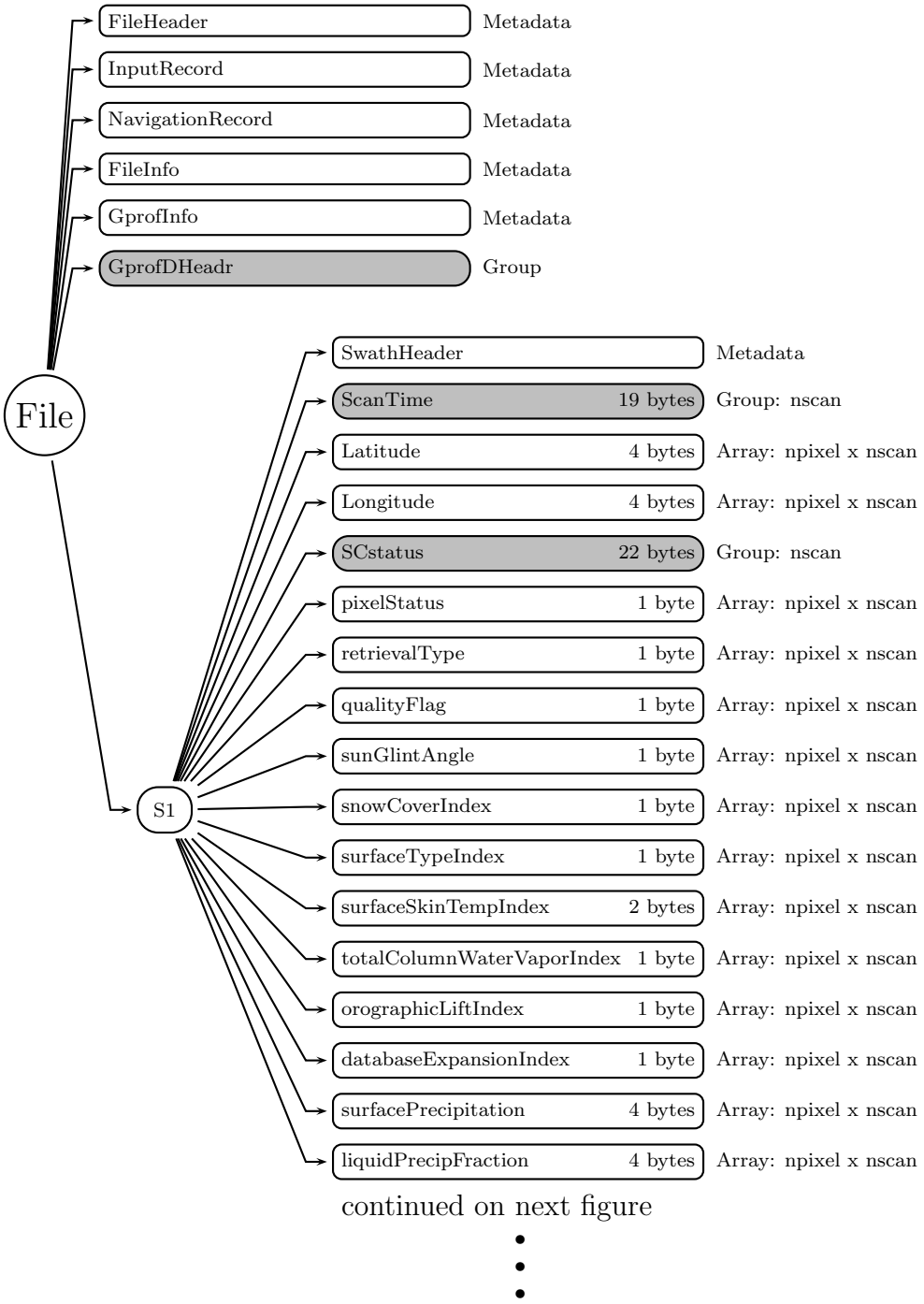
Figure 303 through Figure 307 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.



continued on next figure

Figure 303: Data Format Structure for 2AGPROFAMSR2, Radiometer Profiling

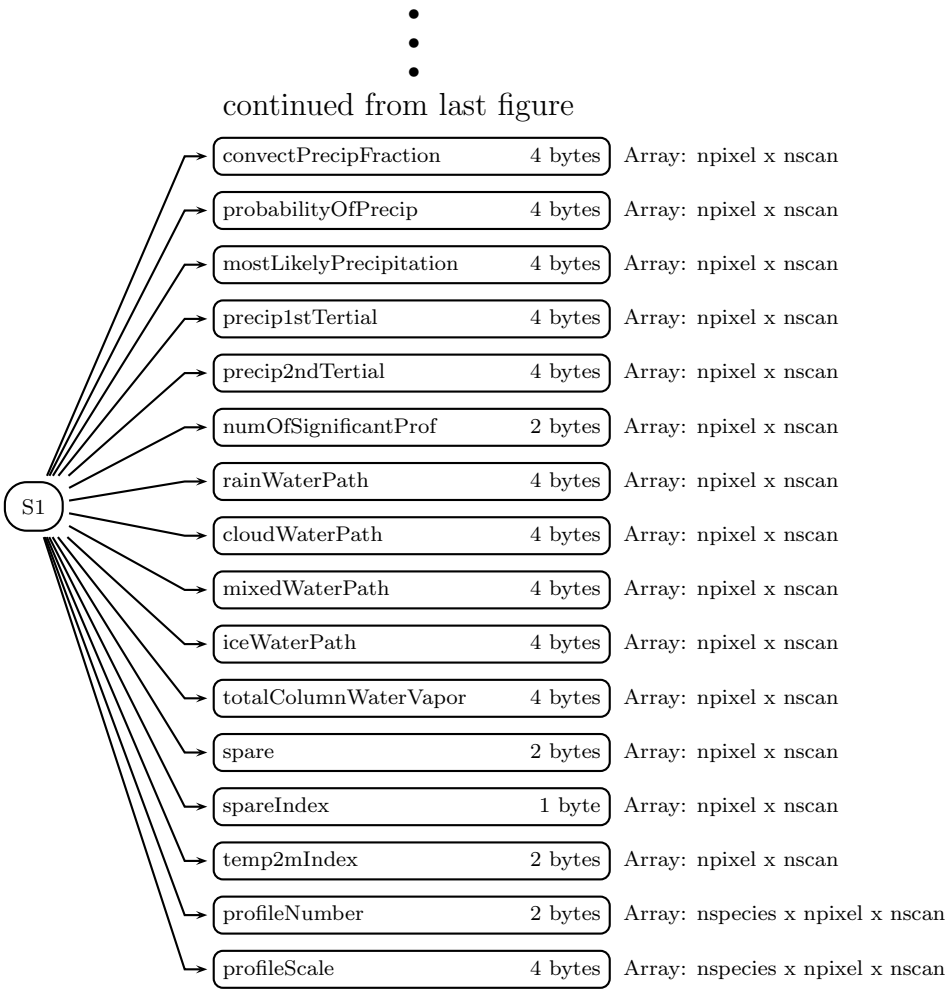


Figure 304: Data Format Structure for 2AGPROFAMSR2, Radiometer Profiling

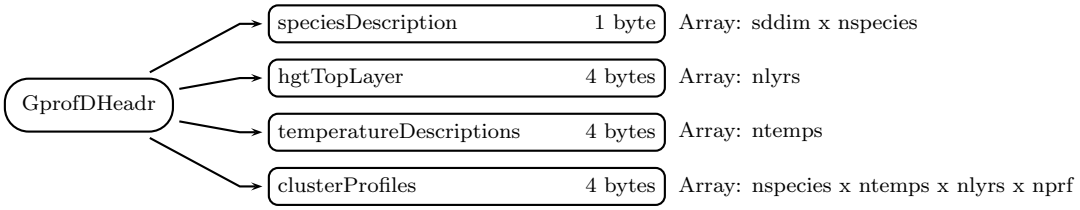


Figure 305: Data Format Structure for 2AGPROFAMSR2, GprofDHeadr

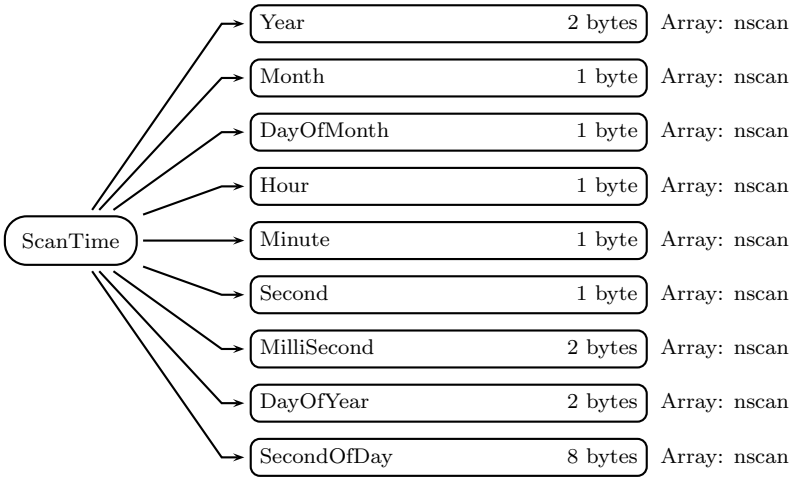


Figure 306: Data Format Structure for 2AGPROFAMSR2, ScanTime

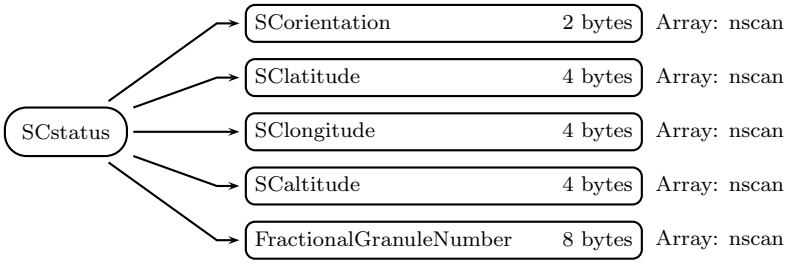


Figure 307: Data Format Structure for 2AGPROFAMSR2, SCstatus

GprofInfo (Metadata):
GprofInfo contains metadata required by Gprof. Used by 2A12 only. See Metadata for GPM Products for details.

GprofDHeadr (Group)

speciesDescription (1-byte char, array size: sddim x nspecies):
Description of each species. Special values are defined as:
255 Missing value

hgtTopLayer (4-byte float, array size: nlyrs):
Height of the top of each of 28 atmospheric layers in the clusterProfiles. The tops are every 0.5 km up to 10 km, then every km after that up to 18.0 km. Values are: 0.5, 1.0, ... 9.5, 10.0, 11.0, ... 18.0. Values range from 0 to 18.0 km. Special values are defined as:
-9999.9 Missing value

temperatureDescriptions (4-byte float, array size: ntemps):
Temperature of 2 meter temperature indeces of clusterProfiles. Values are in C. Special values are defined as:
-9999.9 Missing value

clusterProfiles (4-byte float, array size: nspecies x ntemps x nlyrs x nprf):
Standard GPM profile structures. Dimensions are hydrometeor/heating species (4); 2 meter temperature index (21); vertical layers (28); and profile number (100). To recover values in a profile see the description below in the variable profileScale.

Special values are defined as:
-9999.9 Missing value

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCstatus (Group)

SCorientation (2-byte integer, array size: nscan):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

pixelStatus (1-byte integer, array size: npixel x nscan):
If there is no retrieval at a given pixel, pixelStatus explains the reason (Range 0 - 99).

```
  0 : Valid pixel
  1 : Boundary error in landmask
  2 : Boundary error in sea-ice check
  3 : Boundary error in sea surface temperature
  4 : Invalid time
  5 : Invalid latitude/longitude
  6 : Invalid brightness temperature
  7 : Invalid sea surface temperature
-99 : Missing value
```

retrievalType (1-byte integer, array size: npixel x nscan):
Specifies that for this pixel, the rain retrieval was made with the S0, S1, or S2 (values are 0,1,2).

qualityFlag (1-byte integer, array size: npixel x nscan):
qualityFlag indicates a generalized quality of the retrieved pixel (Range 0 - 99).

```
      High:    Good retrieval using the GPM derived profile databases
      Medium:  Retrieval using the GPM derived profile databases.
               over coastal areas or in areas of oceanic sunglint.
      Low:     Retrievals using at-launch databases.
  Valid values include:
      0 : High quality (retrieval is good, use it)
      1 : Medium quality (use with caution)
      2 : Low quality (recommended qualitative use only)
    -99 : Missing value
```

sunGlintAngle (1-byte integer, array size: npixel x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. sunGlintAngle is the angular separation between the reflected satellite view vector and the sun vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. If this angle is less than ten degrees, the pixel is affected by sunglint and qualityFlag for the pixel is lowered. Values range from 0 to 180 degrees. Special values are defined as:
-99 Missing value

snowCoverIndex (1-byte integer, array size: npixel x nscan):
An index based on snow depth. Not currently implemented. Values range from 0 to 5. Special values are defined as:
-99 Missing value

surfaceTypeIndex (1-byte integer, array size: npixel x nscan):
Indicates the type of surface (Range 0 - 99).

```
  Codes include
  1  : Ocean
  2  : Sea-Ice
  (3-12 are 'land classification')
  3  : Maximum Vegetation
  4  : High Vegetation
  5  : Moderate Vegetation
  6  : Low Vegetation
  7  : Minimal Vegetation
  8  : Maximum Snow
  9  : Moderate Snow
  10 : Low Snow
  11 : Minimal Snow
  12 : Standing Water and Rivers
  13 : Water/Land Coast Boundary
  14 : Water/Ice Boundary
  15 : Land/Ice Boundary
 -99 : Missing value
```

surfaceSkinTempIndex (2-byte integer, array size: npixel x nscan):
Surface temperature from the model, used to select the correct database profiles.

totalColumnWaterVaporIndex (1-byte integer, array size: npixel x nscan):
Liquid equivalent of the total water vapor column used to select the correct database profiles. Values range from 0 to 75 mm. Special values are defined as:
-99 Missing value

orographicLiftIndex (1-byte integer, array size: npixel x nscan):
Index of potential orographic enhancement to precipitation based on vertical motion, atmospheric moisture profile, wind direction, and terrain slope. Not currently implemented. Special values are defined as:
-99 Missing value

databaseExpansionIndex (1-byte integer, array size: npixel x nscan):
Expansion factor of the profile search radius in the profile database beyond the search nominal range. If there are fewer than the minimum number of profiles in the selected database boundaries, then the search radius is expanded. Values range from 0 to 255.

surfacePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous precipitation rate at the surface for each pixel. Check pixelStatus for a valid retrieval. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

liquidPrecipFraction (4-byte float, array size: npixel x nscan):
Fraction of surface precipitation that is liquid. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

convectPrecipFraction (4-byte float, array size: npixel x nscan):
Fraction of surface precipitation that is convective. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

probabilityOfPrecip (4-byte float, array size: npixel x nscan):
A diagnostic variable, in percent, defining the fraction of raining vs. non-raining Database profiles that make up the final solution. Values range from 0 to 100 percent. Special values are defined as:
-9999.9 Missing value

mostLikelyPrecipitation (4-byte float, array size: npixel x nscan):
The surface precipitation value with the highest occurrence within the Bayesian retrieval. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip1stTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 1st tertiary of the precipitation distribution. Values

are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip2ndTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 2nd tertiary of the precipitation distribution. Special values are defined as:
-9999.9 Missing value

numOfSignificantProf (2-byte integer, array size: npixel x nscan):
Number of profiles used in the Bayesian average above 2 sigma. Profiles below this threshold are still used in the average, but are not included in this 'significant' profiles parameter. Special values are defined as:
-9999 Missing value

rainWaterPath (4-byte float, array size: npixel x nscan):
Total integrated rain water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

cloudWaterPath (4-byte float, array size: npixel x nscan):
Total integrated cloud liquid water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

mixedWaterPath (4-byte float, array size: npixel x nscan):
Total integrated mixed phase water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

iceWaterPath (4-byte float, array size: npixel x nscan):
Total integrated cloud ice water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

totalColumnWaterVapor (4-byte float, array size: npixel x nscan):
Total integrated water vapor in the vertical atmospheric column, also known as total precipitable water (TPW). Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

spare (2-byte integer, array size: npixel x nscan):
Spare variable. Special values are defined as:
-9999 Missing value

spareIndex (1-byte integer, array size: npixel x nscan):
Spare index variable. Special values are defined as:
-99 Missing value

temp2mIndex (2-byte integer, array size: npixel x nscan):
Temperature 2 meter height Index in the clusterProfiles array. See profileScale description

below. Values range from 1 to 21. Special values are defined as:
-9999 Missing value

profileNumber (2-byte integer, array size: nspecies x npixel x nscan):
Profile Number in the clusterProfiles array for each species. See profileScale description below. Values range from 1 to 100. Special values are defined as:
-9999 Missing value

profileScale (4-byte float, array size: nspecies x npixel x nscan):
profileScale is used to scale the values of the clusterProfiles array.

```
In order to recover a value of a single pixel,
select your species, layer, and temp2mindex,
then use profileNumber and profileScale
to obtain the value:

Where:
  S = species (1-5)
    Species defined in speciesDescription
  T = temp2mIndex (1-21)
    Temperatures defined in temperatureDescriptions
  L = profile layer (1-28) Top of each layer
    specified in hgtTopLayer
  P = profileNumber (1-100) for species S

In a Fortran program,
  P = profileNumber(S)
  Pixel Value = profileScale(S) * clusterProfiles(S,T,L,P)

In a C program,
  P = profileNumber[S-1]
  Pixel Value = profileScale[S] * clusterProfiles[P-1][L-1][T-1][S-1]
```

C Structure Header file:

```
#ifndef _TK_2AGPROFAMSR2_H_
#define _TK_2AGPROFAMSR2_H_

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
```

```
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2AGPROFAMSR2_S1_
#define _L2AGPROFAMSR2_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[486];
    float Longitude[486];
    SCSTATUS SCstatus;
    signed char pixelStatus[486];
    signed char retrievalType[486];
    signed char qualityFlag[486];
    signed char sunGlintAngle[486];
    signed char snowCoverIndex[486];
    signed char surfaceTypeIndex[486];
    short surfaceSkinTempIndex[486];
    signed char totalColumnWaterVaporIndex[486];
    signed char orographicLiftIndex[486];
    signed char databaseExpansionIndex[486];
    float surfacePrecipitation[486];
```

```
    float liquidPrecipFraction[486];
    float convectPrecipFraction[486];
    float probabilityOfPrecip[486];
    float mostLikelyPrecipitation[486];
    float precip1stTertial[486];
    float precip2ndTertial[486];
    short numOfSignificantProf[486];
    float rainWaterPath[486];
    float cloudWaterPath[486];
    float mixedWaterPath[486];
    float iceWaterPath[486];
    float totalColumnWaterVapor[486];
    short spare[486];
    signed char spareIndex[486];
    short temp2mIndex[486];
    short profileNumber[486][5];
    float profileScale[486][5];
} L2AGPROFAMSR2_S1;

#endif

#ifndef _GPROFDHEADR_
#define _GPROFDHEADR_

typedef struct {
    unsigned char speciesDescription[5][12];
    float hgtTopLayer[28];
    float temperatureDescriptions[21];
    float clusterProfiles[100][28][21][5];
} GPROFDHEADR;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
```

```
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2AGPROFAMSR2_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(486)
    REAL*4 Longitude(486)
    RECORD /SCSTATUS/ SCstatus
    BYTE pixelStatus(486)
    BYTE retrievalType(486)
    BYTE qualityFlag(486)
    BYTE sunGlintAngle(486)
    BYTE snowCoverIndex(486)
    BYTE surfaceTypeIndex(486)
    INTEGER*2 surfaceSkinTempIndex(486)
    BYTE totalColumnWaterVaporIndex(486)
    BYTE orographicLiftIndex(486)
    BYTE databaseExpansionIndex(486)
    REAL*4 surfacePrecipitation(486)
    REAL*4 liquidPrecipFraction(486)
    REAL*4 convectPrecipFraction(486)
    REAL*4 probabilityOfPrecip(486)
    REAL*4 mostLikelyPrecipitation(486)
    REAL*4 precip1stTertial(486)
    REAL*4 precip2ndTertial(486)
    INTEGER*2 numOfSignificantProf(486)
    REAL*4 rainWaterPath(486)
    REAL*4 cloudWaterPath(486)
    REAL*4 mixedWaterPath(486)
    REAL*4 iceWaterPath(486)
    REAL*4 totalColumnWaterVapor(486)
    INTEGER*2 spare(486)
```

```
    BYTE spareIndex(486)
    INTEGER*2 temp2mIndex(486)
    INTEGER*2 profileNumber(5,486)
    REAL*4 profileScale(5,486)
END STRUCTURE

STRUCTURE /GPROFDHEADR/
    CHARACTER speciesDescription(12,5)
    REAL*4 hgtTopLayer(28)
    REAL*4 temperatureDescriptions(21)
    REAL*4 clusterProfiles(5,21,28,100)
END STRUCTURE
```

5.25 2AGPROFATMS - Radiometer Profiling

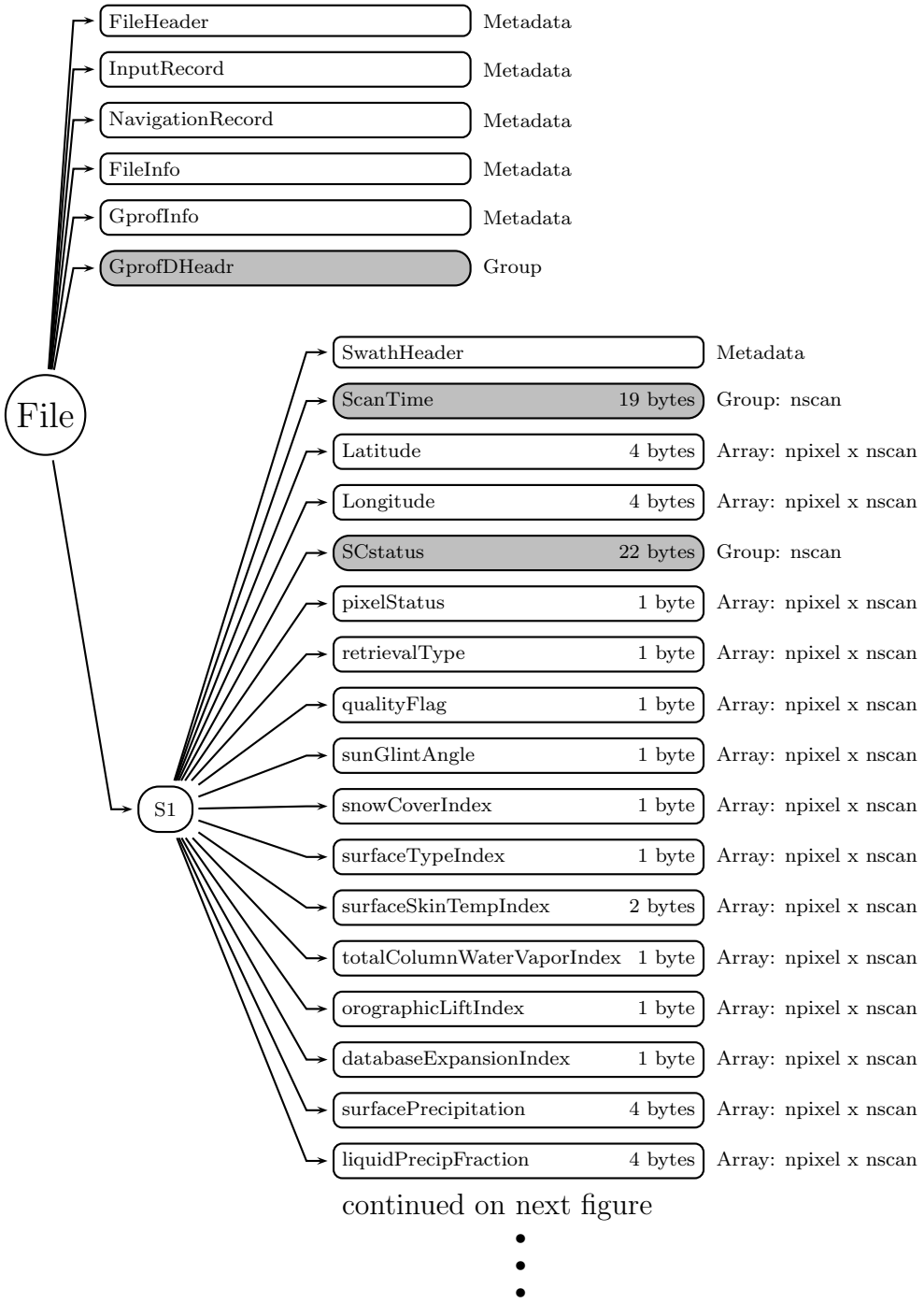
2AGPROFATMS, "Radiometer Profiling", generates surface rainfall and vertical hydrometeor profiles on a pixel by pixel basis from radiometer brightness temperature data using the Goddard Profiling algorithm GPROF2014. Because the vertical information comes from a radiometer, it is not written out in independent vertical layers like the TRMM Precipitation Radar. Instead, the output is referenced to one of 100 typical structures for each hydrometeor or heating profile. These vertical structures are referenced to as profiles in the output structure. Vertical hydrometeor profiles can be reconstructed to 28 layers by knowing the profile number (i.e. shape) of the profile and a scale factor that is written for each pixel.

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel	96	Number of pixels in each scan.
nspecies	5	Number of hydrometeor species. Species are defined in speciesDescription in the DataHeader group.
sddim	12	Number of characters in each species description.
ntemps	21	Number of profile temperature indeces. Indeces are defined in temperatureDescriptions in the DataHeader group.
nlyrs	28	Number of profiling layers. The top height of each layer is defined in hgtTopLayer in the DataHeader group.
nprf	100	Number of unique profiles for each species and 2 meter Temperature index.

Figure 308 through Figure 312 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See



continued on next figure

Figure 308: Data Format Structure for 2AGPROFATMS, Radiometer Profiling

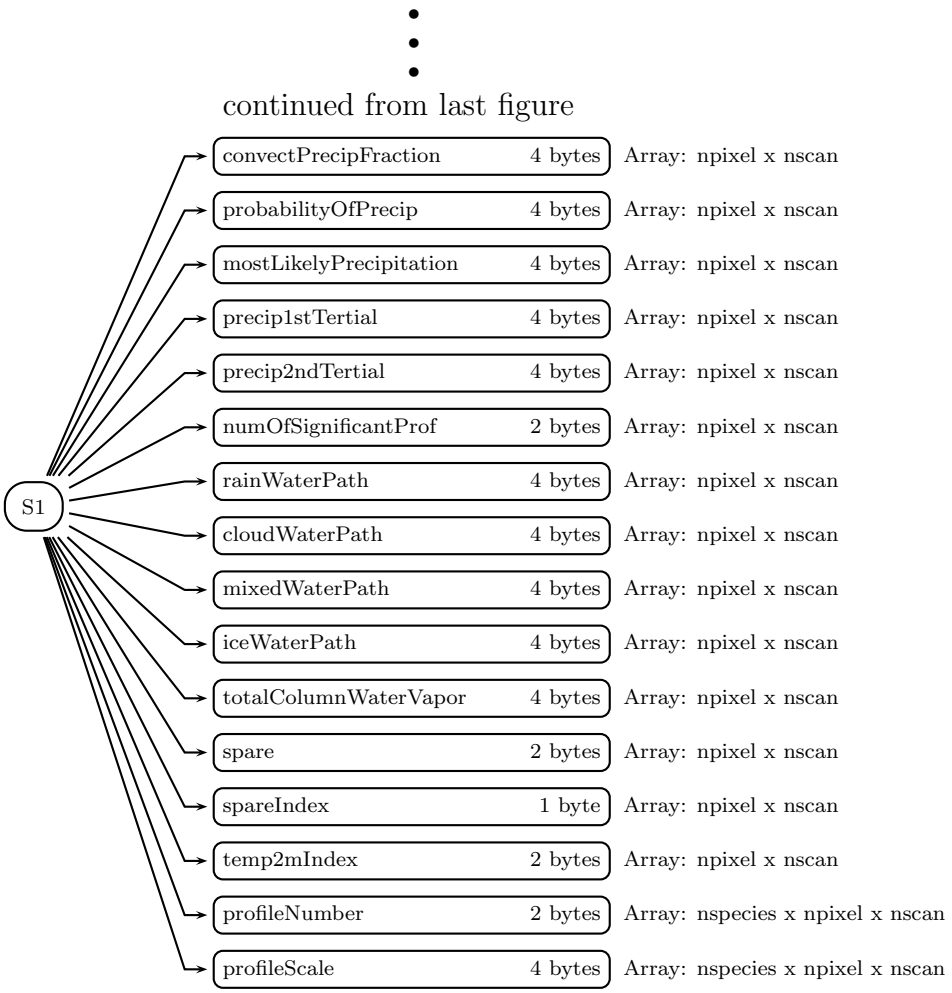


Figure 309: Data Format Structure for 2AGPROFATMS, Radiometer Profiling

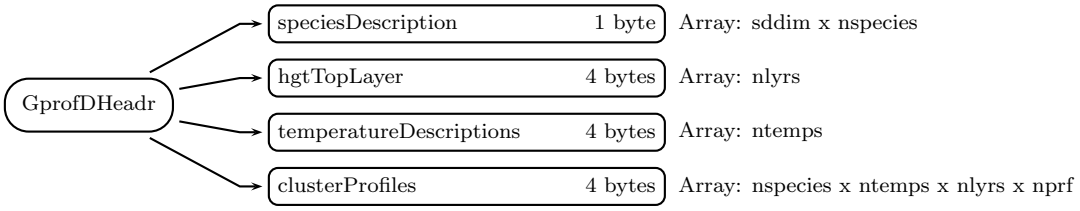


Figure 310: Data Format Structure for 2AGPROFATMS, GprofDHeadr

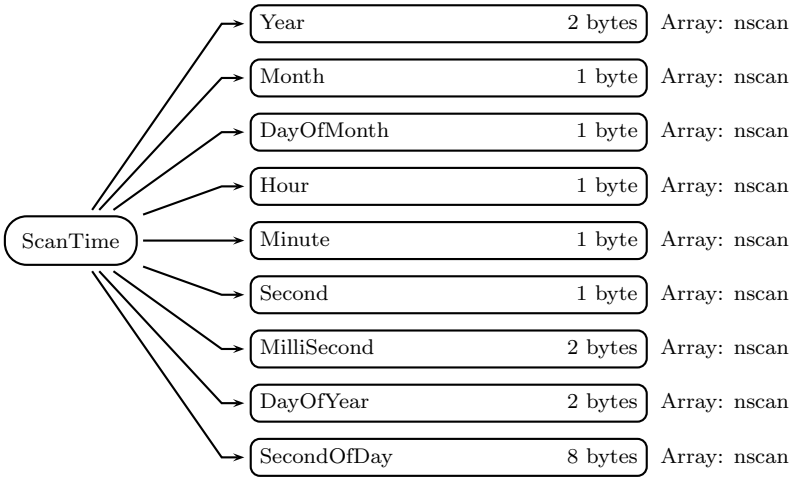


Figure 311: Data Format Structure for 2AGPROFATMS, ScanTime

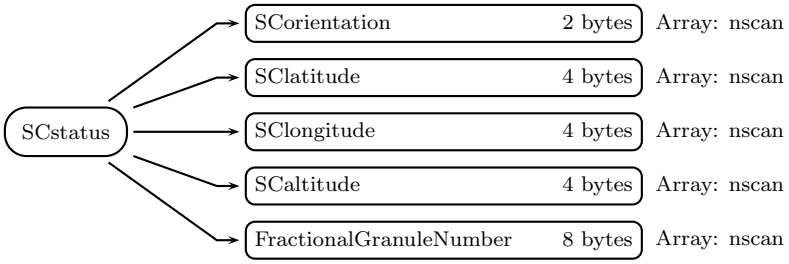


Figure 312: Data Format Structure for 2AGPROFATMS, SCstatus

Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

GprofInfo (Metadata):
GprofInfo contains metadata required by Gprof. Used by 2A12 only. See Metadata for GPM Products for details.

GprofDHeadr (Group)

speciesDescription (1-byte char, array size: sddim x nspecies):
Description of each species. Special values are defined as:
255 Missing value

hgtTopLayer (4-byte float, array size: nlyrs):
Height of the top of each of 28 atmospheric layers in the clusterProfiles. The tops are every 0.5 km up to 10 km, then every km after that up to 18.0 km. Values are: 0.5, 1.0, ... 9.5, 10.0, 11.0, ... 18.0. Values range from 0 to 18.0 km. Special values are defined as:
-9999.9 Missing value

temperatureDescriptions (4-byte float, array size: ntemps):
Temperature of 2 meter temperature indeces of clusterProfiles. Values are in C. Special values are defined as:
-9999.9 Missing value

clusterProfiles (4-byte float, array size: nspecies x ntemps x nlyrs x nprf):
Standard GPM profile structures. Dimensions are hydrometeor/heating species (4); 2 meter temperature index (21); vertical layers (28); and profile number (100). To recover values in a profile see the description below in the variable profileScale.

Special values are defined as:
-9999.9 Missing value

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude

is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCstatus (Group)

SCorientation (2-byte integer, array size: nscan):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

pixelStatus (1-byte integer, array size: npixel x nscan):
If there is no retrieval at a given pixel, pixelStatus explains the reason (Range 0 - 99).

```
0 : Valid pixel
1 : Boundary error in landmask
2 : Boundary error in sea-ice check
3 : Boundary error in sea surface temperature
4 : Invalid time
```

```
   5 : Invalid latitude/longitude
   6 : Invalid brightness temperature
   7 : Invalid sea surface temperature
 -99 : Missing value
```

retrievalType (1-byte integer, array size: npixel x nscan):
Specifies that for this pixel, the rain retrieval was made with the S0, S1, or S2 (values are 0,1,2).

qualityFlag (1-byte integer, array size: npixel x nscan):
qualityFlag indicates a generalized quality of the retrieved pixel (Range 0 - 99).

```
       High:    Good retrieval using the GPM derived profile databases
       Medium:  Retrieval using the GPM derived profile databases.
                over coastal areas or in areas of oceanic sunglint.
       Low:     Retrievals using at-launch databases.
   Valid values include:
       0 : High quality (retrieval is good, use it)
       1 : Medium quality (use with caution)
       2 : Low quality (recommended qualitative use only)
     -99 : Missing value
```

sunGlintAngle (1-byte integer, array size: npixel x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. sunGlintAngle is the angular separation between the reflected satellite view vector and the sun vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. If this angle is less than ten degrees, the pixel is affected by sunglint and qualityFlag for the pixel is lowered. Values range from 0 to 180 degrees. Special values are defined as:
-99 Missing value

snowCoverIndex (1-byte integer, array size: npixel x nscan):
An index based on snow depth. Not currently implemented. Values range from 0 to 5. Special values are defined as:
-99 Missing value

surfaceTypeIndex (1-byte integer, array size: npixel x nscan):
Indicates the type of surface (Range 0 - 99).

```
  Codes include
  1  : Ocean
  2  : Sea-Ice
  (3-12 are 'land classification')
```

```
  3  : Maximum Vegetation
  4  : High Vegetation
  5  : Moderate Vegetation
  6  : Low Vegetation
  7  : Minimal Vegetation
  8  : Maximum Snow
  9  : Moderate Snow
  10 : Low Snow
  11 : Minimal Snow
  12 : Standing Water and Rivers
  13 : Water/Land Coast Boundary
  14 : Water/Ice Boundary
  15 : Land/Ice Boundary
 -99 : Missing value
```

surfaceSkinTempIndex (2-byte integer, array size: npixel x nscan):
Surface temperature from the model, used to select the correct database profiles.

totalColumnWaterVaporIndex (1-byte integer, array size: npixel x nscan):
Liquid equivalent of the total water vapor column used to select the correct database profiles. Values range from 0 to 75 mm. Special values are defined as:
-99 Missing value

orographicLiftIndex (1-byte integer, array size: npixel x nscan):
Index of potential orographic enhancement to precipitation based on vertical motion, atmospheric moisture profile, wind direction, and terrain slope. Not currently implemented. Special values are defined as:
-99 Missing value

databaseExpansionIndex (1-byte integer, array size: npixel x nscan):
Expansion factor of the profile search radius in the profile database beyond the search nominal range. If there are fewer than the minimum number of profiles in the selected database boundaries, then the search radius is expanded. Values range from 0 to 255.

surfacePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous precipitation rate at the surface for each pixel. Check pixelStatus for a valid retrieval. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

liquidPrecipFraction (4-byte float, array size: npixel x nscan):
Fraction of surface precipitation that is liquid. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

convectPrecipFraction (4-byte float, array size: npixel x nscan):
Fraction of surface precipitation that is convective. Values range from 0 to 1. Special

values are defined as:
-9999.9 Missing value

probabilityOfPrecip (4-byte float, array size: npixel x nscan):
A diagnostic variable, in percent, defining the fraction of raining vs. non-raining Database profiles that make up the final solution. Values range from 0 to 100 percent. Special values are defined as:
-9999.9 Missing value

mostLikelyPrecipitation (4-byte float, array size: npixel x nscan):
The surface precipitation value with the highest occurrence within the Bayesian retrieval. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip1stTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 1st tertiary of the precipitation distribution. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip2ndTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 2nd tertiary of the precipitation distribution. Special values are defined as:
-9999.9 Missing value

numOfSignificantProf (2-byte integer, array size: npixel x nscan):
Number of profiles used in the Bayesian average above 2 sigma. Profiles below this threshold are still used in the average, but are not included in this 'significant' profiles parameter. Special values are defined as:
-9999 Missing value

rainWaterPath (4-byte float, array size: npixel x nscan):
Total integrated rain water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

cloudWaterPath (4-byte float, array size: npixel x nscan):
Total integrated cloud liquid water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

mixedWaterPath (4-byte float, array size: npixel x nscan):
Total integrated mixed phase water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

iceWaterPath (4-byte float, array size: npixel x nscan):
Total integrated cloud ice water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

totalColumnWaterVapor (4-byte float, array size: npixel x nscan):
Total integrated water vapor in the vertical atmospheric column, also known as total precipitable water (TPW). Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

spare (2-byte integer, array size: npixel x nscan):
Spare variable. Special values are defined as:
-9999 Missing value

spareIndex (1-byte integer, array size: npixel x nscan):
Spare index variable. Special values are defined as:
-99 Missing value

temp2mIndex (2-byte integer, array size: npixel x nscan):
Temperature 2 meter height Index in the clusterProfiles array. See profileScale description below. Values range from 1 to 21. Special values are defined as:
-9999 Missing value

profileNumber (2-byte integer, array size: nspecies x npixel x nscan):
Profile Number in the clusterProfiles array for each species. See profileScale description below. Values range from 1 to 100. Special values are defined as:
-9999 Missing value

profileScale (4-byte float, array size: nspecies x npixel x nscan):
profileScale is used to scale the values of the clusterProfiles array.

```
In order to recover a value of a single pixel,
select your species, layer, and temp2mindex,
then use profileNumber and profileScale
to obtain the value:

Where:
  S = species (1-5)
    Species defined in speciesDescription
  T = temp2mIndex (1-21)
    Temperatures defined in temperatureDescriptions
  L = profile layer (1-28) Top of each layer
    specified in hgtTopLayer
  P = profileNumber (1-100) for species S

In a Fortran program,
  P = profileNumber(S)
  Pixel Value = profileScale(S) * clusterProfiles(S,T,L,P)

In a C program,
  P = profileNumber[S-1]
```

```
  Pixel Value = profileScale[S] * clusterProfiles[P-1][L-1][T-1][S-1]
```

C Structure Header file:

```
#ifndef _TK_2AGPROFATMS_H_
#define _TK_2AGPROFATMS_H_

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2AGPROFATMS_S1_
#define _L2AGPROFATMS_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[96];
```

```
    float Longitude[96];
    SCSTATUS SCstatus;
    signed char pixelStatus[96];
    signed char retrievalType[96];
    signed char qualityFlag[96];
    signed char sunGlintAngle[96];
    signed char snowCoverIndex[96];
    signed char surfaceTypeIndex[96];
    short surfaceSkinTempIndex[96];
    signed char totalColumnWaterVaporIndex[96];
    signed char orographicLiftIndex[96];
    signed char databaseExpansionIndex[96];
    float surfacePrecipitation[96];
    float liquidPrecipFraction[96];
    float convectPrecipFraction[96];
    float probabilityOfPrecip[96];
    float mostLikelyPrecipitation[96];
    float precip1stTertial[96];
    float precip2ndTertial[96];
    short numOfSignificantProf[96];
    float rainWaterPath[96];
    float cloudWaterPath[96];
    float mixedWaterPath[96];
    float iceWaterPath[96];
    float totalColumnWaterVapor[96];
    short spare[96];
    signed char spareIndex[96];
    short temp2mIndex[96];
    short profileNumber[96][5];
    float profileScale[96][5];
} L2AGPROFATMS_S1;

#endif

#ifndef _GPROFDHEADR_
#define _GPROFDHEADR_

typedef struct {
    unsigned char speciesDescription[5][12];
    float hgtTopLayer[28];
    float temperatureDescriptions[21];
    float clusterProfiles[100][28][21][5];
} GPROFDHEADR;
```

```
#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2AGPROFATMS_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(96)
    REAL*4 Longitude(96)
    RECORD /SCSTATUS/ SCstatus
    BYTE pixelStatus(96)
    BYTE retrievalType(96)
    BYTE qualityFlag(96)
    BYTE sunGlintAngle(96)
    BYTE snowCoverIndex(96)
    BYTE surfaceTypeIndex(96)
    INTEGER*2 surfaceSkinTempIndex(96)
    BYTE totalColumnWaterVaporIndex(96)
    BYTE orographicLiftIndex(96)
    BYTE databaseExpansionIndex(96)
    REAL*4 surfacePrecipitation(96)
```

```
    REAL*4 liquidPrecipFraction(96)
    REAL*4 convectPrecipFraction(96)
    REAL*4 probabilityOfPrecip(96)
    REAL*4 mostLikelyPrecipitation(96)
    REAL*4 precip1stTertial(96)
    REAL*4 precip2ndTertial(96)
    INTEGER*2 numOfSignificantProf(96)
    REAL*4 rainWaterPath(96)
    REAL*4 cloudWaterPath(96)
    REAL*4 mixedWaterPath(96)
    REAL*4 iceWaterPath(96)
    REAL*4 totalColumnWaterVapor(96)
    INTEGER*2 spare(96)
    BYTE spareIndex(96)
    INTEGER*2 temp2mIndex(96)
    INTEGER*2 profileNumber(5,96)
    REAL*4 profileScale(5,96)
END STRUCTURE

STRUCTURE /GPROFDHEADR/
    CHARACTER speciesDescription(12,5)
    REAL*4 hgtTopLayer(28)
    REAL*4 temperatureDescriptions(21)
    REAL*4 clusterProfiles(5,21,28,100)
END STRUCTURE
```

5.26 2AGPROFMHS - Radiometer Profiling

2AGPROFMHS, "Radiometer Profiling", generates surface rainfall and vertical hydrometeor profiles on a pixel by pixel basis from radiometer brightness temperature data using the Goddard Profiling algorithm GPROF2014. Because the vertical information comes from a radiometer, it is not written out in independent vertical layers like the TRMM Precipitation Radar. Instead, the output is referenced to one of 100 typical structures for each hydrometeor or heating profile. These vertical structures are referenced to as profiles in the output structure. Vertical hydrometeor profiles can be reconstructed to 28 layers by knowing the profile number (i.e. shape) of the profile and a scale factor that is written for each pixel.

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel	90	Number of pixels in each scan.
nspecies	5	Number of hydrometeor species. Species are defined in speciesDescription in the DataHeader group.
sddim	12	Number of characters in each species description.
ntemps	21	Number of profile temperature indeces. Indeces are defined in temperatureDescriptions in the DataHeader group.
nlyrs	28	Number of profiling layers. The top height of each layer is defined in hgtTopLayer in the DataHeader group.
nprf	100	Number of unique profiles for each species and 2 meter Temperature index.

Figure 313 through Figure 317 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

GprofInfo (Metadata):
GprofInfo contains metadata required by Gprof. Used by 2A12 only. See Metadata for GPM Products for details.

GprofDHeadr (Group)

speciesDescription (1-byte char, array size: sddim x nspecies):
Description of each species. Special values are defined as:
255 Missing value

hgtTopLayer (4-byte float, array size: nlyrs):
Height of the top of each of 28 atmospheric layers in the clusterProfiles. The tops are every 0.5 km up to 10 km, then every km after that up to 18.0 km. Values are: 0.5, 1.0,

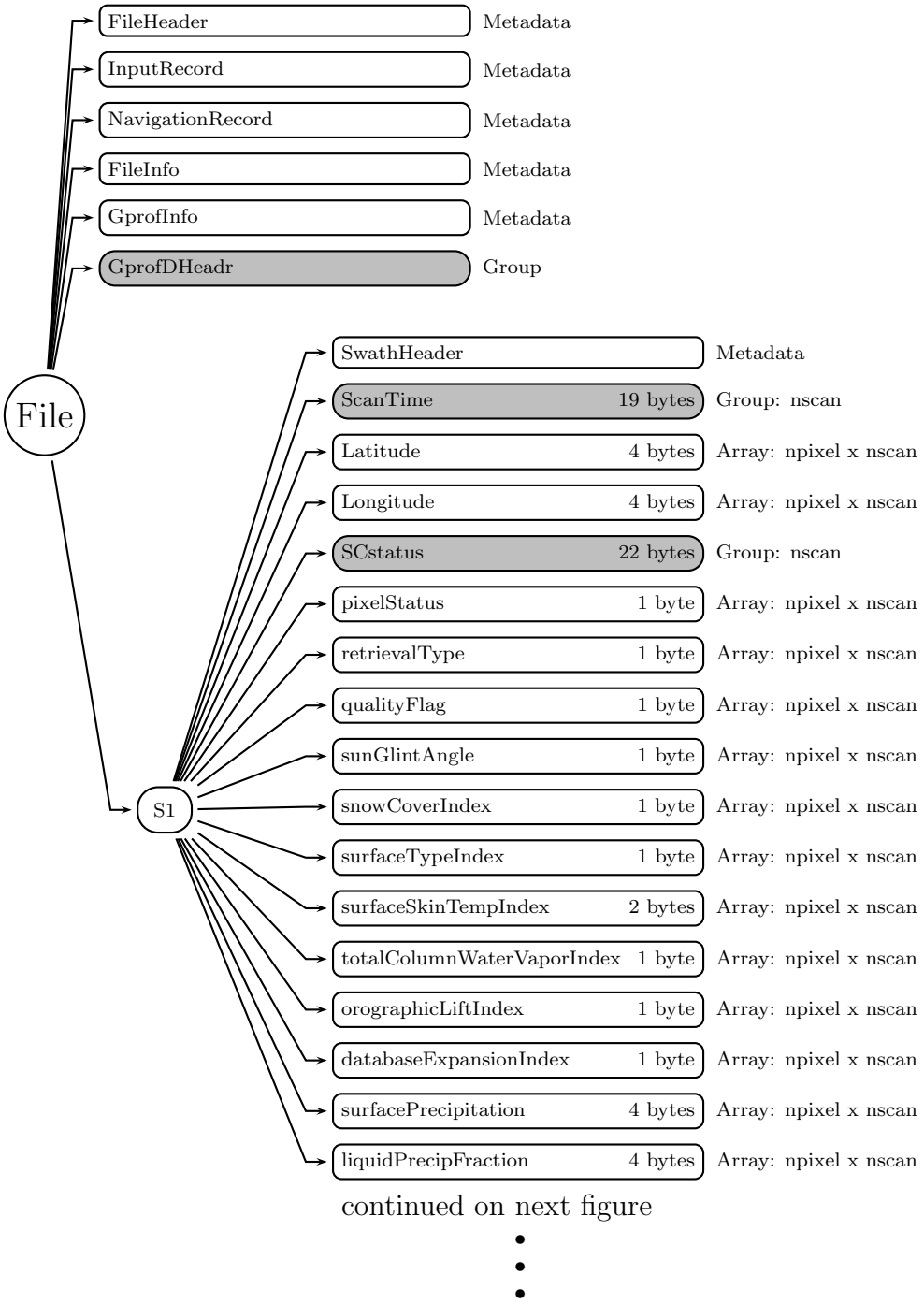


Figure 313: Data Format Structure for 2AGPROFMHS, Radiometer Profiling

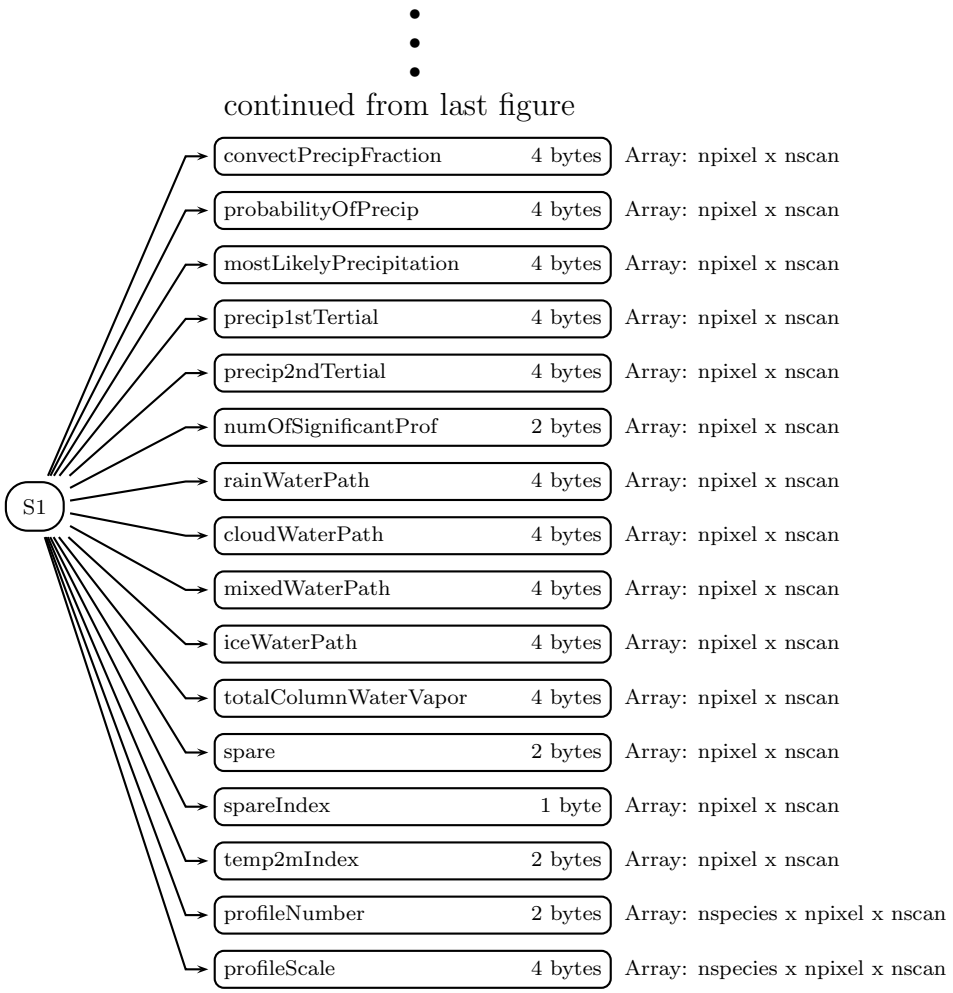


Figure 314: Data Format Structure for 2AGPROFMHS, Radiometer Profiling

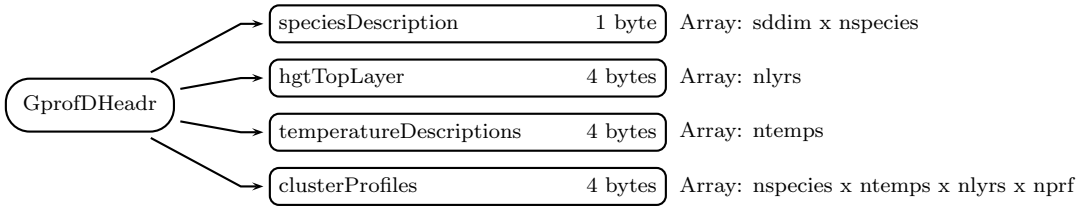


Figure 315: Data Format Structure for 2AGPROFMHS, GprofDHeadr

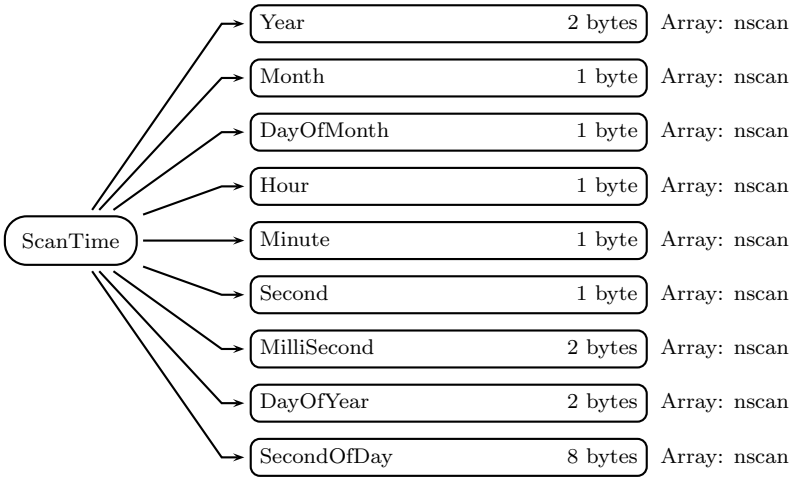


Figure 316: Data Format Structure for 2AGPROFMHS, ScanTime

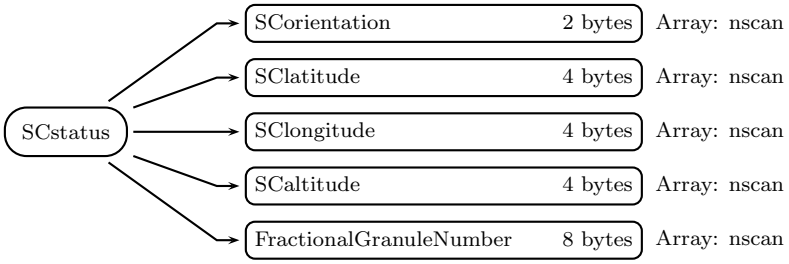


Figure 317: Data Format Structure for 2AGPROFMHS, SCstatus

... 9.5, 10.0, 11.0, ... 18.0. Values range from 0 to 18.0 km. Special values are defined as:
-9999.9 Missing value

temperatureDescriptions (4-byte float, array size: ntemps):
Temperature of 2 meter temperature indeces of clusterProfiles. Values are in C. Special values are defined as:
-9999.9 Missing value

clusterProfiles (4-byte float, array size: nspecies x ntemps x nlyrs x nprf):
Standard GPM profile structures. Dimensions are hydrometeor/heating species (4); 2 meter temperature index (21); vertical layers (28); and profile number (100). To recover values in a profile see the description below in the variable profileScale.

Special values are defined as:
-9999.9 Missing value

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCstatus (Group)

SCorientation (2-byte integer, array size: nscan):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

pixelStatus (1-byte integer, array size: npixel x nscan):
If there is no retrieval at a given pixel, pixelStatus explains the reason (Range 0 - 99).

```
  0 : Valid pixel
  1 : Boundary error in landmask
  2 : Boundary error in sea-ice check
  3 : Boundary error in sea surface temperature
  4 : Invalid time
  5 : Invalid latitude/longitude
  6 : Invalid brightness temperature
  7 : Invalid sea surface temperature
-99 : Missing value
```

retrievalType (1-byte integer, array size: npixel x nscan):
Specifies that for this pixel, the rain retrieval was made with the S0, S1, or S2 (values are 0,1,2).

qualityFlag (1-byte integer, array size: npixel x nscan):
qualityFlag indicates a generalized quality of the retrieved pixel (Range 0 - 99).

```
      High:    Good retrieval using the GPM derived profile databases
      Medium:  Retrieval using the GPM derived profile databases.
               over coastal areas or in areas of oceanic sunglint.
      Low:     Retrievals using at-launch databases.
  Valid values include:
      0 : High quality (retrieval is good, use it)
      1 : Medium quality (use with caution)
      2 : Low quality (recommended qualitative use only)
    -99 : Missing value
```

sunGlintAngle (1-byte integer, array size: npixel x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected

off the Earth's surface. sunGlintAngle is the angular separation between the reflected satellite view vector and the sun vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. If this angle is less than ten degrees, the pixel is affected by sunglint and qualityFlag for the pixel is lowered. Values range from 0 to 180 degrees. Special values are defined as:
-99 Missing value

snowCoverIndex (1-byte integer, array size: npixel x nscan):
An index based on snow depth. Not currently implemented. Values range from 0 to 5. Special values are defined as:
-99 Missing value

surfaceTypeIndex (1-byte integer, array size: npixel x nscan):
Indicates the type of surface (Range 0 - 99).

```
 Codes include
 1  : Ocean
 2  : Sea-Ice
 (3-12 are 'land classification')
 3  : Maximum Vegetation
 4  : High Vegetation
 5  : Moderate Vegetation
 6  : Low Vegetation
 7  : Minimal Vegetation
 8  : Maximum Snow
 9  : Moderate Snow
 10 : Low Snow
 11 : Minimal Snow
 12 : Standing Water and Rivers
 13 : Water/Land Coast Boundary
 14 : Water/Ice Boundary
 15 : Land/Ice Boundary
-99 : Missing value
```

surfaceSkinTempIndex (2-byte integer, array size: npixel x nscan):
Surface temperature from the model, used to select the correct database profiles.

totalColumnWaterVaporIndex (1-byte integer, array size: npixel x nscan):
Liquid equivalent of the total water vapor column used to select the correct database profiles. Values range from 0 to 75 mm. Special values are defined as:
-99 Missing value

orographicLiftIndex (1-byte integer, array size: npixel x nscan):
Index of potential orographic enhancement to precipitation based on vertical motion, atmospheric moisture profile, wind direction, and terrain slope. Not currently implemented. Special values are defined as:
-99 Missing value

databaseExpansionIndex (1-byte integer, array size: npixel x nscan):
Expansion factor of the profile search radius in the profile database beyond the search nominal range. If there are fewer than the minimum number of profiles in the selected database boundaries, then the search radius is expanded. Values range from 0 to 255.

surfacePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous precipitation rate at the surface for each pixel. Check pixelStatus for a valid retrieval. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

liquidPrecipFraction (4-byte float, array size: npixel x nscan):
Fraction of surface precipitation that is liquid. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

convectPrecipFraction (4-byte float, array size: npixel x nscan):
Fraction of surface precipitation that is convective. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

probabilityOfPrecip (4-byte float, array size: npixel x nscan):
A diagnostic variable, in percent, defining the fraction of raining vs. non-raining Database profiles that make up the final solution. Values range from 0 to 100 percent. Special values are defined as:
-9999.9 Missing value

mostLikelyPrecipitation (4-byte float, array size: npixel x nscan):
The surface precipitation value with the highest occurrence within the Bayesian retrieval. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip1stTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 1st tertiary of the precipitation distribution. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip2ndTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 2nd tertiary of the precipitation distribution. Special values are defined as:
-9999.9 Missing value

numOfSignificantProf (2-byte integer, array size: npixel x nscan):
Number of profiles used in the Bayesian average above 2 sigma. Profiles below this threshold are still used in the average, but are not included in this 'significant' profiles parameter. Special values are defined as:
-9999 Missing value

rainWaterPath (4-byte float, array size: npixel x nscan):
Total integrated rain water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

cloudWaterPath (4-byte float, array size: npixel x nscan):
Total integrated cloud liquid water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

mixedWaterPath (4-byte float, array size: npixel x nscan):
Total integrated mixed phase water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

iceWaterPath (4-byte float, array size: npixel x nscan):
Total integrated cloud ice water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

totalColumnWaterVapor (4-byte float, array size: npixel x nscan):
Total integrated water vapor in the vertical atmospheric column, also known as total precipitable water (TPW). Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

spare (2-byte integer, array size: npixel x nscan):
Spare variable. Special values are defined as:
-9999 Missing value

spareIndex (1-byte integer, array size: npixel x nscan):
Spare index variable. Special values are defined as:
-99 Missing value

temp2mIndex (2-byte integer, array size: npixel x nscan):
Temperature 2 meter height Index in the clusterProfiles array. See profileScale description below. Values range from 1 to 21. Special values are defined as:
-9999 Missing value

profileNumber (2-byte integer, array size: nspecies x npixel x nscan):
Profile Number in the clusterProfiles array for each species. See profileScale description below. Values range from 1 to 100. Special values are defined as:
-9999 Missing value

profileScale (4-byte float, array size: nspecies x npixel x nscan):
profileScale is used to scale the values of the clusterProfiles array.

```
In order to recover a value of a single pixel,
select your species, layer, and temp2mindex,
then use profileNumber and profileScale
```

```
to obtain the value:

Where:
  S = species (1-5)
    Species defined in speciesDescription
  T = temp2mIndex (1-21)
    Temperatures defined in temperatureDescriptions
  L = profile layer (1-28) Top of each layer
    specified in hgtTopLayer
  P = profileNumber (1-100) for species S

In a Fortran program,
  P = profileNumber(S)
  Pixel Value = profileScale(S) * clusterProfiles(S,T,L,P)

In a C program,
  P = profileNumber[S-1]
  Pixel Value = profileScale[S] * clusterProfiles[P-1][L-1][T-1][S-1]
```

C Structure Header file:

```
#ifndef _TK_2AGPROFMHS_H_
#define _TK_2AGPROFMHS_H_

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
```

```
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2AGPROFMHS_S1_
#define _L2AGPROFMHS_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[90];
    float Longitude[90];
    SCSTATUS SCstatus;
    signed char pixelStatus[90];
    signed char retrievalType[90];
    signed char qualityFlag[90];
    signed char sunGlintAngle[90];
    signed char snowCoverIndex[90];
    signed char surfaceTypeIndex[90];
    short surfaceSkinTempIndex[90];
    signed char totalColumnWaterVaporIndex[90];
    signed char orographicLiftIndex[90];
    signed char databaseExpansionIndex[90];
    float surfacePrecipitation[90];
    float liquidPrecipFraction[90];
    float convectPrecipFraction[90];
    float probabilityOfPrecip[90];
    float mostLikelyPrecipitation[90];
    float precip1stTertial[90];
    float precip2ndTertial[90];
    short numOfSignificantProf[90];
    float rainWaterPath[90];
    float cloudWaterPath[90];
    float mixedWaterPath[90];
    float iceWaterPath[90];
    float totalColumnWaterVapor[90];
    short spare[90];
```

```
    signed char spareIndex[90];
    short temp2mIndex[90];
    short profileNumber[90][5];
    float profileScale[90][5];
} L2AGPROFMHS_S1;

#endif

#ifndef _GPROFDHEADR_
#define _GPROFDHEADR_

typedef struct {
    unsigned char speciesDescription[5][12];
    float hgtTopLayer[28];
    float temperatureDescriptions[21];
    float clusterProfiles[100][28][21][5];
} GPROFDHEADR;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE
```

```
STRUCTURE /L2AGPROFMHS_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(90)
    REAL*4 Longitude(90)
    RECORD /SCSTATUS/ SCstatus
    BYTE pixelStatus(90)
    BYTE retrievalType(90)
    BYTE qualityFlag(90)
    BYTE sunGlintAngle(90)
    BYTE snowCoverIndex(90)
    BYTE surfaceTypeIndex(90)
    INTEGER*2 surfaceSkinTempIndex(90)
    BYTE totalColumnWaterVaporIndex(90)
    BYTE orographicLiftIndex(90)
    BYTE databaseExpansionIndex(90)
    REAL*4 surfacePrecipitation(90)
    REAL*4 liquidPrecipFraction(90)
    REAL*4 convectPrecipFraction(90)
    REAL*4 probabilityOfPrecip(90)
    REAL*4 mostLikelyPrecipitation(90)
    REAL*4 precip1stTertial(90)
    REAL*4 precip2ndTertial(90)
    INTEGER*2 numOfSignificantProf(90)
    REAL*4 rainWaterPath(90)
    REAL*4 cloudWaterPath(90)
    REAL*4 mixedWaterPath(90)
    REAL*4 iceWaterPath(90)
    REAL*4 totalColumnWaterVapor(90)
    INTEGER*2 spare(90)
    BYTE spareIndex(90)
    INTEGER*2 temp2mIndex(90)
    INTEGER*2 profileNumber(5,90)
    REAL*4 profileScale(5,90)
END STRUCTURE

STRUCTURE /GPROFDHEADR/
    CHARACTER speciesDescription(12,5)
    REAL*4 hgtTopLayer(28)
    REAL*4 temperatureDescriptions(21)
    REAL*4 clusterProfiles(5,21,28,100)
END STRUCTURE
```

5.27 2AGPROFSAPHIR - Radiometer Profiling

2AGPROFSAPHIR, "Radiometer Profiling", generates surface rainfall and vertical hydrometeor profiles on a pixel by pixel basis from radiometer brightness temperature data using the Goddard Profiling algorithm GPROF2014. Because the vertical information comes from a radiometer, it is not written out in independent vertical layers like the TRMM Precipitation Radar. Instead, the output is referenced to one of 100 typical structures for each hydrometeor or heating profile. These vertical structures are referenced to as profiles in the output structure. Vertical hydrometeor profiles can be reconstructed to 28 layers by knowing the profile number (i.e. shape) of the profile and a scale factor that is written for each pixel.

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel	182	Number of pixels in each scan.
nspecies	5	Number of hydrometeor species. Species are defined in speciesDescription in the DataHeader group.
sddim	12	Number of characters in each species description.
ntemps	21	Number of profile temperature indeces. Indeces are defined in temperatureDescriptions in the DataHeader group.
nlyrs	28	Number of profiling layers. The top height of each layer is defined in hgtTopLayer in the DataHeader group.
nprf	100	Number of unique profiles for each species and 2 meter Temperature index.

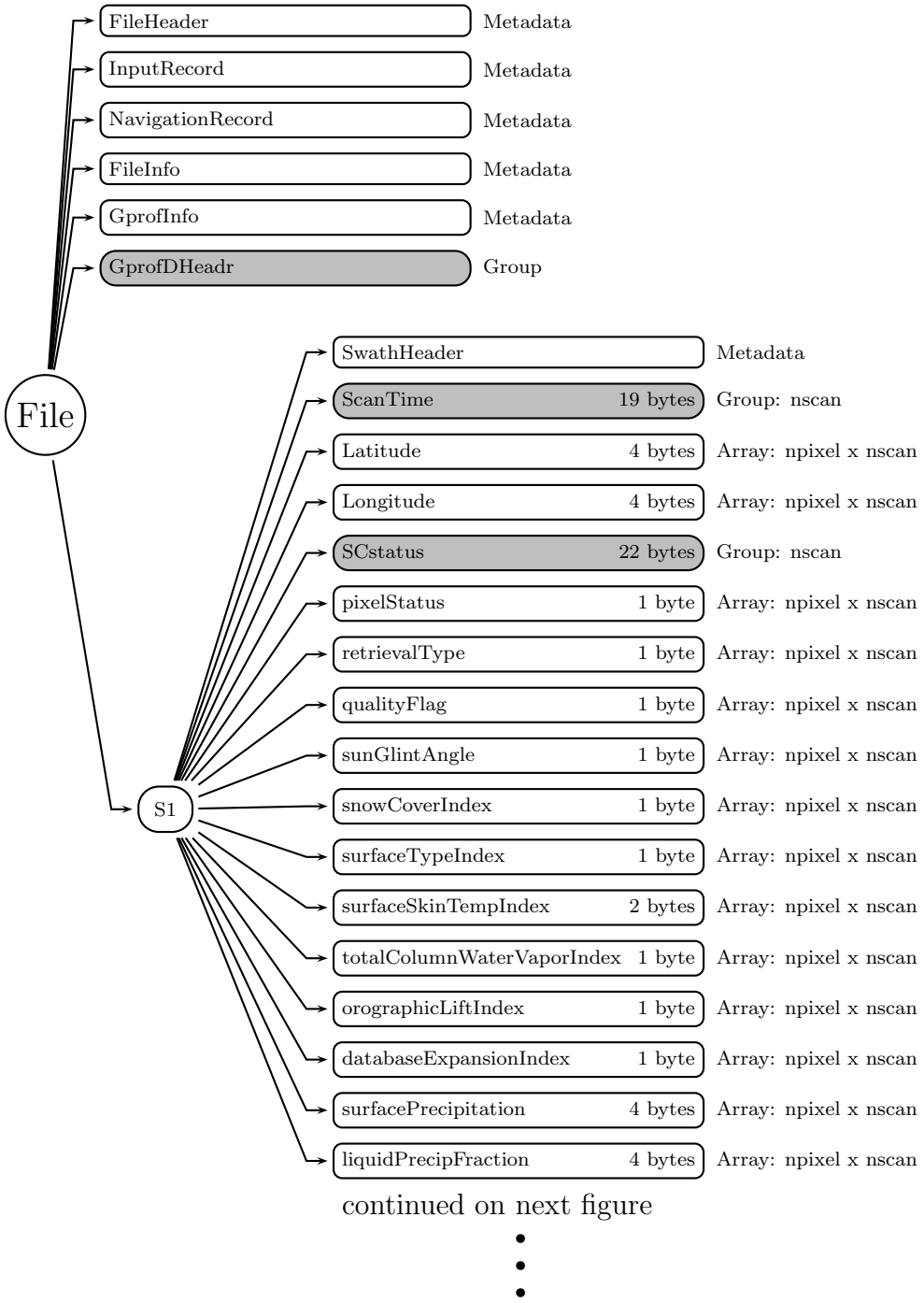
Figure 318 through Figure 322 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.



continued on next figure

Figure 318: Data Format Structure for 2AGPROFSAPHIR, Radiometer Profiling

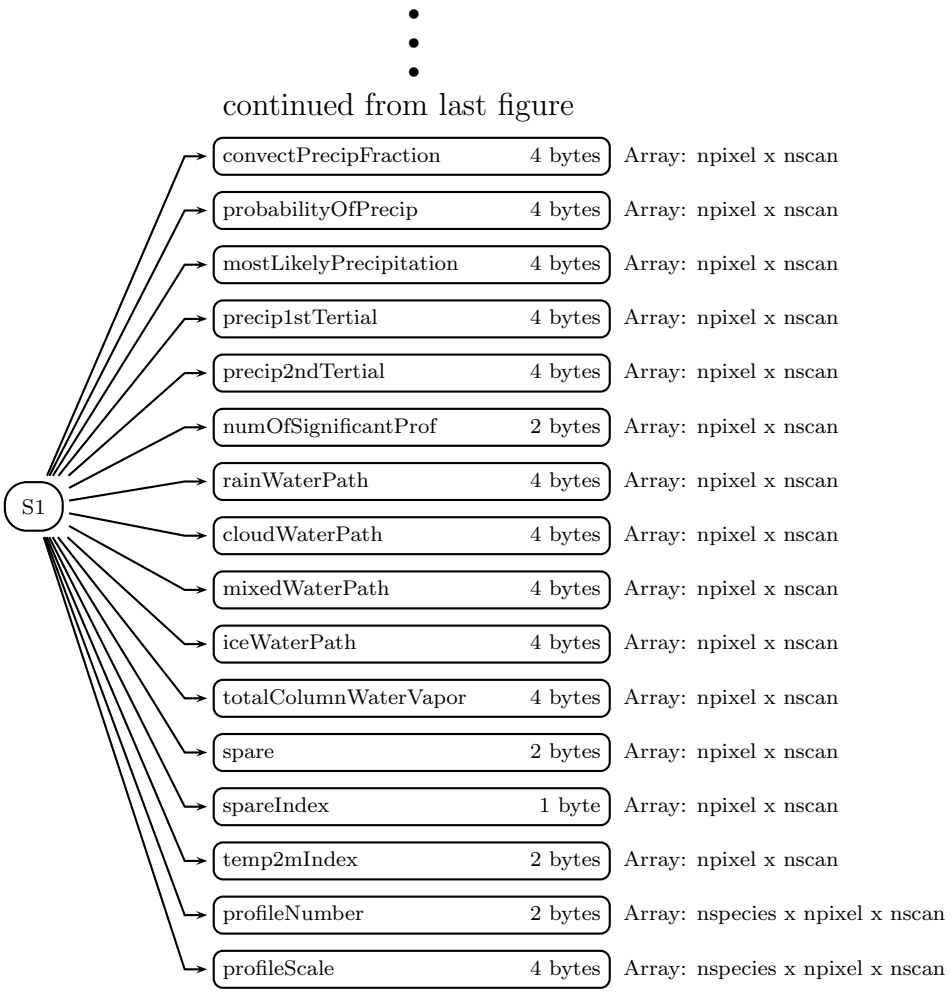


Figure 319: Data Format Structure for 2AGPROFSAPHIR, Radiometer Profiling

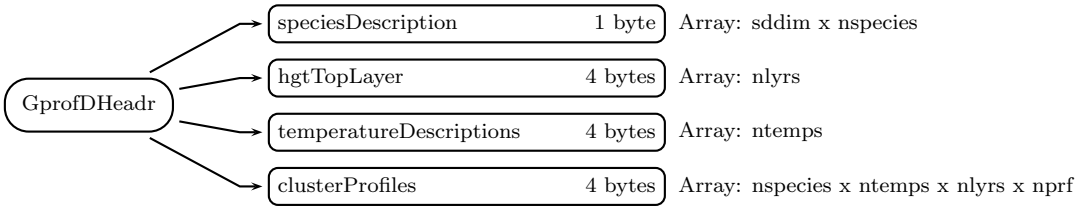


Figure 320: Data Format Structure for 2AGPROFSAPHIR, GprofDHeadr

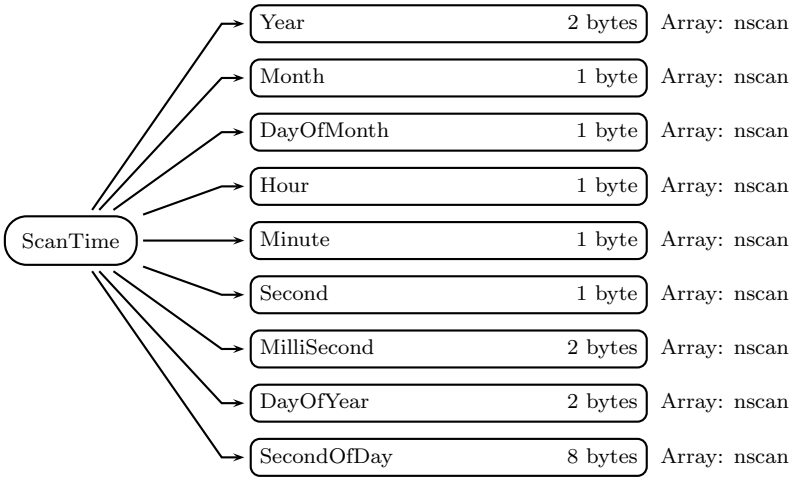


Figure 321: Data Format Structure for 2AGPROFSAPHIR, ScanTime

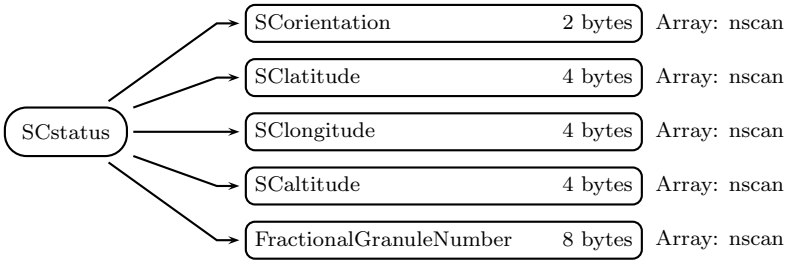


Figure 322: Data Format Structure for 2AGPROFSAPHIR, SCstatus

GprofInfo (Metadata):
GprofInfo contains metadata required by Gprof. Used by 2A12 only. See Metadata for GPM Products for details.

GprofDHeadr (Group)

speciesDescription (1-byte char, array size: sddim x nspecies):
Description of each species. Special values are defined as:
255 Missing value

hgtTopLayer (4-byte float, array size: nlyrs):
Height of the top of each of 28 atmospheric layers in the clusterProfiles. The tops are every 0.5 km up to 10 km, then every km after that up to 18.0 km. Values are: 0.5, 1.0, ... 9.5, 10.0, 11.0, ... 18.0. Values range from 0 to 18.0 km. Special values are defined as:
-9999.9 Missing value

temperatureDescriptions (4-byte float, array size: ntemps):
Temperature of 2 meter temperature indeces of clusterProfiles. Values are in C. Special values are defined as:
-9999.9 Missing value

clusterProfiles (4-byte float, array size: nspecies x ntemps x nlyrs x nprf):
Standard GPM profile structures. Dimensions are hydrometeor/heating species (4); 2 meter temperature index (21); vertical layers (28); and profile number (100). To recover values in a profile see the description below in the variable profileScale.

Special values are defined as:
-9999.9 Missing value

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCstatus (Group)

SCorientation (2-byte integer, array size: nscan):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

pixelStatus (1-byte integer, array size: npixel x nscan):
If there is no retrieval at a given pixel, pixelStatus explains the reason (Range 0 - 99).

```
  0 : Valid pixel
  1 : Boundary error in landmask
  2 : Boundary error in sea-ice check
  3 : Boundary error in sea surface temperature
  4 : Invalid time
  5 : Invalid latitude/longitude
  6 : Invalid brightness temperature
  7 : Invalid sea surface temperature
-99 : Missing value
```

retrievalType (1-byte integer, array size: npixel x nscan):
Specifies that for this pixel, the rain retrieval was made with the S0, S1, or S2 (values are 0,1,2).

qualityFlag (1-byte integer, array size: npixel x nscan):
qualityFlag indicates a generalized quality of the retrieved pixel (Range 0 - 99).

```
      High:    Good retrieval using the GPM derived profile databases
      Medium:  Retrieval using the GPM derived profile databases.
               over coastal areas or in areas of oceanic sunglint.
      Low:     Retrievals using at-launch databases.
  Valid values include:
      0 : High quality (retrieval is good, use it)
      1 : Medium quality (use with caution)
      2 : Low quality (recommended qualitative use only)
    -99 : Missing value
```

sunGlintAngle (1-byte integer, array size: npixel x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. sunGlintAngle is the angular separation between the reflected satellite view vector and the sun vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. If this angle is less than ten degrees, the pixel is affected by sunglint and qualityFlag for the pixel is lowered. Values range from 0 to 180 degrees. Special values are defined as:
-99 Missing value

snowCoverIndex (1-byte integer, array size: npixel x nscan):
An index based on snow depth. Not currently implemented. Values range from 0 to 5. Special values are defined as:
-99 Missing value

surfaceTypeIndex (1-byte integer, array size: npixel x nscan):
Indicates the type of surface (Range 0 - 99).

```
 Codes include
 1  : Ocean
 2  : Sea-Ice
 (3-12 are 'land classification')
 3  : Maximum Vegetation
 4  : High Vegetation
 5  : Moderate Vegetation
 6  : Low Vegetation
 7  : Minimal Vegetation
 8  : Maximum Snow
 9  : Moderate Snow
 10 : Low Snow
 11 : Minimal Snow
 12 : Standing Water and Rivers
 13 : Water/Land Coast Boundary
 14 : Water/Ice Boundary
 15 : Land/Ice Boundary
-99 : Missing value
```

surfaceSkinTempIndex (2-byte integer, array size: npixel x nscan):
Surface temperature from the model, used to select the correct database profiles.

totalColumnWaterVaporIndex (1-byte integer, array size: npixel x nscan):
Liquid equivalent of the total water vapor column used to select the correct database profiles. Values range from 0 to 75 mm. Special values are defined as:
-99 Missing value

orographicLiftIndex (1-byte integer, array size: npixel x nscan):
Index of potential orographic enhancement to precipitation based on vertical motion, atmospheric moisture profile, wind direction, and terrain slope. Not currently implemented. Special values are defined as:
-99 Missing value

databaseExpansionIndex (1-byte integer, array size: npixel x nscan):
Expansion factor of the profile search radius in the profile database beyond the search nominal range. If there are fewer than the minimum number of profiles in the selected database boundaries, then the search radius is expanded. Values range from 0 to 255.

surfacePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous precipitation rate at the surface for each pixel. Check pixelStatus for a valid retrieval. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

liquidPrecipFraction (4-byte float, array size: npixel x nscan):
Fraction of surface precipitation that is liquid. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

convectPrecipFraction (4-byte float, array size: npixel x nscan):
Fraction of surface precipitation that is convective. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

probabilityOfPrecip (4-byte float, array size: npixel x nscan):
A diagnostic variable, in percent, defining the fraction of raining vs. non-raining Database profiles that make up the final solution. Values range from 0 to 100 percent. Special values are defined as:
-9999.9 Missing value

mostLikelyPrecipitation (4-byte float, array size: npixel x nscan):
The surface precipitation value with the highest occurrence within the Bayesian retrieval. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip1stTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 1st tertiary of the precipitation distribution. Values

are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip2ndTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 2nd tertiary of the precipitation distribution. Special values are defined as:
-9999.9 Missing value

numOfSignificantProf (2-byte integer, array size: npixel x nscan):
Number of profiles used in the Bayesian average above 2 sigma. Profiles below this threshold are still used in the average, but are not included in this 'significant' profiles parameter. Special values are defined as:
-9999 Missing value

rainWaterPath (4-byte float, array size: npixel x nscan):
Total integrated rain water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

cloudWaterPath (4-byte float, array size: npixel x nscan):
Total integrated cloud liquid water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

mixedWaterPath (4-byte float, array size: npixel x nscan):
Total integrated mixed phase water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

iceWaterPath (4-byte float, array size: npixel x nscan):
Total integrated cloud ice water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

totalColumnWaterVapor (4-byte float, array size: npixel x nscan):
Total integrated water vapor in the vertical atmospheric column, also known as total precipitable water (TPW). Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

spare (2-byte integer, array size: npixel x nscan):
Spare variable. Special values are defined as:
-9999 Missing value

spareIndex (1-byte integer, array size: npixel x nscan):
Spare index variable. Special values are defined as:
-99 Missing value

temp2mIndex (2-byte integer, array size: npixel x nscan):
Temperature 2 meter height Index in the clusterProfiles array. See profileScale description

below. Values range from 1 to 21. Special values are defined as:
-9999 Missing value

profileNumber (2-byte integer, array size: nspecies x npixel x nscan):
Profile Number in the clusterProfiles array for each species. See profileScale description below. Values range from 1 to 100. Special values are defined as:
-9999 Missing value

profileScale (4-byte float, array size: nspecies x npixel x nscan):
profileScale is used to scale the values of the clusterProfiles array.

```
In order to recover a value of a single pixel,
select your species, layer, and temp2mindex,
then use profileNumber and profileScale
to obtain the value:

Where:
  S = species (1-5)
    Species defined in speciesDescription
  T = temp2mIndex (1-21)
    Temperatures defined in temperatureDescriptions
  L = profile layer (1-28) Top of each layer
    specified in hgtTopLayer
  P = profileNumber (1-100) for species S

In a Fortran program,
  P = profileNumber(S)
  Pixel Value = profileScale(S) * clusterProfiles(S,T,L,P)

In a C program,
  P = profileNumber[S-1]
  Pixel Value = profileScale[S] * clusterProfiles[P-1][L-1][T-1][S-1]
```

C Structure Header file:

```
#ifndef _TK_2AGPROFSAPHIR_H_
#define _TK_2AGPROFSAPHIR_H_

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
```

```
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2AGPROFSAPHIR_S1_
#define _L2AGPROFSAPHIR_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[182];
    float Longitude[182];
    SCSTATUS SCstatus;
    signed char pixelStatus[182];
    signed char retrievalType[182];
    signed char qualityFlag[182];
    signed char sunGlintAngle[182];
    signed char snowCoverIndex[182];
    signed char surfaceTypeIndex[182];
    short surfaceSkinTempIndex[182];
    signed char totalColumnWaterVaporIndex[182];
    signed char orographicLiftIndex[182];
    signed char databaseExpansionIndex[182];
    float surfacePrecipitation[182];
```

```
    float liquidPrecipFraction[182];
    float convectPrecipFraction[182];
    float probabilityOfPrecip[182];
    float mostLikelyPrecipitation[182];
    float precip1stTertial[182];
    float precip2ndTertial[182];
    short numOfSignificantProf[182];
    float rainWaterPath[182];
    float cloudWaterPath[182];
    float mixedWaterPath[182];
    float iceWaterPath[182];
    float totalColumnWaterVapor[182];
    short spare[182];
    signed char spareIndex[182];
    short temp2mIndex[182];
    short profileNumber[182][5];
    float profileScale[182][5];
} L2AGPROFSAPHIR_S1;

#endif

#ifndef _GPROFDHEADR_
#define _GPROFDHEADR_

typedef struct {
    unsigned char speciesDescription[5][12];
    float hgtTopLayer[28];
    float temperatureDescriptions[21];
    float clusterProfiles[100][28][21][5];
} GPROFDHEADR;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
```

```
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2AGPROFSAPHIR_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(182)
    REAL*4 Longitude(182)
    RECORD /SCSTATUS/ SCstatus
    BYTE pixelStatus(182)
    BYTE retrievalType(182)
    BYTE qualityFlag(182)
    BYTE sunGlintAngle(182)
    BYTE snowCoverIndex(182)
    BYTE surfaceTypeIndex(182)
    INTEGER*2 surfaceSkinTempIndex(182)
    BYTE totalColumnWaterVaporIndex(182)
    BYTE orographicLiftIndex(182)
    BYTE databaseExpansionIndex(182)
    REAL*4 surfacePrecipitation(182)
    REAL*4 liquidPrecipFraction(182)
    REAL*4 convectPrecipFraction(182)
    REAL*4 probabilityOfPrecip(182)
    REAL*4 mostLikelyPrecipitation(182)
    REAL*4 precip1stTertial(182)
    REAL*4 precip2ndTertial(182)
    INTEGER*2 numOfSignificantProf(182)
    REAL*4 rainWaterPath(182)
    REAL*4 cloudWaterPath(182)
    REAL*4 mixedWaterPath(182)
    REAL*4 iceWaterPath(182)
    REAL*4 totalColumnWaterVapor(182)
    INTEGER*2 spare(182)
```

```
    BYTE spareIndex(182)
    INTEGER*2 temp2mIndex(182)
    INTEGER*2 profileNumber(5,182)
    REAL*4 profileScale(5,182)
END STRUCTURE

STRUCTURE /GPROFDHEADR/
    CHARACTER speciesDescription(12,5)
    REAL*4 hgtTopLayer(28)
    REAL*4 temperatureDescriptions(21)
    REAL*4 clusterProfiles(5,21,28,100)
END STRUCTURE
```

5.28 2BCMB - Level-2 DPR and GMI Combined

The Combined Level-2 product, 2BCMB, "Level-2 DPR and GMI Combined," is written as a two-swath structure. The first swath, NS, contains 49 rays that match Ku DPR. The second swath, MS, contains 25 rays that match Ka Matched DPR. Surface variables refer to the level of the 2ADPR "near surface", not the "estimated surface". The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nrayNS	49	Number of rays (angle bins) in each NS scan.
nrayMS	25	Number of rays (angle bins) in each MS scan.
nBnEnv	10	Number of environmental bins.
nBnPSDlo	9	Number of low resolution vertical range bins. The bin indices of the low resolution PSD profile parameters are found in PSDparamLowNode.
nBnPSDhi	88	Number of high resolution vertical range bins at 250m interval.
nPSDlo	2	Number of low resolution precipitation drop-size distribution parameters. Parameters are log10(Nw), mu.
nPSDhi	1	Number of high resolution precipitation drop-size distribution parameters.
nBnTrBnd	2	Number of bins in phase transition boundary.
nBnTr	10	Number of bins in phase transition.
nPhsBnN	5	Number of phase bin nodes.
nAB	2	Number of power law parameters. These parameters describe particle density. The parameters are alpha and beta.
nemiss	15	Number of microwave surface emissivities for GMI channels, including separate emissivities for the double side-band channels.
nKuKa	2	Number of Ku and Ka

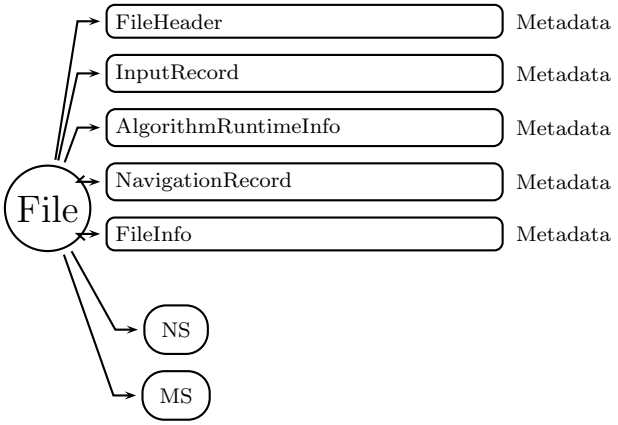
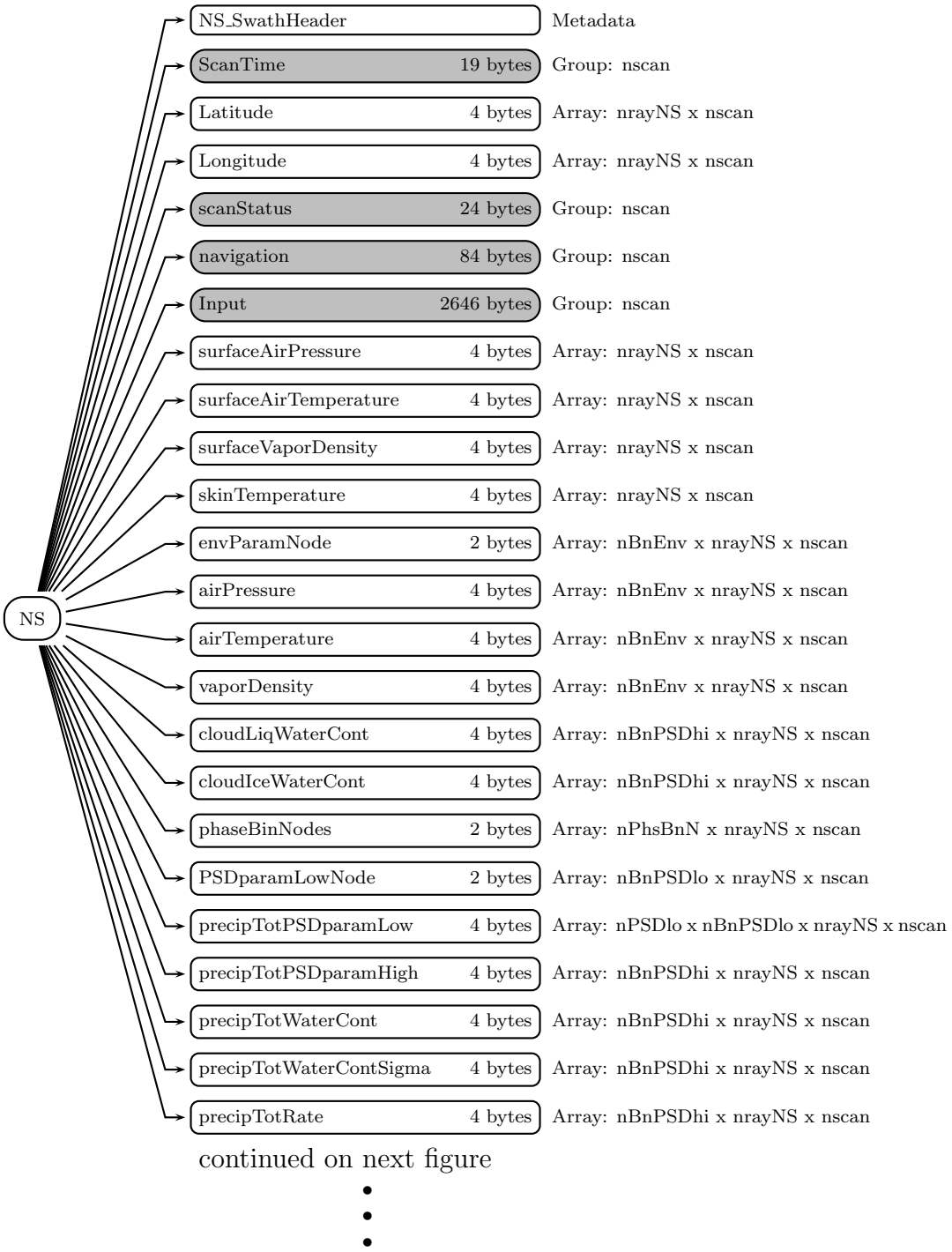


Figure 323: Data Format Structure for 2BCMB, Level-2 DPR and GMI Combined

Figure 323 through Figure 337 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.



continued on next figure

Figure 324: Data Format Structure for 2BCMB, NS, NS

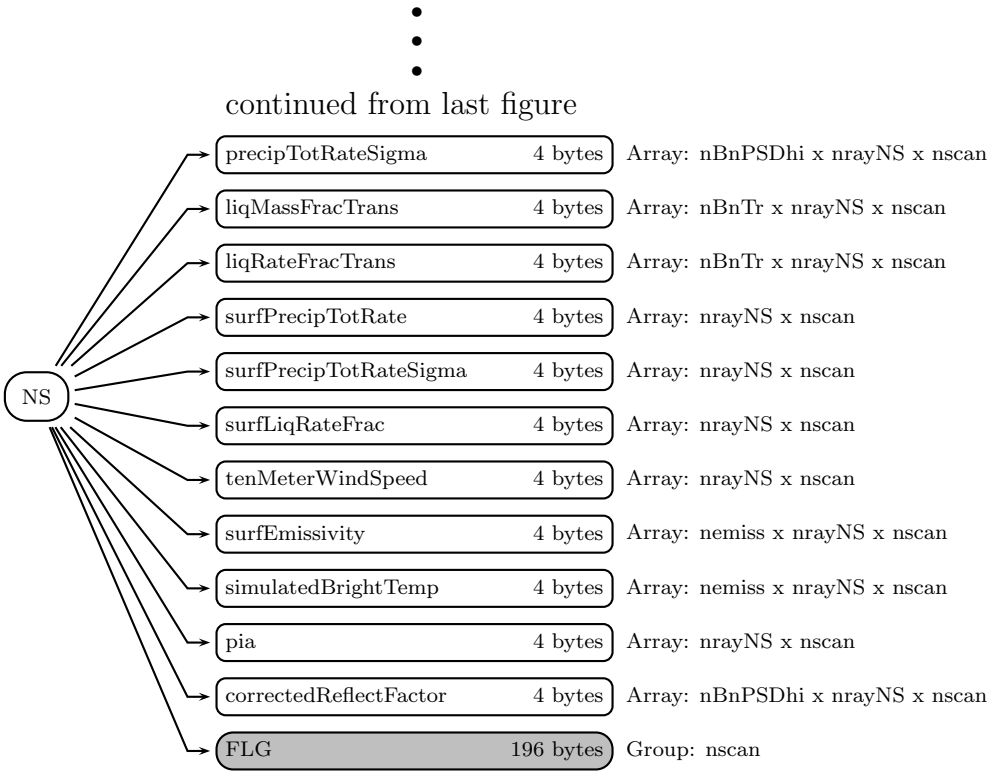
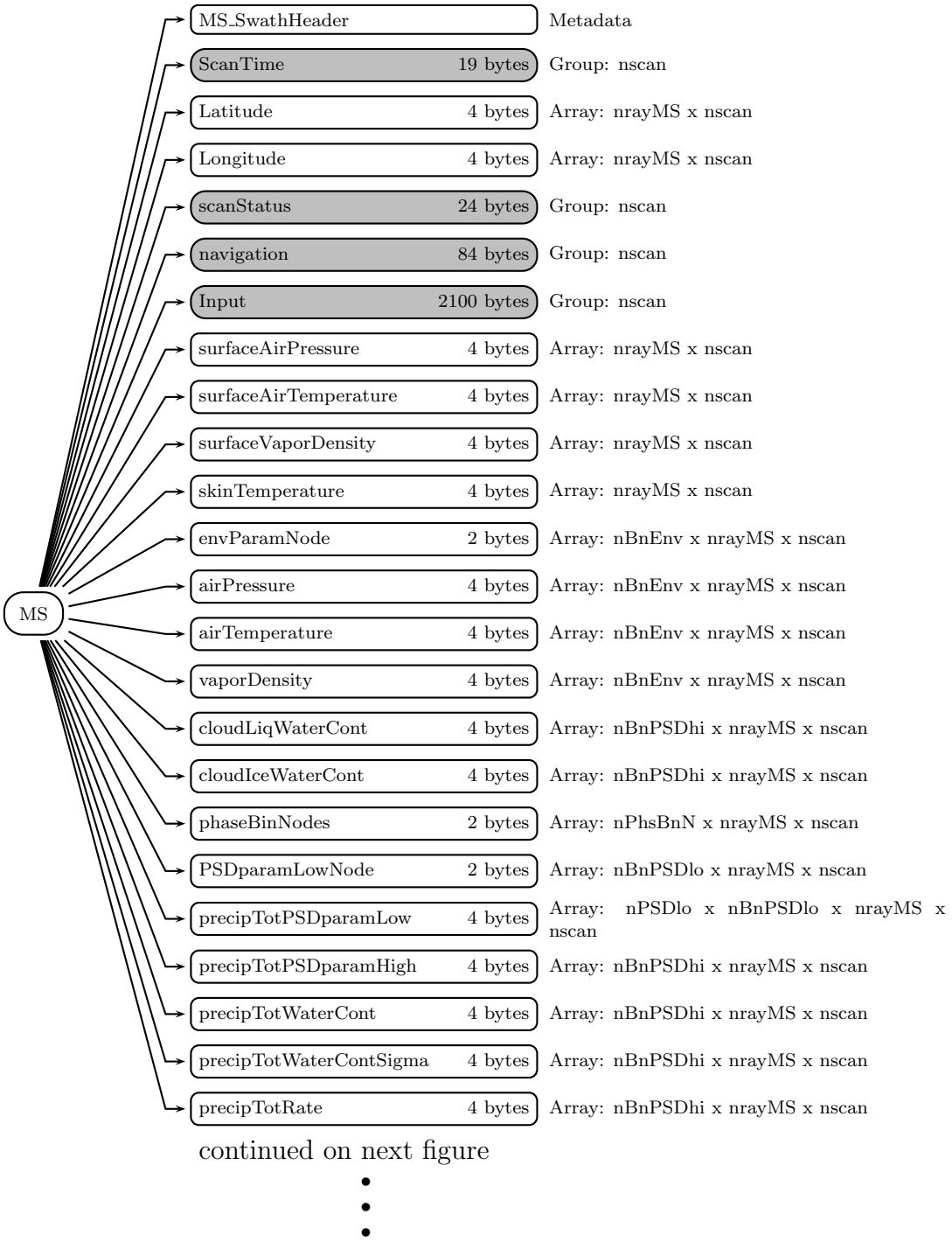


Figure 325: Data Format Structure for 2BCMB, NS



continued on next figure

Figure 326: Data Format Structure for 2BCMB, MS, MS

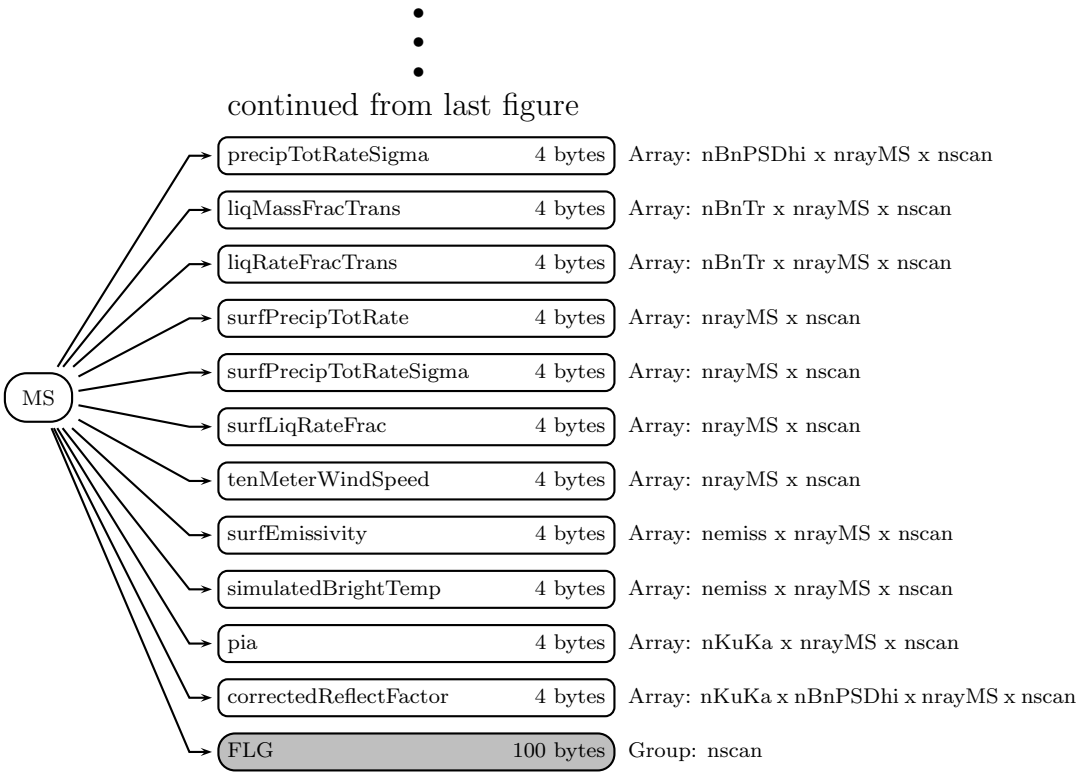


Figure 327: Data Format Structure for 2BCMB, MS

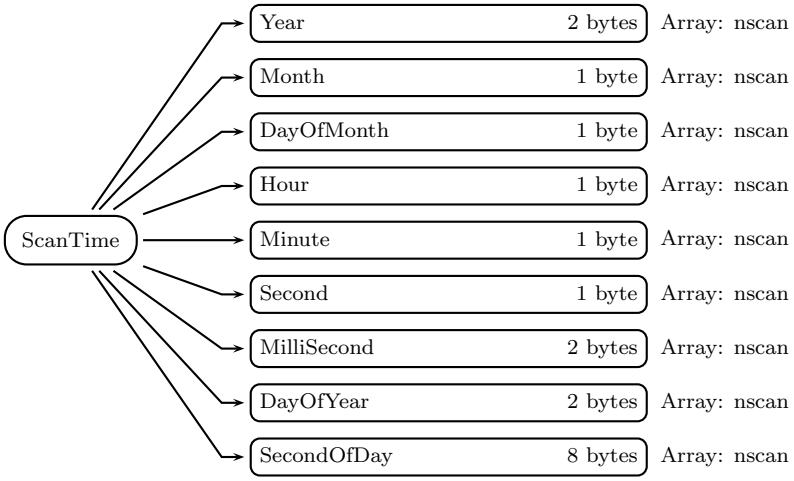


Figure 328: Data Format Structure for 2BCMB, NS, ScanTime

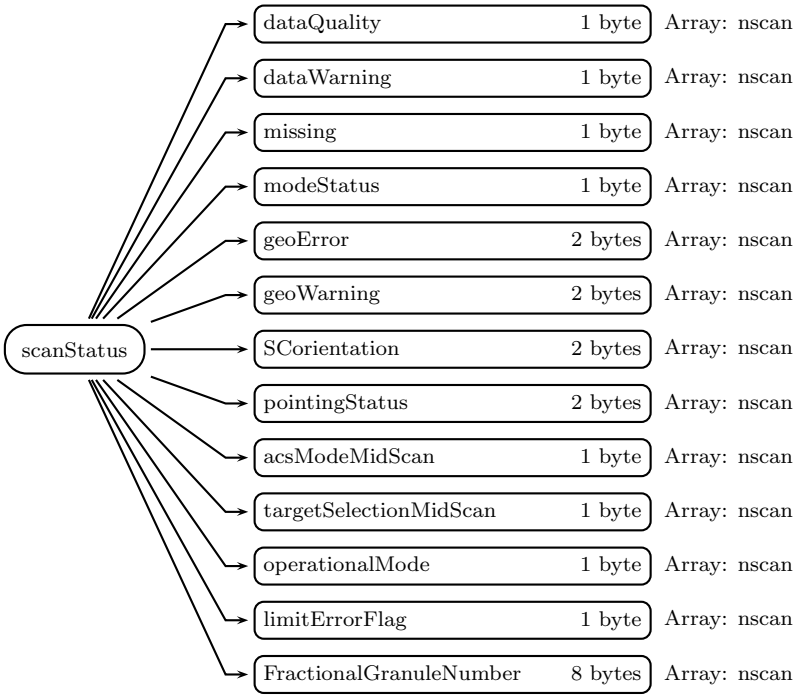


Figure 329: Data Format Structure for 2BCMB, NS, scanStatus

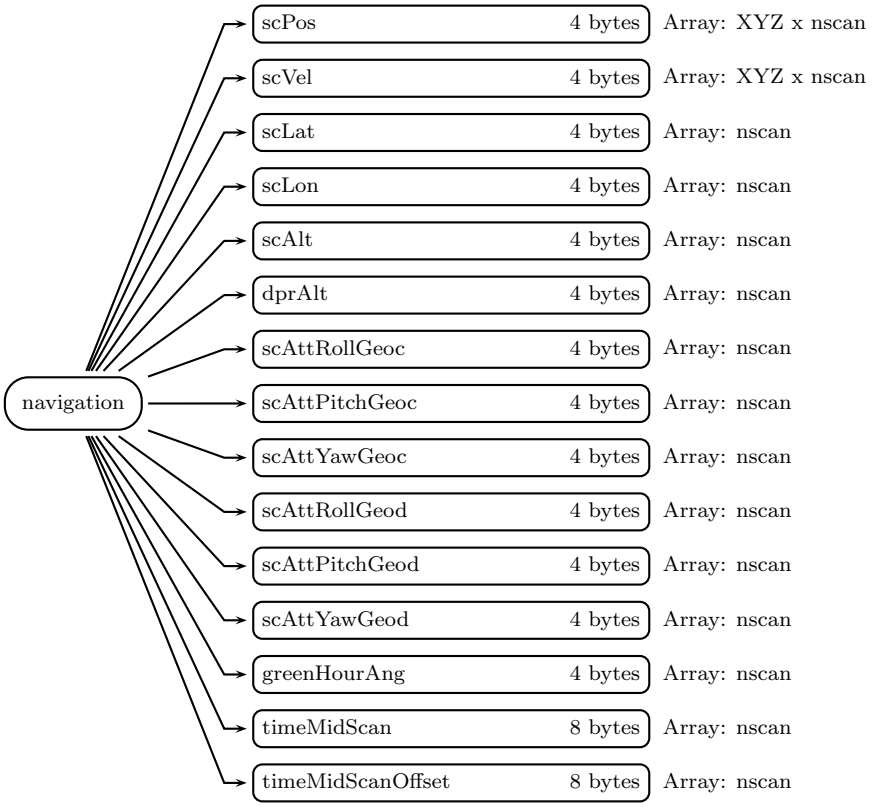


Figure 330: Data Format Structure for 2BCMB, NS, navigation

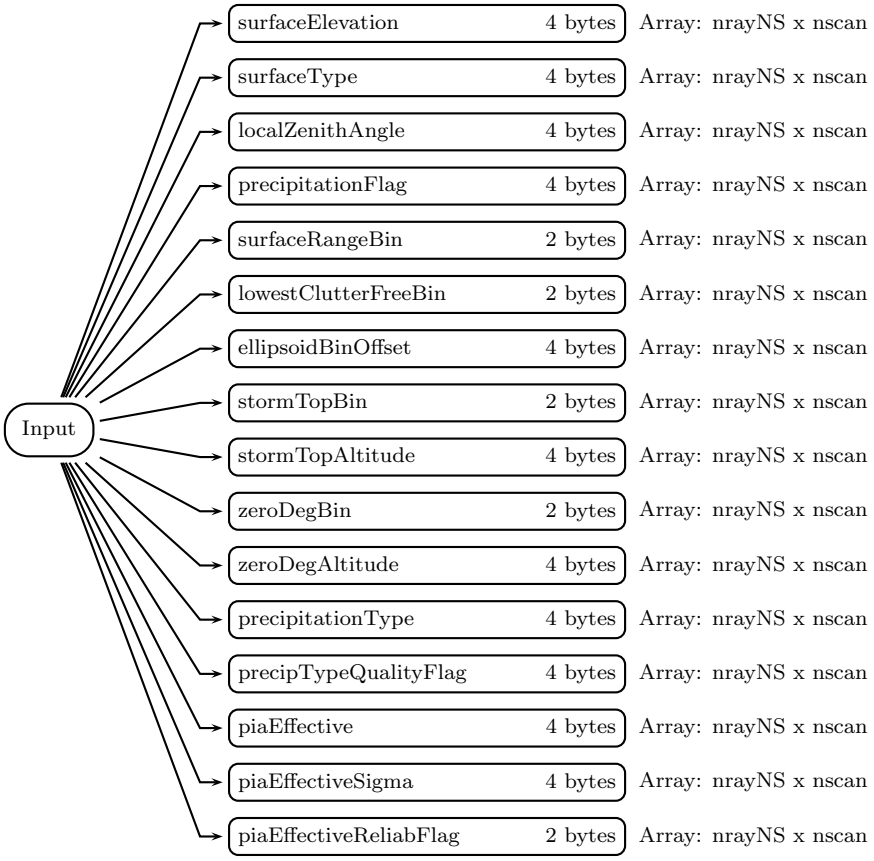


Figure 331: Data Format Structure for 2BCMB, NS, Input

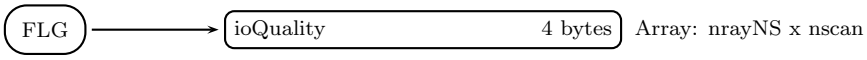


Figure 332: Data Format Structure for 2BCMB, NS, FLG

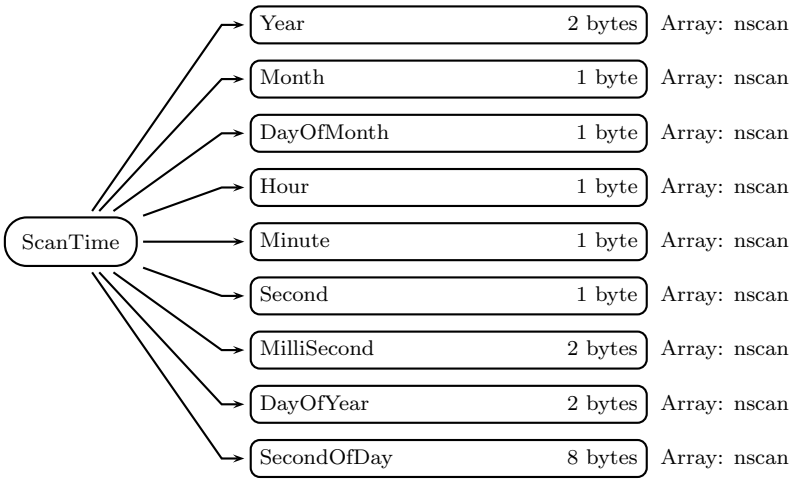


Figure 333: Data Format Structure for 2BCMB, MS, ScanTime

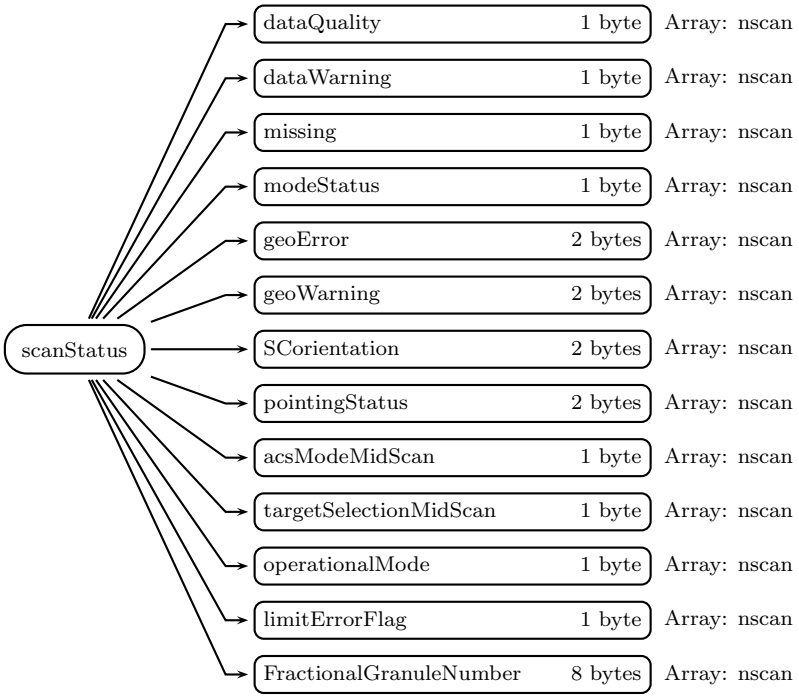


Figure 334: Data Format Structure for 2BCMB, MS, scanStatus

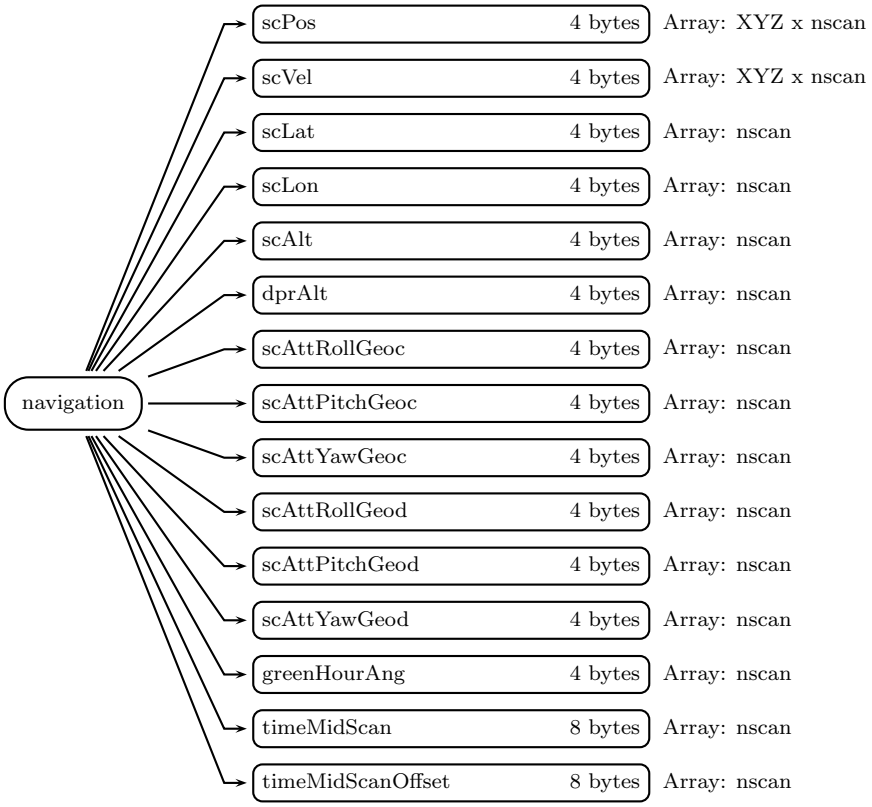


Figure 335: Data Format Structure for 2BCMB, MS, navigation

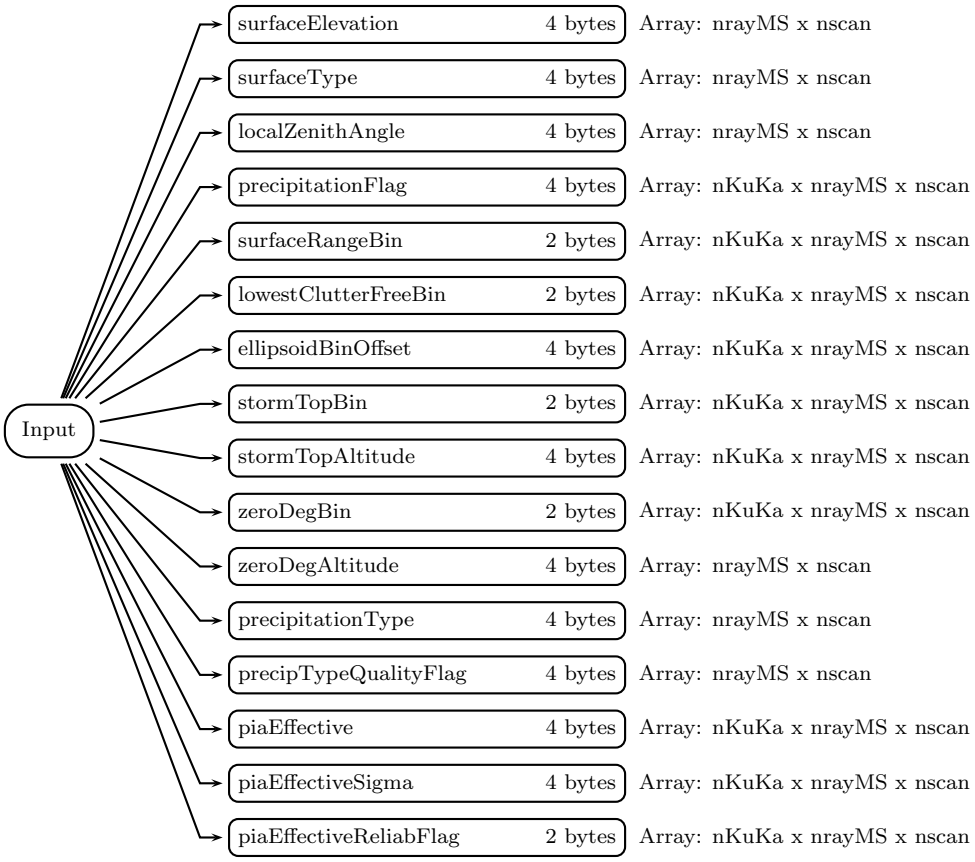


Figure 336: Data Format Structure for 2BCMB, MS, Input

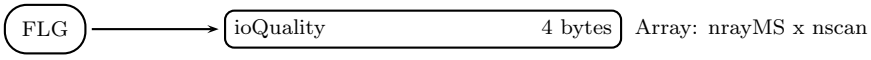


Figure 337: Data Format Structure for 2BCMB, MS, FLG

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

AlgorithmRuntimeInfo (Metadata):
AlgorithmRuntimeInfo contains text runtime information written by the algorithm. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

NS (Swath)

NS_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in NS)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nrayNS x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nrayNS x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in NS)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nscan):
Flag of data warning for each scan.

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
```

```
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
```

```
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):

```
The operational mode of KuPR/KaPR stored in science telemetry.
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
7     Ku/Ka Standby VPRF Table OUT
8     Ku/Ka Standby Phase Out
9     Ku/Ka Standby Dump Out
10    Ku/Ka Standby (No Science Data)
11    Ku/Ka Independent Observation
12    Ku/Ka Independent External Calibration
13    Ku/Ka Independent Internal Calibration
```

```
14    Ku/Ka Independent SSPA Analysis
15    Ku/Ka Independent LNA Analysis
16    Ku/Ka Independent Health-Check
17    Ku/Ka Independent Standby VPRF Table OUT
18    Ku/Ka Independent Standby Phase Out
19    Ku/Ka Independent Standby Dump Out
20    Ku/Ka Independent Standby (No Science Data)
```

limitErrorFlag (1-byte integer, array size: nscan):

```
Bit flags for every ray with information
about echo power limit checks.
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group in NS)

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values

range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity

direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

Input (Group in NS)

surfaceElevation (4-byte float, array size: nrayNS x nscan):
Altitudes above the earth ellipsoid of the surface gates from 2AKu. Values are in m. Special values are defined as:
-9999.9 Missing value

surfaceType (4-byte integer, array size: nrayNS x nscan):
Surface type from 2AKu. Special values are defined as:
-9999 Missing value

localZenithAngle (4-byte float, array size: nrayNS x nscan):
Zenith angle of the ray at the earth's surface from 2AKu. Values are in degree. Special values are defined as:
-9999.9 Missing value

precipitationFlag (4-byte integer, array size: nrayNS x nscan):
Precipitation flag from 2AKu. Special values are defined as:
-9999 Missing value

surfaceRangeBin (2-byte integer, array size: nrayNS x nscan):
Index of the surface range bin from 2AKu. Special values are defined as:
-9999 Missing value

lowestClutterFreeBin (2-byte integer, array size: nrayNS x nscan):
Index of lowest clutter-free bin from 2AKu. Special values are defined as:
-9999 Missing value

ellipsoidBinOffset (4-byte float, array size: nrayNS x nscan):
Offset of surface bin from the earth ellipsoid from 2AKu. Values are in m. Special values are defined as:
-9999.9 Missing value

stormTopBin (2-byte integer, array size: nrayNS x nscan):
Index of storm top bin from 2AKu. Special values are defined as:
-9999 Missing value

stormTopAltitude (4-byte float, array size: nrayNS x nscan):
Altitude of storm top bin from 2AKu. Values are in m. Special values are defined as:
-9999.9 Missing value

zeroDegBin (2-byte integer, array size: nrayNS x nscan):
Range bin of the freezing level. Special values are defined as:
-9999 Missing value

zeroDegAltitude (4-byte float, array size: nrayNS x nscan):
Altitude of the freezing level. Values are in m. Special values are defined as:
-9999.9 Missing value

precipitationType (4-byte integer, array size: nrayNS x nscan):
Precipitation type classification from 2AKu. Special values are defined as:
-9999 Missing value

precipTypeQualityFlag (4-byte integer, array size: nrayNS x nscan):
Quality flag of precipitation type from 2AKu. Special values are defined as:
-9999 Missing value

piaEffective (4-byte float, array size: nrayNS x nscan):
Effective 2-way PIA from 2AKu. Values are in dB. Special values are defined as:
-9999.9 Missing value

piaEffectiveSigma (4-byte float, array size: nrayNS x nscan):
Effective PIA uncertainty from 2AKu. Values are in dB. Special values are defined as:
-9999.9 Missing value

piaEffectiveReliabFlag (2-byte integer, array size: nrayNS x nscan):
Reliability flag of effective PIA from 2AKu. Special values are defined as:
-9999 Missing value

surfaceAirPressure (4-byte float, array size: nrayNS x nscan):
Surface air pressure. Values range from 300 to 1100 hPa. Special values are defined as:
-9999.9 Missing value

surfaceAirTemperature (4-byte float, array size: nrayNS x nscan):
Surface air temperature. Values range from 150 to 350 K. Special values are defined as:
-9999.9 Missing value

surfaceVaporDensity (4-byte float, array size: nrayNS x nscan):
Surface vapor density. Values range from 0 to 60 g/m^3. Special values are defined as:
-9999.9 Missing value

skinTemperature (4-byte float, array size: nrayNS x nscan):
Surface skin temperature. Values range from 150 to 350 K. Special values are defined as:
-9999.9 Missing value

envParamNode (2-byte integer, array size: nBnEnv x nrayNS x nscan):
Bin indices for environmental parameters. Special values are defined as:
-9999 Missing value

airPressure (4-byte float, array size: nBnEnv x nrayNS x nscan):
Air pressure. Values range from 50 to 1100 hPa. Special values are defined as:
-9999.9 Missing value

airTemperature (4-byte float, array size: nBnEnv x nrayNS x nscan):
Air temperature. Values range from 150 to 350 K. Special values are defined as:
-9999.9 Missing value

vaporDensity (4-byte float, array size: nBnEnv x nrayNS x nscan):
Vapor density. Values range from 0 to 60 g/m^3. Special values are defined as:
-9999.9 Missing value

cloudLiqWaterCont (4-byte float, array size: nBnPSDhi x nrayNS x nscan):
Cloud liquid water content. Values range from 0 to 60 g/m^3. Special values are defined as:
-9999.9 Missing value

cloudIceWaterCont (4-byte float, array size: nBnPSDhi x nrayNS x nscan):
Cloud ice water content. Values range from 0 to 18 g/m^3. Special values are defined as:
-9999.9 Missing value

phaseBinNodes (2-byte integer, array size: nPhsBnN x nrayNS x nscan):
Bin numbers indicating (0) storm top, (1) top of mixed-phase later, (2) maximum reflectivity in mixed-phase layer if bright band detected; otherwise, the freezing level from analysis, (3) bottom of mixed-phase layer, and (4) bottom of rain layer. Special values are defined as:
-9999 Missing value

PSDparamLowNode (2-byte integer, array size: nBnPSDlo x nrayNS x nscan):
Bin indices for low-resolution PSD parameters. Special values are defined as:
-9999 Missing value

precipTotPSDparamLow (4-byte float, array size: nPSDlo x nBnPSDlo x nrayNS x nscan):
Total precipitation low-resolution PSD parameters. Values are in Nw_mu. Special values are defined as:
-9999.9 Missing value

precipTotPSDparamHigh (4-byte float, array size: nBnPSDhi x nrayNS x nscan):
Total precipitation high-resolution PSD parameters. Values range from 0 to 20 mm_Dm. Special values are defined as:
-9999.9 Missing value

precipTotWaterCont (4-byte float, array size: nBnPSDhi x nrayNS x nscan):
Total precipitation liquid water content. Values range from 0 to 18 g/m^3. Special values are defined as:
-9999.9 Missing value

precipTotWaterContSigma (4-byte float, array size: nBnPSDhi x nrayNS x nscan):
Total precipitation liquid water content uncertainty. Values range from 0 to 18 g/m^3. Special values are defined as:
-9999.9 Missing value

precipTotRate (4-byte float, array size: nBnPSDhi x nrayNS x nscan):
Total precipitation rate. Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

precipTotRateSigma (4-byte float, array size: nBnPSDhi x nrayNS x nscan):
Total precipitation rate uncertainty. Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

liqMassFracTrans (4-byte float, array size: nBnTr x nrayNS x nscan):
Liquid precipitation mass fraction in phase transition. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

liqRateFracTrans (4-byte float, array size: nBnTr x nrayNS x nscan):
Liquid precipitation rate fraction in phase transition. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

surfPrecipTotRate (4-byte float, array size: nrayNS x nscan):
Surface rain rate. Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

surfPrecipTotRateSigma (4-byte float, array size: nrayNS x nscan):
Surface rain rate uncertainty. Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

surfLiqRateFrac (4-byte float, array size: nrayNS x nscan):
Surface liquid precipitation rate fraction. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

tenMeterWindSpeed (4-byte float, array size: nrayNS x nscan):
Ten meter altitude wind speed magnitude. Values range from 0 to 100 m/s. Special values are defined as:
-9999.9 Missing value

surfEmissivity (4-byte float, array size: nemiss x nrayNS x nscan):
GMI emissivities. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

simulatedBrightTemp (4-byte float, array size: nemiss x nrayNS x nscan):
GMI simulated brightness temperatures. Values range from 20 to 350 K. Special values are defined as:
-9999.9 Missing value

pia (4-byte float, array size: nrayNS x nscan):
Two-way path-integrated attenuation at Ku. Values range from 0 to 1000 dB. Special values are defined as:
-9999.9 Missing value

correctedReflectFactor (4-byte float, array size: nBnPSDhi x nrayNS x nscan):
Corrected radar reflectivities at Ku band. Values range from -20 to 100 dBZ. Special values are defined as:
-9999.9 Missing value

FLG (Group in NS)

ioQuality (4-byte integer, array size: nrayNS x nscan):
Quality flag for input and output.

```
0 : nominal; data available and valid
1 : otherwise

Future versions will have more detailed information.
```

Special values are defined as:
-9999 Missing value

MS (Swath)

MS_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in MS)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nrayMS x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are

defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nrayMS x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in MS)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nscan):
Flag of data warning for each scan.

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
```

```
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
```

```
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
```

```
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):

```
The operational mode of KuPR/KaPR stored in science telemetry.
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
7     Ku/Ka Standby VPRF Table OUT
8     Ku/Ka Standby Phase Out
9     Ku/Ka Standby Dump Out
10    Ku/Ka Standby (No Science Data)
11    Ku/Ka Independent Observation
12    Ku/Ka Independent External Calibration
13    Ku/Ka Independent Internal Calibration
14    Ku/Ka Independent SSPA Analysis
15    Ku/Ka Independent LNA Analysis
16    Ku/Ka Independent Health-Check
17    Ku/Ka Independent Standby VPRF Table OUT
18    Ku/Ka Independent Standby Phase Out
19    Ku/Ka Independent Standby Dump Out
20    Ku/Ka Independent Standby (No Science Data)
```

limitErrorFlag (1-byte integer, array size: nscan):

```
Bit flags for every ray with information
about echo power limit checks.
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group in MS)

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

Input (Group in MS)

surfaceElevation (4-byte float, array size: nrayMS x nscan):
Altitudes above the earth ellipsoid of the surface gates from 2ADPR. Values are in m. Special values are defined as:
-9999.9 Missing value

surfaceType (4-byte integer, array size: nrayMS x nscan):
Surface type from 2ADPR. Special values are defined as:
-9999 Missing value

localZenithAngle (4-byte float, array size: nrayMS x nscan):
Zenith angle of the ray at the earth's surface from 2ADPR. Values are in degree. Special values are defined as:
-9999.9 Missing value

precipitationFlag (4-byte integer, array size: nKuKa x nrayMS x nscan):
Precipitation flag from 2ADPR (Ku/Ka). Special values are defined as:
-9999 Missing value

surfaceRangeBin (2-byte integer, array size: nKuKa x nrayMS x nscan):
Index of the surface range bin from 2ADPR (Ku/Ka). Special values are defined as:
-9999 Missing value

lowestClutterFreeBin (2-byte integer, array size: nKuKa x nrayMS x nscan):
Index of lowest clutter-free bin from 2ADPR (Ku/Ka). Special values are defined as:
-9999 Missing value

ellipsoidBinOffset (4-byte float, array size: nKuKa x nrayMS x nscan):
Offset of surface bin from the earth ellipsoid from 2ADPR (Ku/Ka). Values are in m. Special values are defined as:
-9999.9 Missing value

stormTopBin (2-byte integer, array size: nKuKa x nrayMS x nscan):
Index of storm top bin from 2ADPR (Ku/Ka). Special values are defined as:
-9999 Missing value

stormTopAltitude (4-byte float, array size: nKuKa x nrayMS x nscan):
Altitude of storm top bin from 2ADPR (Ku/Ka). Values are in m. Special values are defined as:
-9999.9 Missing value

zeroDegBin (2-byte integer, array size: nKuKa x nrayMS x nscan):
Range bin of the freezing level. Special values are defined as:
-9999 Missing value

zeroDegAltitude (4-byte float, array size: nrayMS x nscan):
Altitude of the freezing level. Values are in m. Special values are defined as:
-9999.9 Missing value

precipitationType (4-byte integer, array size: nrayMS x nscan):
Precipitation type classification from 2ADPR. Special values are defined as:
-9999 Missing value

precipTypeQualityFlag (4-byte integer, array size: nrayMS x nscan):
Quality flag of precipitation type from 2ADPR. Special values are defined as:
-9999 Missing value

piaEffective (4-byte float, array size: nKuKa x nrayMS x nscan):
Effective 2-way PIA at Ku band from 2ADPR (Ku/Ka). Values are in dB. Special values are defined as:
-9999.9 Missing value

piaEffectiveSigma (4-byte float, array size: nKuKa x nrayMS x nscan):
Effective PIA uncertainty at Ku band from 2ADPR (Ku/Ka). Values are in dB. Special values are defined as:
-9999.9 Missing value

piaEffectiveReliabFlag (2-byte integer, array size: nKuKa x nrayMS x nscan):
Reliability flag of effective PIA from 2ADPR (Ku/Ka). Special values are defined as:
-9999 Missing value

surfaceAirPressure (4-byte float, array size: nrayMS x nscan):
Surface air pressure. Values range from 300 to 1100 hPa. Special values are defined as:
-9999.9 Missing value

surfaceAirTemperature (4-byte float, array size: nrayMS x nscan):
Surface air temperature. Values range from 150 to 350 K. Special values are defined as:
-9999.9 Missing value

surfaceVaporDensity (4-byte float, array size: nrayMS x nscan):
Surface vapor density. Values range from 0 to 60 g/m^3. Special values are defined as:
-9999.9 Missing value

skinTemperature (4-byte float, array size: nrayMS x nscan):
Surface skin temperature. Values range from 150 to 350 K. Special values are defined as:
-9999.9 Missing value

envParamNode (2-byte integer, array size: nBnEnv x nrayMS x nscan):
Bin indices for environmental parameters. Special values are defined as:
-9999 Missing value

airPressure (4-byte float, array size: nBnEnv x nrayMS x nscan):
Air pressure. Values range from 50 to 1100 hPa. Special values are defined as:
-9999.9 Missing value

airTemperature (4-byte float, array size: nBnEnv x nrayMS x nscan):
Air temperature. Values range from 150 to 350 K. Special values are defined as:
-9999.9 Missing value

vaporDensity (4-byte float, array size: nBnEnv x nrayMS x nscan):
Vapor density. Values range from 0 to 60 g/m^3. Special values are defined as:
-9999.9 Missing value

cloudLiqWaterCont (4-byte float, array size: nBnPSDhi x nrayMS x nscan):
Cloud liquid water content. Values range from 0 to 60 g/m^3. Special values are defined as:
-9999.9 Missing value

cloudIceWaterCont (4-byte float, array size: nBnPSDhi x nrayMS x nscan):
Cloud ice water content. Values range from 0 to 18 g/m^3. Special values are defined as:
-9999.9 Missing value

phaseBinNodes (2-byte integer, array size: nPhsBnN x nrayMS x nscan):
Bin numbers indicating (0) storm top, (1) top of mixed-phase later, (2) maximum reflectivity in mixed-phase layer if bright band detected; otherwise, the freezing level from analysis, (3) bottom of mixed-phase layer, and (4) bottom of rain layer. Special values are defined as:
-9999 Missing value

PSDparamLowNode (2-byte integer, array size: nBnPSDlo x nrayMS x nscan):
Bin indices for low-resolution PSD parameters. Special values are defined as:
-9999 Missing value

precipTotPSDparamLow (4-byte float, array size: nPSDlo x nBnPSDlo x nrayMS x nscan):
Total precipitation low-resolution PSD parameters. Values are in Nw_mu. Special values are defined as:
-9999.9 Missing value

precipTotPSDparamHigh (4-byte float, array size: nBnPSDhi x nrayMS x nscan):
Total precipitation high-resolution PSD parameters. Values range from 0 to 20 mm_Dm. Special values are defined as:
-9999.9 Missing value

precipTotWaterCont (4-byte float, array size: nBnPSDhi x nrayMS x nscan):
Total precipitation liquid water content. Values range from 0 to 18 g/m^3. Special values are defined as:
-9999.9 Missing value

precipTotWaterContSigma (4-byte float, array size: nBnPSDhi x nrayMS x nscan):
Total precipitation liquid water content uncertainty. Values range from 0 to 18 g/m^3. Special values are defined as:
-9999.9 Missing value

precipTotRate (4-byte float, array size: nBnPSDhi x nrayMS x nscan):
Total precipitation rate. Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

precipTotRateSigma (4-byte float, array size: nBnPSDhi x nrayMS x nscan):
Total precipitation rate uncertainty. Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

liqMassFracTrans (4-byte float, array size: nBnTr x nrayMS x nscan):
Liquid precipitation mass fraction in phase transition. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

liqRateFracTrans (4-byte float, array size: nBnTr x nrayMS x nscan):
Liquid precipitation rate fraction in phase transition. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

surfPrecipTotRate (4-byte float, array size: nrayMS x nscan):
Surface rain rate. Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

surfPrecipTotRateSigma (4-byte float, array size: nrayMS x nscan):
Surface rain rate uncertainty. Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

surfLiqRateFrac (4-byte float, array size: nrayMS x nscan):
Surface liquid precipitation rate fraction. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

tenMeterWindSpeed (4-byte float, array size: nrayMS x nscan):
Ten meter altitude wind speed magnitude. Values range from 0 to 100 m/s. Special values are defined as:
-9999.9 Missing value

surfEmissivity (4-byte float, array size: nemiss x nrayMS x nscan):
GMI emissivities. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

simulatedBrightTemp (4-byte float, array size: nemiss x nrayMS x nscan):
GMI simulated brightness temperatures. Values range from 20 to 350 K. Special values are defined as:
-9999.9 Missing value

pia (4-byte float, array size: nKuKa x nrayMS x nscan):
Two-way path-integrated attenuation (Ku/Ka). Values range from 0 to 1000 dB. Special

values are defined as:
-9999.9 Missing value

correctedReflectFactor (4-byte float, array size: nKuKa x nBnPSDhi x nrayMS x nscan):
Corrected radar reflectivities (Ku/Ka). Values range from -20 to 100 dBZ. Special values are defined as:
-9999.9 Missing value

FLG (Group in MS)

ioQuality (4-byte integer, array size: nrayMS x nscan):
Quality flag for input and output.

```
0 : nominal; data available and valid
1 : otherwise

Future versions will have more detailed information.
```

Special values are defined as:
-9999 Missing value

C Structure Header file:

```
#ifndef _TK_2BCMB_H_
#define _TK_2BCMB_H_

#ifndef _L2BCMB_MS_FLG_
#define _L2BCMB_MS_FLG_

typedef struct {
    int ioQuality[25];
} L2BCMB_MS_FLG;

#endif

#ifndef _L2BCMB_MS_INPUT_
#define _L2BCMB_MS_INPUT_

typedef struct {
    float surfaceElevation[25];
    int surfaceType[25];
```

```
    float localZenithAngle[25];
    int precipitationFlag[25][2];
    short surfaceRangeBin[25][2];
    short lowestClutterFreeBin[25][2];
    float ellipsoidBinOffset[25][2];
    short stormTopBin[25][2];
    float stormTopAltitude[25][2];
    short zeroDegBin[25][2];
    float zeroDegAltitude[25];
    int precipitationType[25];
    int precipTypeQualityFlag[25];
    float piaEffective[25][2];
    float piaEffectiveSigma[25][2];
    short piaEffectiveReliabFlag[25][2];
} L2BCMB_MS_INPUT;

#endif

#ifndef _L2BCMB_MS_SCANSTATUS_
#define _L2BCMB_MS_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char dataWarning;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    signed char limitErrorFlag;
    double FractionalGranuleNumber;
} L2BCMB_MS_SCANSTATUS;

#endif

#ifndef _L2BCMB_MS_
#define _L2BCMB_MS_

typedef struct {
```

```
    SCANTIME ScanTime;
    float Latitude[25];
    float Longitude[25];
    L2BCMB_MS_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L2BCMB_MS_INPUT Input;
    float surfaceAirPressure[25];
    float surfaceAirTemperature[25];
    float surfaceVaporDensity[25];
    float skinTemperature[25];
    short envParamNode[25][10];
    float airPressure[25][10];
    float airTemperature[25][10];
    float vaporDensity[25][10];
    float cloudLiqWaterCont[25][88];
    float cloudIceWaterCont[25][88];
    short phaseBinNodes[25][5];
    short PSDparamLowNode[25][9];
    float precipTotPSDparamLow[25][9][2];
    float precipTotPSDparamHigh[25][88];
    float precipTotWaterCont[25][88];
    float precipTotWaterContSigma[25][88];
    float precipTotRate[25][88];
    float precipTotRateSigma[25][88];
    float liqMassFracTrans[25][10];
    float liqRateFracTrans[25][10];
    float surfPrecipTotRate[25];
    float surfPrecipTotRateSigma[25];
    float surfLiqRateFrac[25];
    float tenMeterWindSpeed[25];
    float surfEmissivity[25][15];
    float simulatedBrightTemp[25][15];
    float pia[25][2];
    float correctedReflectFactor[25][88][2];
    L2BCMB_MS_FLG FLG;
} L2BCMB_MS;

#endif

#ifndef _L2BCMB_NS_FLG_
#define _L2BCMB_NS_FLG_

typedef struct {
```

```
    int ioQuality[49];
} L2BCMB_NS_FLG;

#endif

#ifndef _L2BCMB_NS_INPUT_
#define _L2BCMB_NS_INPUT_

typedef struct {
    float surfaceElevation[49];
    int surfaceType[49];
    float localZenithAngle[49];
    int precipitationFlag[49];
    short surfaceRangeBin[49];
    short lowestClutterFreeBin[49];
    float ellipsoidBinOffset[49];
    short stormTopBin[49];
    float stormTopAltitude[49];
    short zeroDegBin[49];
    float zeroDegAltitude[49];
    int precipitationType[49];
    int precipTypeQualityFlag[49];
    float piaEffective[49];
    float piaEffectiveSigma[49];
    short piaEffectiveReliabFlag[49];
} L2BCMB_NS_INPUT;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
```

```
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _L2BCMB_NS_SCANSTATUS_
#define _L2BCMB_NS_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char dataWarning;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    signed char limitErrorFlag;
    double FractionalGranuleNumber;
} L2BCMB_NS_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
```

```
} SCANTIME;

#endif

#ifndef _L2BCMB_NS_
#define _L2BCMB_NS_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[49];
    float Longitude[49];
    L2BCMB_NS_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L2BCMB_NS_INPUT Input;
    float surfaceAirPressure[49];
    float surfaceAirTemperature[49];
    float surfaceVaporDensity[49];
    float skinTemperature[49];
    short envParamNode[49][10];
    float airPressure[49][10];
    float airTemperature[49][10];
    float vaporDensity[49][10];
    float cloudLiqWaterCont[49][88];
    float cloudIceWaterCont[49][88];
    short phaseBinNodes[49][5];
    short PSDparamLowNode[49][9];
    float precipTotPSDparamLow[49][9][2];
    float precipTotPSDparamHigh[49][88];
    float precipTotWaterCont[49][88];
    float precipTotWaterContSigma[49][88];
    float precipTotRate[49][88];
    float precipTotRateSigma[49][88];
    float liqMassFracTrans[49][10];
    float liqRateFracTrans[49][10];
    float surfPrecipTotRate[49];
    float surfPrecipTotRateSigma[49];
    float surfLiqRateFrac[49];
    float tenMeterWindSpeed[49];
    float surfEmissivity[49][15];
    float simulatedBrightTemp[49][15];
    float pia[49];
    float correctedReflectFactor[49][88];
    L2BCMB_NS_FLG FLG;
```

```
} L2BCMB_NS;

#endif

#ifndef _L2BCMB_SWATHS_
#define _L2BCMB_SWATHS_

typedef struct {
    L2BCMB_NS NS;
    L2BCMB_MS MS;
} L2BCMB_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L2BCMB_MS_FLG/
    INTEGER*4 ioQuality(25)
END STRUCTURE

STRUCTURE /L2BCMB_MS_INPUT/
    REAL*4 surfaceElevation(25)
    INTEGER*4 surfaceType(25)
    REAL*4 localZenithAngle(25)
    INTEGER*4 precipitationFlag(2,25)
    INTEGER*2 surfaceRangeBin(2,25)
    INTEGER*2 lowestClutterFreeBin(2,25)
    REAL*4 ellipsoidBinOffset(2,25)
    INTEGER*2 stormTopBin(2,25)
    REAL*4 stormTopAltitude(2,25)
    INTEGER*2 zeroDegBin(2,25)
    REAL*4 zeroDegAltitude(25)
    INTEGER*4 precipitationType(25)
    INTEGER*4 precipTypeQualityFlag(25)
    REAL*4 piaEffective(2,25)
    REAL*4 piaEffectiveSigma(2,25)
    INTEGER*2 piaEffectiveReliabFlag(2,25)
END STRUCTURE

STRUCTURE /L2BCMB_MS_SCANSTATUS/
    BYTE dataQuality
```

```
    BYTE dataWarning
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    BYTE limitErrorFlag
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /L2BCMB_MS/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(25)
    REAL*4 Longitude(25)
    RECORD /L2BCMB_MS_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L2BCMB_MS_INPUT/ Input
    REAL*4 surfaceAirPressure(25)
    REAL*4 surfaceAirTemperature(25)
    REAL*4 surfaceVaporDensity(25)
    REAL*4 skinTemperature(25)
    INTEGER*2 envParamNode(10,25)
    REAL*4 airPressure(10,25)
    REAL*4 airTemperature(10,25)
    REAL*4 vaporDensity(10,25)
    REAL*4 cloudLiqWaterCont(88,25)
    REAL*4 cloudIceWaterCont(88,25)
    INTEGER*2 phaseBinNodes(5,25)
    INTEGER*2 PSDparamLowNode(9,25)
    REAL*4 precipTotPSDparamLow(2,9,25)
    REAL*4 precipTotPSDparamHigh(88,25)
    REAL*4 precipTotWaterCont(88,25)
    REAL*4 precipTotWaterContSigma(88,25)
    REAL*4 precipTotRate(88,25)
    REAL*4 precipTotRateSigma(88,25)
    REAL*4 liqMassFracTrans(10,25)
    REAL*4 liqRateFracTrans(10,25)
    REAL*4 surfPrecipTotRate(25)
    REAL*4 surfPrecipTotRateSigma(25)
```

```
    REAL*4 surfLiqRateFrac(25)
    REAL*4 tenMeterWindSpeed(25)
    REAL*4 surfEmissivity(15,25)
    REAL*4 simulatedBrightTemp(15,25)
    REAL*4 pia(2,25)
    REAL*4 correctedReflectFactor(2,88,25)
    RECORD /L2BCMB_MS_FLG/ FLG
END STRUCTURE

STRUCTURE /L2BCMB_NS_FLG/
    INTEGER*4 ioQuality(49)
END STRUCTURE

STRUCTURE /L2BCMB_NS_INPUT/
    REAL*4 surfaceElevation(49)
    INTEGER*4 surfaceType(49)
    REAL*4 localZenithAngle(49)
    INTEGER*4 precipitationFlag(49)
    INTEGER*2 surfaceRangeBin(49)
    INTEGER*2 lowestClutterFreeBin(49)
    REAL*4 ellipsoidBinOffset(49)
    INTEGER*2 stormTopBin(49)
    REAL*4 stormTopAltitude(49)
    INTEGER*2 zeroDegBin(49)
    REAL*4 zeroDegAltitude(49)
    INTEGER*4 precipitationType(49)
    INTEGER*4 precipTypeQualityFlag(49)
    REAL*4 piaEffective(49)
    REAL*4 piaEffectiveSigma(49)
    INTEGER*2 piaEffectiveReliabFlag(49)
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
```

```
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L2BCMB_NS_SCANSTATUS/
    BYTE dataQuality
    BYTE dataWarning
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    BYTE limitErrorFlag
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2BCMB_NS/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(49)
    REAL*4 Longitude(49)
    RECORD /L2BCMB_NS_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L2BCMB_NS_INPUT/ Input
    REAL*4 surfaceAirPressure(49)
```

```
    REAL*4 surfaceAirTemperature(49)
    REAL*4 surfaceVaporDensity(49)
    REAL*4 skinTemperature(49)
    INTEGER*2 envParamNode(10,49)
    REAL*4 airPressure(10,49)
    REAL*4 airTemperature(10,49)
    REAL*4 vaporDensity(10,49)
    REAL*4 cloudLiqWaterCont(88,49)
    REAL*4 cloudIceWaterCont(88,49)
    INTEGER*2 phaseBinNodes(5,49)
    INTEGER*2 PSDparamLowNode(9,49)
    REAL*4 precipTotPSDparamLow(2,9,49)
    REAL*4 precipTotPSDparamHigh(88,49)
    REAL*4 precipTotWaterCont(88,49)
    REAL*4 precipTotWaterContSigma(88,49)
    REAL*4 precipTotRate(88,49)
    REAL*4 precipTotRateSigma(88,49)
    REAL*4 liqMassFracTrans(10,49)
    REAL*4 liqRateFracTrans(10,49)
    REAL*4 surfPrecipTotRate(49)
    REAL*4 surfPrecipTotRateSigma(49)
    REAL*4 surfLiqRateFrac(49)
    REAL*4 tenMeterWindSpeed(49)
    REAL*4 surfEmissivity(15,49)
    REAL*4 simulatedBrightTemp(15,49)
    REAL*4 pia(49)
    REAL*4 correctedReflectFactor(88,49)
    RECORD /L2BCMB_NS_FLG/ FLG
END STRUCTURE

STRUCTURE /L2BCMB_SWATHS/
    RECORD /L2BCMB_NS/ NS
    RECORD /L2BCMB_MS/ MS
END STRUCTURE
```

5.29 2AKu - Ku precipitation

The Ku Level-2A product, 2AKu, "Ku precipitation," is written as a 1 swath structure. The swath is NS, normal scans. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nray	49	Number of angle bins in each NS scan.
nrayMS	25	Number of angle bins in each MS scan.
nrayHS	24	Number of angle bins in each HS scan.
nbin	176	Number of range bins in each NS and MS ray. Bin interval is 125 m.
nbinHS	88	Number of range bins in each HS ray. Bin interval is 250 m.
nbinSZP	7	Number of range bins for sigmaZeroProfile.
nNP	4	Number of NP kinds.
nearFar	2	Near reference, Far reference.
foreBack	2	Foreward, Backward.
method	6	Number of SRT methods.
nNode	5	Number of binNode.
nDSD	2	Number of DSD parameters. Parameters are dBNw and Dm (mm).
LS	2	Liquid, solid.

Figure 338 through Figure 349 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

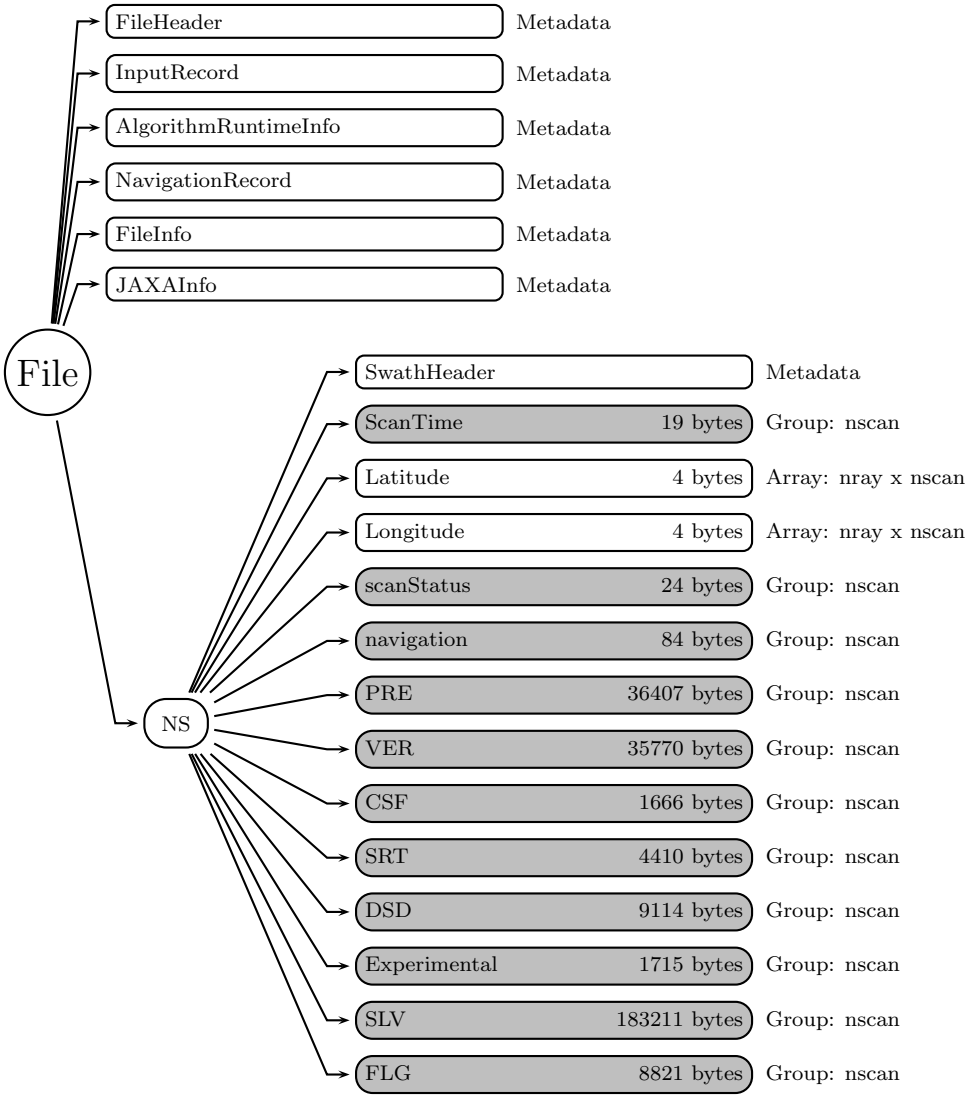


Figure 338: Data Format Structure for 2AKu, Ku precipitation

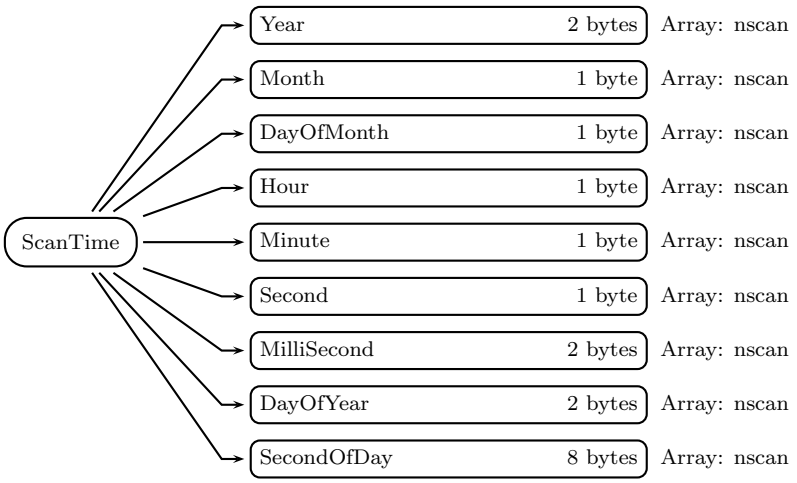


Figure 339: Data Format Structure for 2AKu, ScanTime

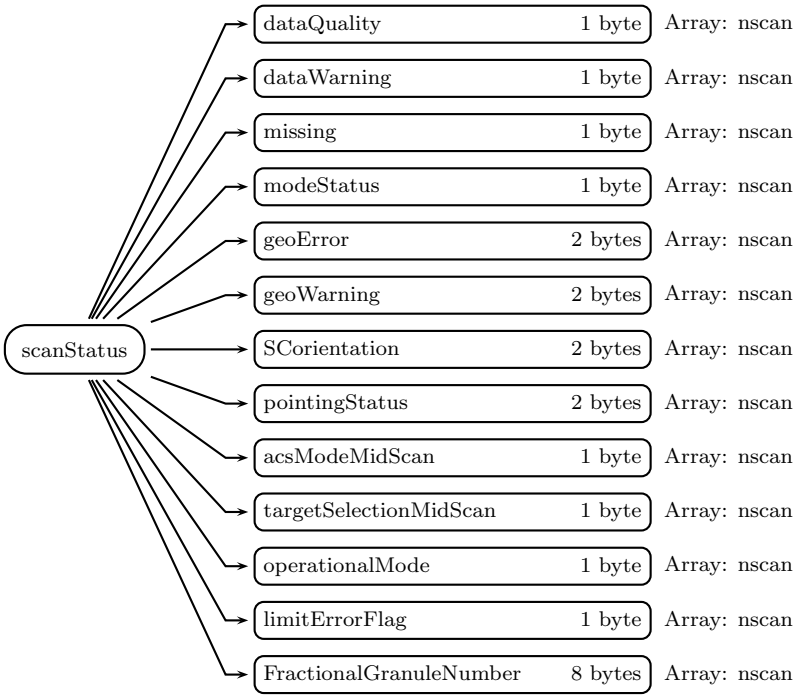


Figure 340: Data Format Structure for 2AKu, scanStatus

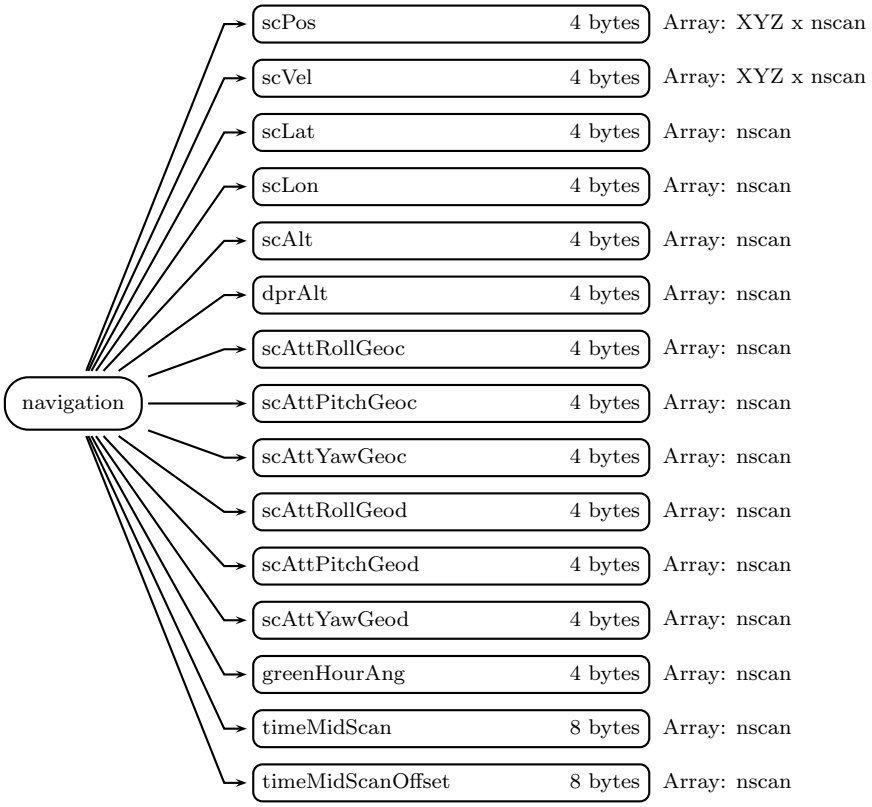


Figure 341: Data Format Structure for 2AKu, navigation

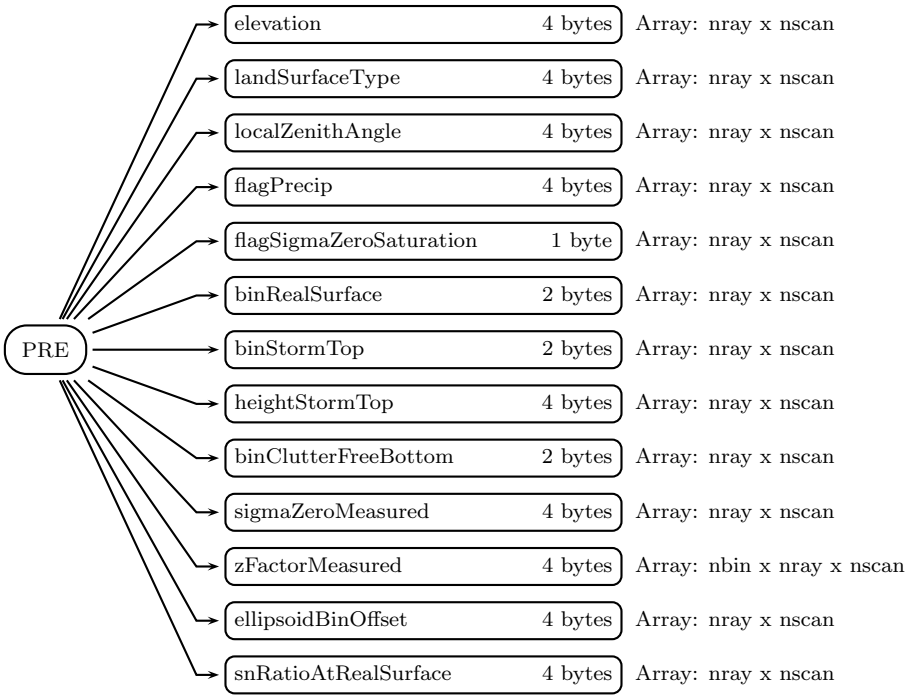


Figure 342: Data Format Structure for 2AKu, PRE

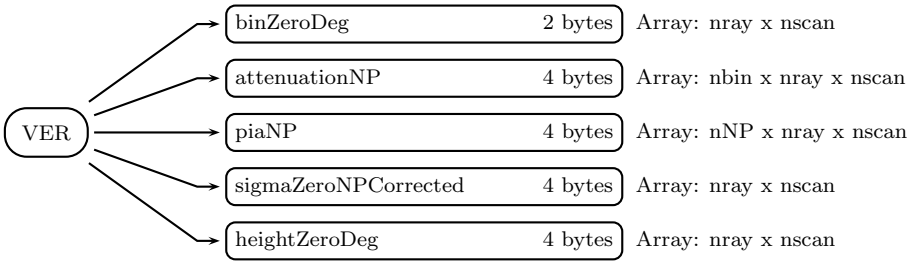


Figure 343: Data Format Structure for 2AKu, VER

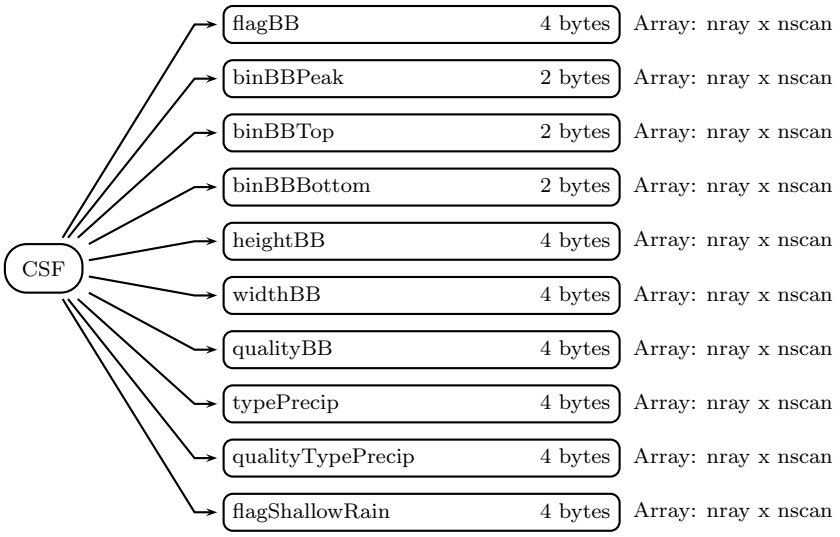


Figure 344: Data Format Structure for 2AKu, CSF

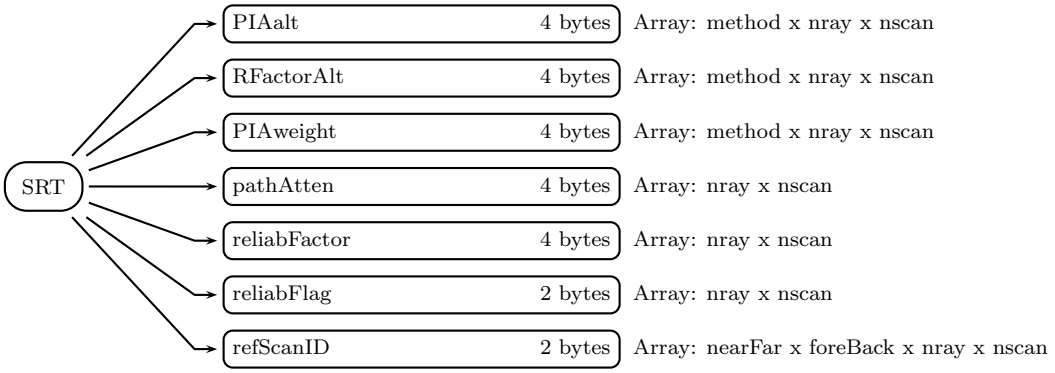


Figure 345: Data Format Structure for 2AKu, SRT

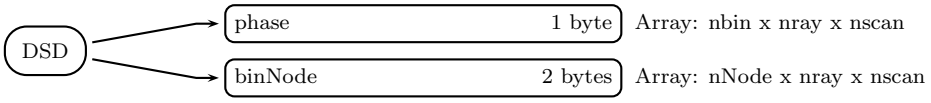


Figure 346: Data Format Structure for 2AKu, DSD

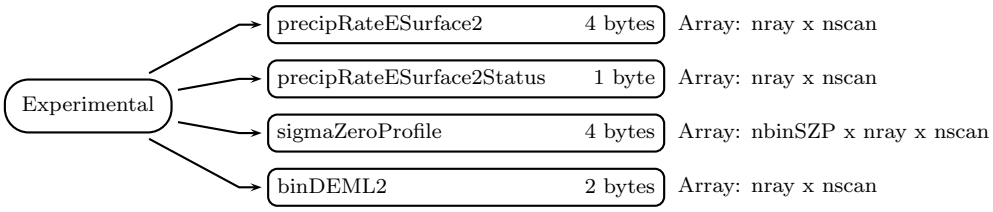


Figure 347: Data Format Structure for 2AKu, Experimental

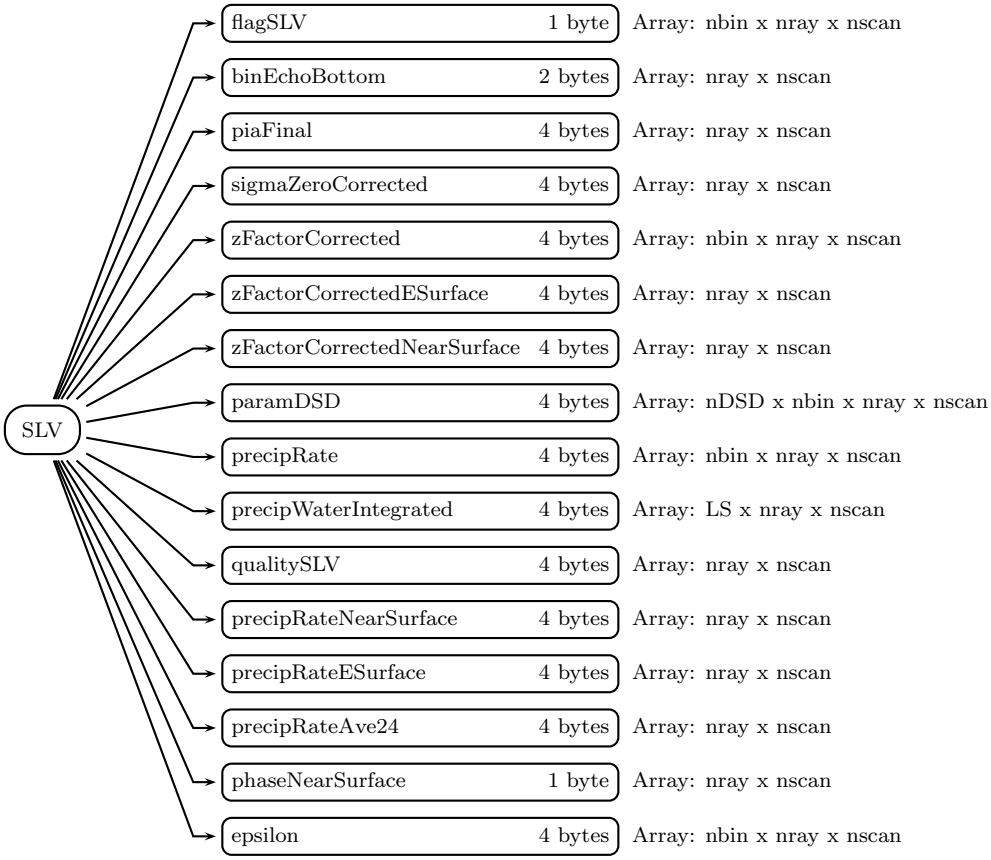


Figure 348: Data Format Structure for 2AKu, SLV

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

AlgorithmRuntimeInfo (Metadata):
AlgorithmRuntimeInfo contains text runtime information written by the algorithm. See

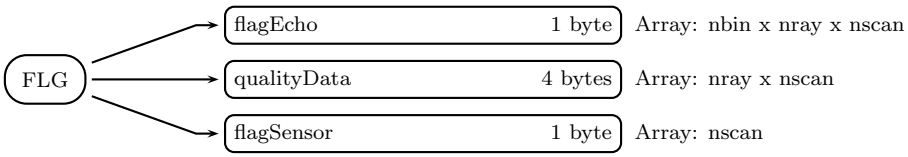


Figure 349: Data Format Structure for 2AKu, FLG

Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

NS (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nray x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nray x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nscan):
Flag of data warning for each scan.

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken

down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
```

```
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
```

```
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):

```
The operational mode of KuPR/KaPR stored in science telemetry.
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
7     Ku/Ka Standby VPRF Table OUT
8     Ku/Ka Standby Phase Out
9     Ku/Ka Standby Dump Out
10    Ku/Ka Standby (No Science Data)
11    Ku/Ka Independent Observation
12    Ku/Ka Independent External Calibration
13    Ku/Ka Independent Internal Calibration
14    Ku/Ka Independent SSPA Analysis
15    Ku/Ka Independent LNA Analysis
16    Ku/Ka Independent Health-Check
17    Ku/Ka Independent Standby VPRF Table OUT
18    Ku/Ka Independent Standby Phase Out
19    Ku/Ka Independent Standby Dump Out
20    Ku/Ka Independent Standby (No Science Data)
```

limitErrorFlag (1-byte integer, array size: nscan):

```
Bit flags for every ray with information
about echo power limit checks.
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group)

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from

DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

PRE (Group)

elevation (4-byte float, array size: nray x nscan):
Elevation of the measurement point. It is a copy of DEMHmean of level 1B product. Values are in m. Special values are defined as:
-9999.9 Missing value

landSurfaceType (4-byte integer, array size: nray x nscan):

```
Land surface type.

0 - 99     Ocean
100 - 199  Land
200 - 299  Coast
300 - 399  Inland water
-9999      Missing value
```

localZenithAngle (4-byte float, array size: nray x nscan):
Local zenith angle of each ray. It is a copy of scLocalZenith of level 1B product. Values are in degree. Special values are defined as:
-9999.9 Missing value

flagPrecip (4-byte integer, array size: nray x nscan):

```
Precipitation or no precipitation.

For L2 Ku and L2 Ka

0       No precipitation
1       Precipitation
-9999   Missing value


For L2 DPR

0       No precipitation by both Ku and Ka
1       Precipitation by Ka, no rain by Ku
10      Precipitation by Ku, no rain by Ka
11      Precipitation by both Ku and Ka
-9999   Missing value
```

flagSigmaZeroSaturation (1-byte char, array size: nray x nscan):

```
A flag to show whether echoPower is under a saturated
level or not at a range bin with a calculation of
sigmaZeroMeasured.  Values are:

0 : normal (under saturated level)
1 : possible saturated level at real surface
2 : saturated level at real surface
```

binRealSurface (2-byte integer, array size: nray x nscan):
Range bin number for real surface. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

binStormTop (2-byte integer, array size: nray x nscan):
Range bin number for the storm top. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

heightStormTop (4-byte float, array size: nray x nscan):
Height of storm top. Values are in m. Special values are defined as:
-9999.9 Missing value

binClutterFreeBottom (2-byte integer, array size: nray x nscan):
Range bin number for clutter free bottom. Special values are defined as:
-9999 Missing value

sigmaZeroMeasured (4-byte float, array size: nray x nscan):
Surface backscattering cross section without attenuation correction (as measured). Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorMeasured (4-byte float, array size: nbin x nray x nscan):
Vertical profile of reflectivity factor without attenuation correction (as measured). Values are in dBZ. Special values are defined as:
-9999.9 Missing value

ellipsoidBinOffset (4-byte float, array size: nray x nscan):
Distance between the ellipsoid and a center range bin of binEllipsoid defined by level 1B algorithm.

```
ellipsoidBinOffset =
    scRangeEllipsoid - { startBinRange + (binEllipsoid-1) x rangeBinSize}

scRangeEllipsoid : Distance between a sensor and the ellipsoid [m]
startBinRange : Distance between a sensor and a center
                of the highest observed range bin [m]
binEllipsoid : Range bin number of the Ellipsoid (1 - 260)
rangeBinSize : Range bin size [m]

-9999   Missing value
```

snRatioAtRealSurface (4-byte float, array size: nray x nscan):
Signal/Noise ratio at real surface range bin.

```
snRatioAtRealSurface =
    10.*log10(echoPowertrueV[mW]/noisePowertrueV[mW])

-9999   Missing value
```

VER (Group)

binZeroDeg (2-byte integer, array size: nray x nscan):

```
Range bin number with 0 degrees C level.
For NS and MS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 176 at the Ellipsoid.
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
Special values are:
177: temperature at a surface is below 0 deg. C in Ku, KaMS, DPR(NS, MS).
89: temperature at a surface is below 0 deg. C in KaHS, DPR(HS).
```

attenuationNP (4-byte float, array size: nbin x nray x nscan):
Vertical profile of attenuation by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB/km. Special values are defined as:
-9999.9 Missing value

piaNP (4-byte float, array size: nNP x nray x nscan):
Path integrated attenuation caused by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroNPCorrected (4-byte float, array size: nray x nscan):
Surface backscattering cross section with attenuation correction only for non-precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

heightZeroDeg (4-byte float, array size: nray x nscan):
Height of freezing level (0 degrees C level) Values are in m. Special values are defined as:
-9999.9 Missing value

CSF (Group)

flagBB (4-byte integer, array size: nray x nscan):
Bright band (BB) exists or not.

```
0      BB not detected
1      BB detected
-1111  No rain value
-9999  Missing value
```

binBBPeak (2-byte integer, array size: nray x nscan):
Range bin number for the peak of bright band. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

binBBTop (2-byte integer, array size: nray x nscan):
Range bin number for the top of bright band. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

binBBBottom (2-byte integer, array size: nray x nscan):
Range bin number for the bottom of bright band. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

heightBB (4-byte float, array size: nray x nscan):
Height of bright band. Values are in m. Special values are defined as:
-9999.9 Missing value

widthBB (4-byte float, array size: nray x nscan):
The width of bright band. Values are in m. Special values are defined as:
-9999.9 Missing value

qualityBB (4-byte integer, array size: nray x nscan):

```
Quality of the bright band.

1      Good
0      BB not detected in the case of rain
-1111  No rain value
-9999  Missing value
```

typePrecip (4-byte integer, array size: nray x nscan):
Precipitation type is expressed by an 8-digit number. The three major rain categories, stratiform, onvective, and other, can be obtained as follows:

```
When typePrecip is greater than zero,
Major rain type = typePrecip/10000000
     = 1    stratiform
     = 2    convective
```

```
     = 3    other

-1111  No rain value
-9999  Missing value
```

In the DPR product, rain type by the CSU's DFRm (measured dual frequency ratio) method is also included in typePrecip and can be obtained as follows:

```
DFRm rain type = (typePrecip%10000000)/1000000 in C
DFRm rain type = (MOD(typePrecip,10000000)/1000000 in FORTRAN

DFRm rain type
     = 1    stratiform
     = 2    convective
     = 4    transition
     = 9    DFRm method cannot be applicable (in this case
       the conventional method determines the major rain type)

-1111  No rain value
-9999  Missing value
```

qualityTypePrecip (4-byte integer, array size: nray x nscan):

```
Quality of the precipitation type.

1      Good
-1111  No rain value
-9999  Missing value
```

flagShallowRain (4-byte integer, array size: nray x nscan):

```
Type of shallow rain
0      No shallow rain
10     Shallow isolated (maybe)
11     Shallow isolated (certain)
20     Shallow non-isolated (maybe)
21     Shallow non-isolated (certain)
-1111  No rain value
-9999  Missing value
```

SRT (Group)

PIAalt (4-byte float, array size: method x nray x nscan):
The two-way path integrated attenuation (PIA) at from the each method estimate. The path-integrated attenuation from the jth method, where

PIAalt (j=1) = PIA_Ku from forward along-track spatial at kth angle bin
PIAalt (j=2) = PIA_Ku from backward along-track spatial at kth angle bin
PIAalt (j=3) = PIA_Ku from forward hybrid at kth angle bin
PIAalt (j=4) = PIA_Ku from backward hybrid at kth angle bin
PIAalt (j=5) = PIA_Ku from temporal reference at kth angle bin
PIAalt (j=6) = PIA_Ku from light-rain temporal reference at kth angle bin

Values are in dB. Special values are defined as:
-9999.9 Missing value

RFactorAlt (4-byte float, array size: method x nray x nscan):
The reliability factors associated with the individual PIA estimates corresponding to PIAalt. Special values are defined as:
-9999.9 Missing value

PIAweight (4-byte float, array size: method x nray x nscan):
The weights of the individual PIA_Ku estimates used in deriving the effective path attenuation estimate, pathAtten. The sum of the weights should equal one. Where j is method and sigma_j is the standard deviation of reference data for method j.

PIAweight_j = 1/sigma_j^2 * (1/Sum_j(1/sigma_j^2))

Special values are defined as:
-9999.9 Missing value

pathAtten (4-byte float, array size: nray x nscan):
The effective 2-way path integrated attenuation. Values are in dB. Special values are defined as:
-9999.9 Missing value

reliabFactor (4-byte float, array size: nray x nscan):
Reliability Factor for the effective PIA estimate, pathAtten. Special values are defined as:
-9999.9 Missing value

reliabFlag (2-byte integer, array size: nray x nscan):
The reliability flag for the effective PIA estimate (pathAtten) based on the reliability factor (Rel_eff) in reliabFactor. Reliability Flag is:

= 1 if Rel_eff > 3 ; PIAeff estimate is considered reliable
= 2 if 3 ≥ Rel_eff > 1 ; PIAeff estimate is considered marginally reliable
= 3 if Rel_eff ≤ 1 ; PIAeff is unreliable
= 4 if SNR_at surface < 2dB; provides a lower bound to the path-attenuation
= 9 (no-rain case)

Special values are defined as:
-9999 Missing value

refScanID (2-byte integer, array size: nearFar x foreBack x nray x nscan):
The number of scan lines between the current scan and the beginning (or end) of the along-track reference data at each angle bin. The values are computed by the equation: Current Scan Number - Reference Scan Number. The values are positive for the Forward estimates and negative for the Backward estimates. The Fortran indices for nearFar foreBack are:

```
1,1 - Forward - Near reference
2,1 - Forward - Far reference
1,2 - Backward - Near reference
2,2 - Backward - Far reference
```

Special values are defined as:
-9999 Missing value

DSD (Group)

phase (1-byte char, array size: nbin x nray x nscan):
Phase state of the precipitation. As an unsigned byte value this represents:

```
phase < 100 Temperature(C)=phase-100
phase > 200 Temperature(C)=phase-200
phase = 100 Top of the bright band
phase = 200 Bottom of the bright band
phase = 125 is used for the range bins between
                        the top and peak of bright band
phase = 175 is used for the range bins between
                        the peak and bottom of bright band

Integer values of phase/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

binNode (2-byte integer, array size: nNode x nray x nscan):

```
The bin number of the 5 nodes defined as:

0 - Bin number of storm top.
1 - Stratiform: 500m above center of bright band.
    Convective: 750m above 0deg C level.
2 - Stratiform: center of bright band.
    Convective: 0deg C level.
3 - Stratiform: 500m below center of bright band.
    Convective: 750m below 0deg C level.
4 - Bin number of real surface equal to
    binRealSurface in PRE group.
For NS and MS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 176 at the Ellipsoid.
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
-9999 - Missing
```

Experimental (Group)

precipRateESurface2 (4-byte float, array size: nray x nscan):
Estimates Surface Precipitation using alternate method. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface2Status (1-byte char, array size: nray x nscan):
Status of the estimated surface precipitation using alternate method. Special values are defined as:
255 Missing value

sigmaZeroProfile (4-byte float, array size: nbinSZP x nray x nscan):
Surface backscattering cross section profile around the current ifov. Values are in dB. Special values are defined as:
-9999.9 Missing value

binDEML2 (2-byte integer, array size: nray x nscan):
Range bin number of the digital elevation model surface estimate. Special values are defined as:
-9999 Missing value

SLV (Group)

flagSLV (1-byte integer, array size: nbin x nray x nscan):
Special values are defined as:
-99 Missing value

binEchoBottom (2-byte integer, array size: nray x nscan):
For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

piaFinal (4-byte float, array size: nray x nscan):
The final estimates of path integrated attenuation caused by precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroCorrected (4-byte float, array size: nray x nscan):
Surface backscatter cross section with attenuation correction. Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorCorrected (4-byte float, array size: nbin x nray x nscan):
Vertical profile of reflectivity factor with attenuation correction. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorCorrectedESurface (4-byte float, array size: nray x nscan):
Reflectivity factor with attenuation correction at estimated surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorCorrectedNearSurface (4-byte float, array size: nray x nscan):
Reflectivity factor with attenuation correction at near surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

paramDSD (4-byte float, array size: nDSD x nbin x nray x nscan):
Parameters of the drop size distribution. The first index is dBNw; the second index is Dm in mm. Special values are defined as:
-9999.9 Missing value

precipRate (4-byte float, array size: nbin x nray x nscan):
Precipitation rate. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipWaterIntegrated (4-byte float, array size: LS x nray x nscan):
Precipitation water vertically integrated. Values are in g/m^2. Special values are defined as:
-9999.9 Missing value

qualitySLV (4-byte integer, array size: nray x nscan):
A flag to show methods in which precipRateNearSurface is retrieved. Special values are defined as:
-9999 Missing value

precipRateNearSurface (4-byte float, array size: nray x nscan):
Precipitation rate for the near surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface (4-byte float, array size: nray x nscan):
Precipitation rate for the estimated surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateAve24 (4-byte float, array size: nray x nscan):
Average of precipitation rate for 2 to 4km height. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

phaseNearSurface (1-byte char, array size: nray x nscan):
Phase state of the precipitation at the Near-surface level. This is a copy of the phase in the DSD group at the Near-surface level. As an unsigned byte value this represents:

```
phaseNearSurface < 100 Temperature(C)=phaseNearSurface-100
phaseNearSurface > 200 Temperature(C)=phaseNearSurface-200
phaseNearSurface = 100 Top of the bright band
phaseNearSurface = 200 Bottom of the bright band
phaseNearSurface = 125 is used for the range bins between
                       the top and peak of bright band
phaseNearSurface = 175 is used for the range bins between
                       the peak and bottom of bright band

Integer values of phaseNearSurface/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

epsilon (4-byte float, array size: nbin x nray x nscan):
Epsilon is the indication of the adjustment away from the initial drop size distribution,

epsilon = 1 is no adjustment. Special values are defined as:
-9999.9 Missing value

FLG (Group)

flagEcho (1-byte integer, array size: nbin x nray x nscan):

```
Flag of precipitation and main/side lobe clutter
information of each range bin.

Bit  Meaning
0    For L2 Ku:  Precipitation judged by L2 Ku algorithm (copy of bit 2)
0    For L2 Ka:  Precipitation judged by L2 Ka algorithm (copy of bit 3)
0    For L2 DPR:  Precipitation judged by L2 DPR algorithm (copy of bit 1)
1    Precipitation judged by L2 DPR algorithm
2    Precipitation judged by L2 Ku algorithm
3    Precipitation judged by L2 Ka algorithm
4    Main lobe clutter judged by L2 Ku algorithm
5    Main lobe clutter judged by L2 Ka algorithm
6    Side lobe clutter judged by L2 Ku algorithm
7    Side lobe clutter judged by L2 Ka algorithm
```

qualityData (4-byte integer, array size: nray x nscan):
Normal data gives "0". Non-zero values mean the kinds of errors. Special values are defined as:
-9999 Missing value

```
Flag of quality data.  Bit range from 8 to 23
contains flags by each module.  Each module flag
has 2 bits of information.

The 2 bit flag for each module has values:
[higher bit    lower bit]
[0 0]  Good
[0 1]  Warning but usable
[1 0]  NG or error

The bits of qualityData are assigned as follows:

Bit      Meaning
0 - 7    Copy of dataQuality in level 1B product
```

```
8 - 9    Flag by input module
10 - 11  Flag by preparation module
12 - 13  Flag by vertical module
14 - 15  Flag by classification module
16 - 17  Flag by SRT module
18 - 19  Flag by DSD module
20 - 21  Flag by solver module
22 - 23  Flag by output module
24 - 31  Spare
```

flagSensor (1-byte integer, array size: nscan):

```
Flag of input Ku/Ka data condition.

Value  Meaning
1      Valid
-99    Invalid (judged by dataQuality)
```

C Structure Header file:

```
#ifndef _TK_2AKu_H_
#define _TK_2AKu_H_

#ifndef _L2AKu_FLG_
#define _L2AKu_FLG_

typedef struct {
    signed char flagEcho[49][176];
    int qualityData[49];
    signed char flagSensor;
} L2AKu_FLG;

#endif

#ifndef _L2AKu_SLV_
#define _L2AKu_SLV_

typedef struct {
    signed char flagSLV[49][176];
    short binEchoBottom[49];
    float piaFinal[49];
    float sigmaZeroCorrected[49];
```

```
    float zFactorCorrected[49][176];
    float zFactorCorrectedESurface[49];
    float zFactorCorrectedNearSurface[49];
    float paramDSD[49][176][2];
    float precipRate[49][176];
    float precipWaterIntegrated[49][2];
    int qualitySLV[49];
    float precipRateNearSurface[49];
    float precipRateESurface[49];
    float precipRateAve24[49];
    unsigned char phaseNearSurface[49];
    float epsilon[49][176];
} L2AKu_SLV;

#endif

#ifndef _L2AKu_EXPERIMENTAL_
#define _L2AKu_EXPERIMENTAL_

typedef struct {
    float precipRateESurface2[49];
    unsigned char precipRateESurface2Status[49];
    float sigmaZeroProfile[49][7];
    short binDEML2[49];
} L2AKu_EXPERIMENTAL;

#endif

#ifndef _L2AKu_DSD_
#define _L2AKu_DSD_

typedef struct {
    unsigned char phase[49][176];
    short binNode[49][5];
} L2AKu_DSD;

#endif

#ifndef _L2AKu_SRT_
#define _L2AKu_SRT_

typedef struct {
    float PIAalt[49][6];
```

```
    float RFactorAlt[49][6];
    float PIAweight[49][6];
    float pathAtten[49];
    float reliabFactor[49];
    short reliabFlag[49];
    short refScanID[49][2][2];
} L2AKu_SRT;

#endif

#ifndef _L2AKu_CSF_
#define _L2AKu_CSF_

typedef struct {
    int flagBB[49];
    short binBBPeak[49];
    short binBBTop[49];
    short binBBBottom[49];
    float heightBB[49];
    float widthBB[49];
    int qualityBB[49];
    int typePrecip[49];
    int qualityTypePrecip[49];
    int flagShallowRain[49];
} L2AKu_CSF;

#endif

#ifndef _L2AKu_VER_
#define _L2AKu_VER_

typedef struct {
    short binZeroDeg[49];
    float attenuationNP[49][176];
    float piaNP[49][4];
    float sigmaZeroNPCorrected[49];
    float heightZeroDeg[49];
} L2AKu_VER;

#endif

#ifndef _L2AKu_PRE_
#define _L2AKu_PRE_
```

```
typedef struct {
    float elevation[49];
    int landSurfaceType[49];
    float localZenithAngle[49];
    int flagPrecip[49];
    unsigned char flagSigmaZeroSaturation[49];
    short binRealSurface[49];
    short binStormTop[49];
    float heightStormTop[49];
    short binClutterFreeBottom[49];
    float sigmaZeroMeasured[49];
    float zFactorMeasured[49][176];
    float ellipsoidBinOffset[49];
    float snRatioAtRealSurface[49];
} L2AKu_PRE;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _L2AKu_SCANSTATUS_
```

```
#define _L2AKu_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char dataWarning;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    signed char limitErrorFlag;
    double FractionalGranuleNumber;
} L2AKu_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2AKu_NS_
#define _L2AKu_NS_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[49];
```

```
    float Longitude[49];
    L2AKu_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L2AKu_PRE PRE;
    L2AKu_VER VER;
    L2AKu_CSF CSF;
    L2AKu_SRT SRT;
    L2AKu_DSD DSD;
    L2AKu_EXPERIMENTAL Experimental;
    L2AKu_SLV SLV;
    L2AKu_FLG FLG;
} L2AKu_NS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L2AKu_FLG/
    BYTE flagEcho(176,49)
    INTEGER*4 qualityData(49)
    BYTE flagSensor
END STRUCTURE

STRUCTURE /L2AKu_SLV/
    BYTE flagSLV(176,49)
    INTEGER*2 binEchoBottom(49)
    REAL*4 piaFinal(49)
    REAL*4 sigmaZeroCorrected(49)
    REAL*4 zFactorCorrected(176,49)
    REAL*4 zFactorCorrectedESurface(49)
    REAL*4 zFactorCorrectedNearSurface(49)
    REAL*4 paramDSD(2,176,49)
    REAL*4 precipRate(176,49)
    REAL*4 precipWaterIntegrated(2,49)
    INTEGER*4 qualitySLV(49)
    REAL*4 precipRateNearSurface(49)
    REAL*4 precipRateESurface(49)
    REAL*4 precipRateAve24(49)
    CHARACTER phaseNearSurface(49)
    REAL*4 epsilon(176,49)
END STRUCTURE
```

```
STRUCTURE /L2AKu_EXPERIMENTAL/
    REAL*4 precipRateESurface2(49)
    CHARACTER precipRateESurface2Status(49)
    REAL*4 sigmaZeroProfile(7,49)
    INTEGER*2 binDEML2(49)
END STRUCTURE

STRUCTURE /L2AKu_DSD/
    CHARACTER phase(176,49)
    INTEGER*2 binNode(5,49)
END STRUCTURE

STRUCTURE /L2AKu_SRT/
    REAL*4 PIAalt(6,49)
    REAL*4 RFactorAlt(6,49)
    REAL*4 PIAweight(6,49)
    REAL*4 pathAtten(49)
    REAL*4 reliabFactor(49)
    INTEGER*2 reliabFlag(49)
    INTEGER*2 refScanID(2,2,49)
END STRUCTURE

STRUCTURE /L2AKu_CSF/
    INTEGER*4 flagBB(49)
    INTEGER*2 binBBPeak(49)
    INTEGER*2 binBBTop(49)
    INTEGER*2 binBBBottom(49)
    REAL*4 heightBB(49)
    REAL*4 widthBB(49)
    INTEGER*4 qualityBB(49)
    INTEGER*4 typePrecip(49)
    INTEGER*4 qualityTypePrecip(49)
    INTEGER*4 flagShallowRain(49)
END STRUCTURE

STRUCTURE /L2AKu_VER/
    INTEGER*2 binZeroDeg(49)
    REAL*4 attenuationNP(176,49)
    REAL*4 piaNP(4,49)
    REAL*4 sigmaZeroNPCorrected(49)
    REAL*4 heightZeroDeg(49)
END STRUCTURE
```

```
STRUCTURE /L2AKu_PRE/
    REAL*4 elevation(49)
    INTEGER*4 landSurfaceType(49)
    REAL*4 localZenithAngle(49)
    INTEGER*4 flagPrecip(49)
    CHARACTER flagSigmaZeroSaturation(49)
    INTEGER*2 binRealSurface(49)
    INTEGER*2 binStormTop(49)
    REAL*4 heightStormTop(49)
    INTEGER*2 binClutterFreeBottom(49)
    REAL*4 sigmaZeroMeasured(49)
    REAL*4 zFactorMeasured(176,49)
    REAL*4 ellipsoidBinOffset(49)
    REAL*4 snRatioAtRealSurface(49)
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L2AKu_SCANSTATUS/
    BYTE dataQuality
    BYTE dataWarning
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
```

```
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    BYTE limitErrorFlag
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2AKu_NS/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(49)
    REAL*4 Longitude(49)
    RECORD /L2AKu_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L2AKu_PRE/ PRE
    RECORD /L2AKu_VER/ VER
    RECORD /L2AKu_CSF/ CSF
    RECORD /L2AKu_SRT/ SRT
    RECORD /L2AKu_DSD/ DSD
    RECORD /L2AKu_EXPERIMENTAL/ Experimental
    RECORD /L2AKu_SLV/ SLV
    RECORD /L2AKu_FLG/ FLG
END STRUCTURE
```

5.30 2AKa - Ka precipitation

The Ka Level-2A product, 2AKa, "Ka precipitation," is written as a 2 swath structure. The swaths are MS, matched scans, and HS, high sensitivity scans. The following sections describe the structure and contents of the format.

Dimension definitions:

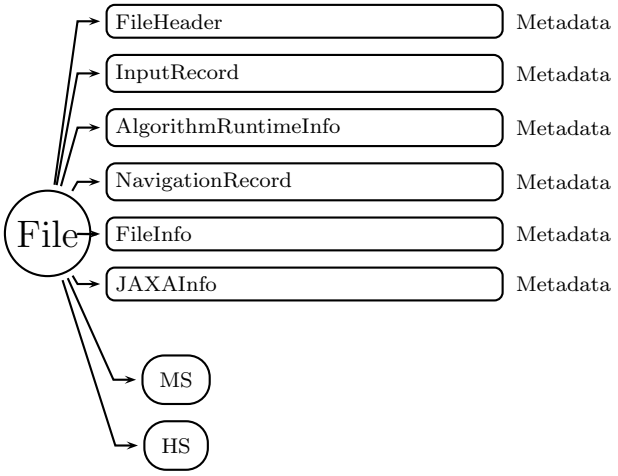


Figure 350: Data Format Structure for 2AKa, Ka precipitation

nscan	var	Number of scans in the granule.
nrayMS	25	Number of angle bins in each MS scan.
nrayHS	24	Number of angle bins in each HS scan.
nbin	176	Number of range bins in each NS and MS ray. Bin interval is 125 m.
nbinHS	88	Number of range bins in each HS ray. Bin interval is 250 m.
nbinSZP	7	Number of range bins for sigmaZeroProfile.
nbinSZPHS	5	Number of range bins for sigmaZeroProfile in each HS scan.
nNP	4	Number of NP kinds.
nearFar	2	Near reference, Far reference.
foreBack	2	Foreward, Backward.
method	6	Number of SRT methods.
nNode	5	Number of binNode.
nDSD	2	Number of DSD parameters. Parameters are dBNw and Dm (mm).
LS	2	Liquid, solid.

Figure 350 through Figure 374 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

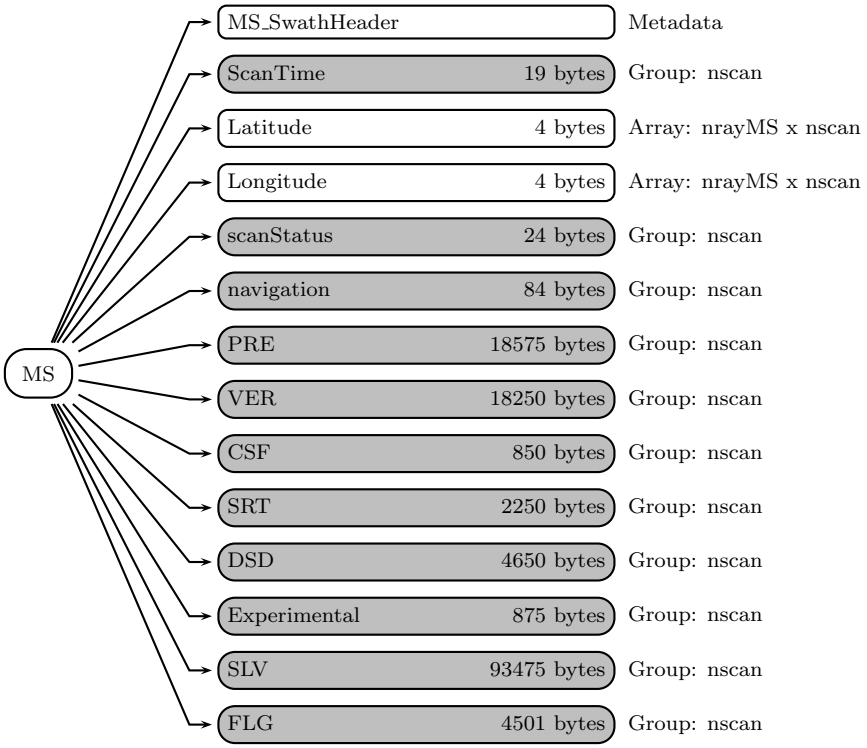


Figure 351: Data Format Structure for 2AKa, MS

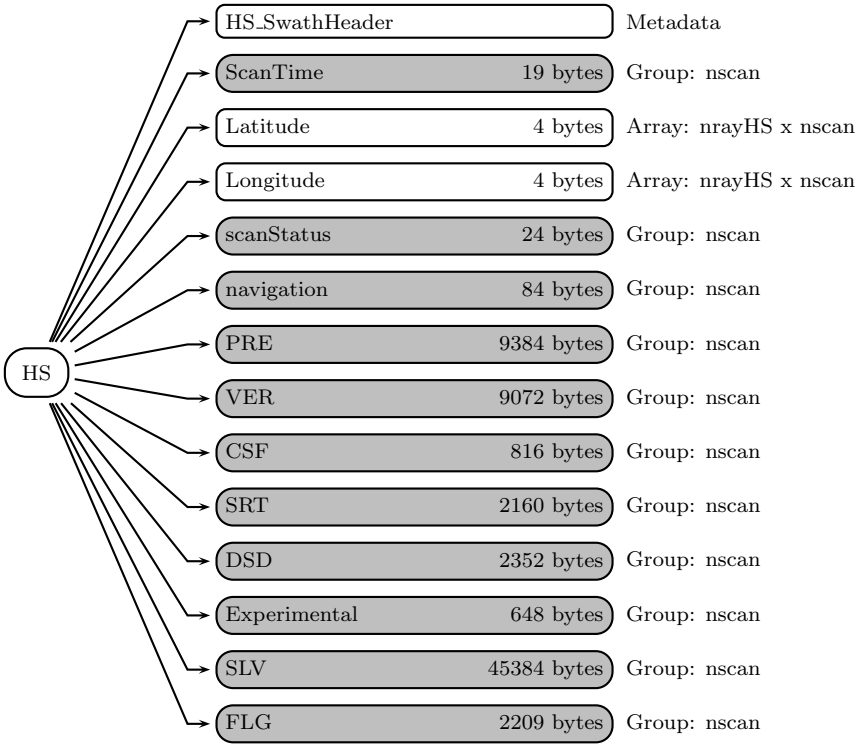


Figure 352: Data Format Structure for 2AKa, HS

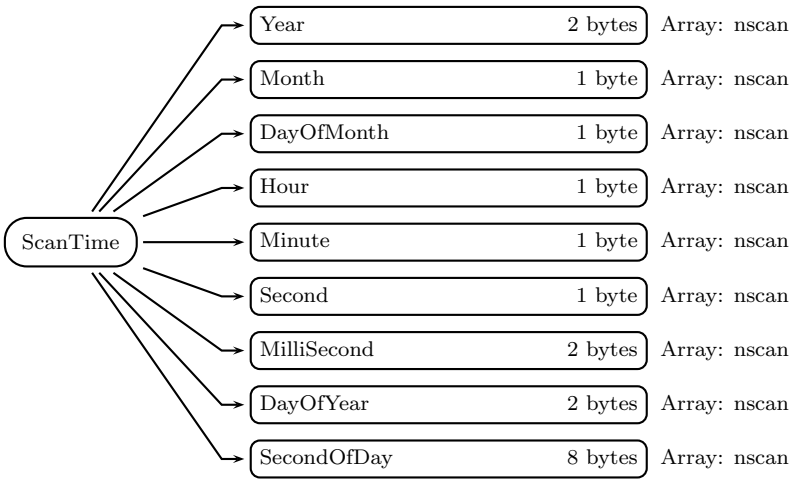


Figure 353: Data Format Structure for 2AKa, MS, ScanTime

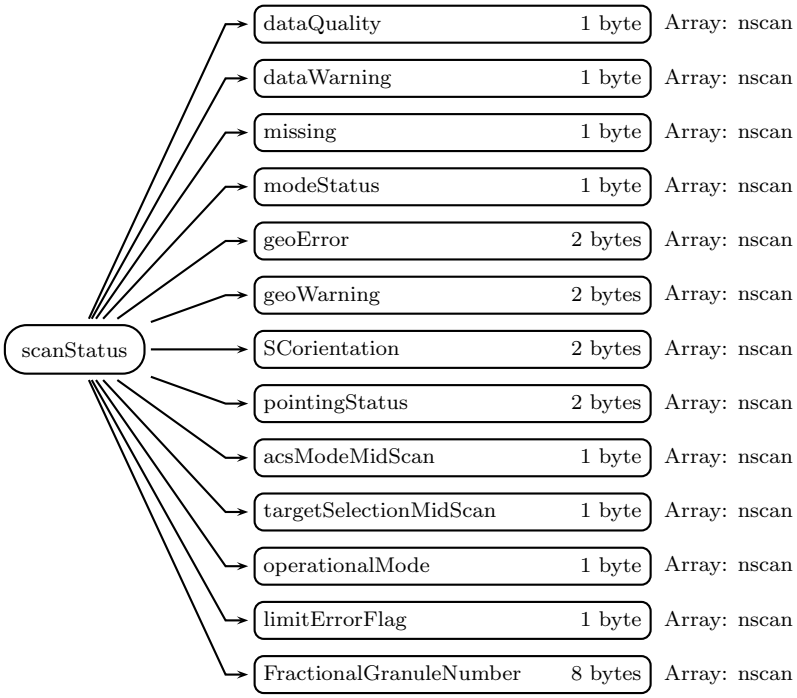


Figure 354: Data Format Structure for 2AKa, MS, scanStatus

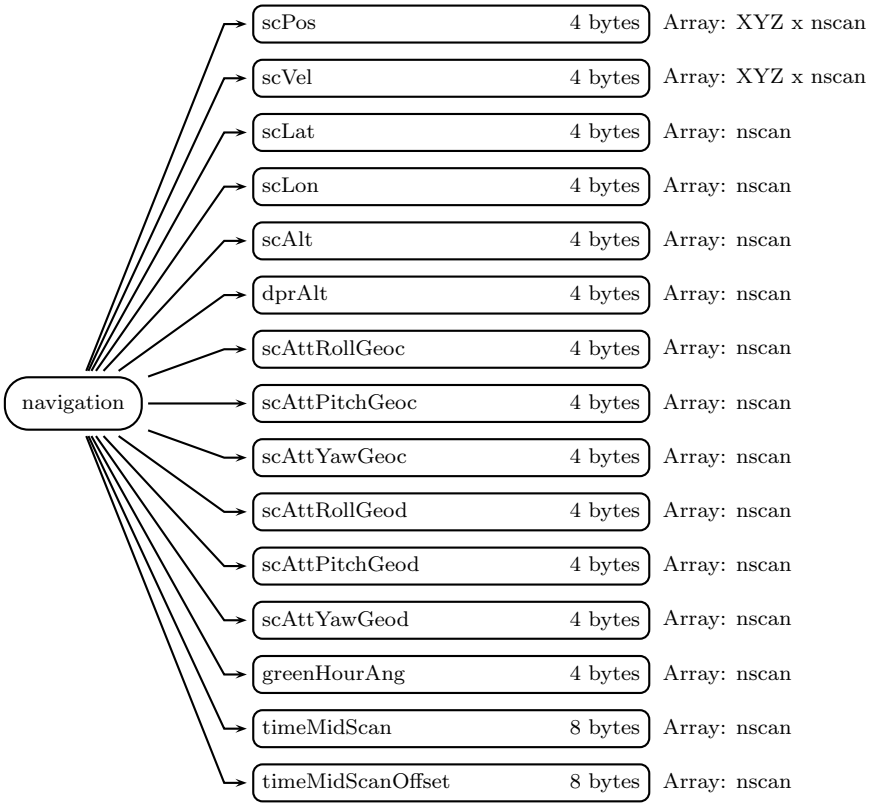


Figure 355: Data Format Structure for 2AKa, MS, navigation

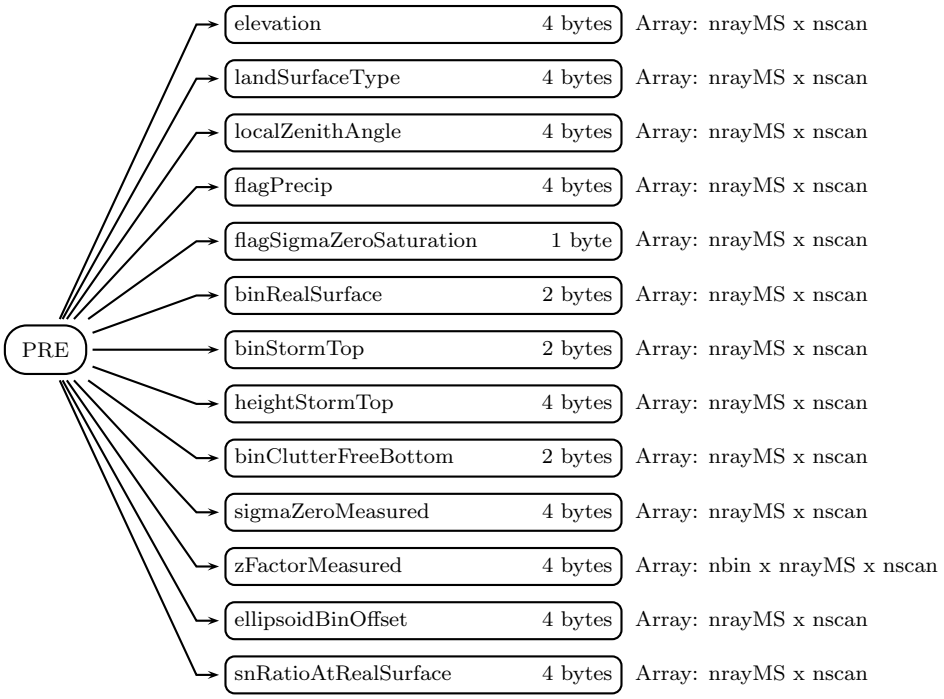


Figure 356: Data Format Structure for 2AKa, MS, PRE

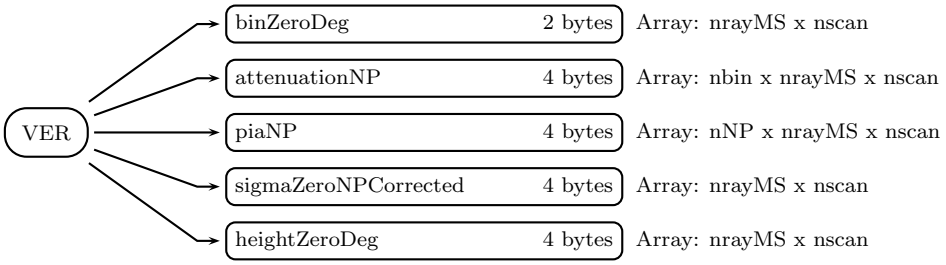


Figure 357: Data Format Structure for 2AKa, MS, VER

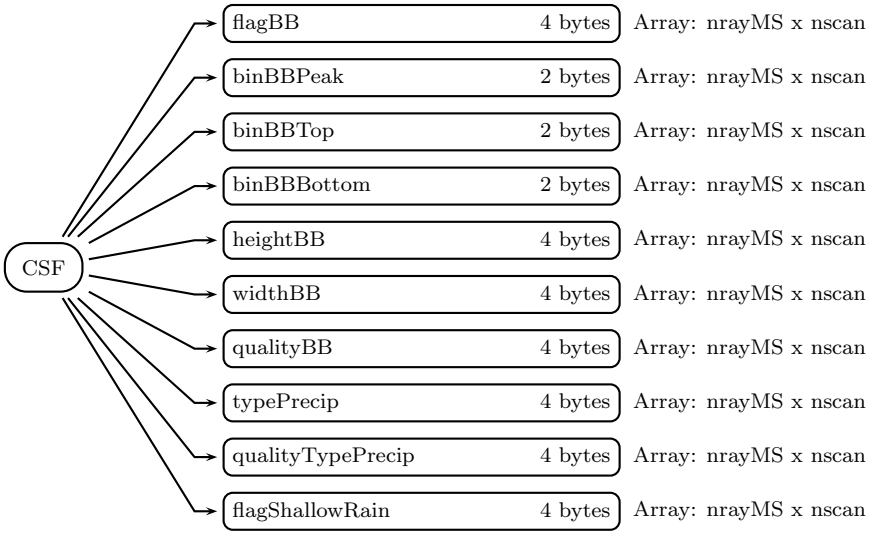


Figure 358: Data Format Structure for 2AKa, MS, CSF

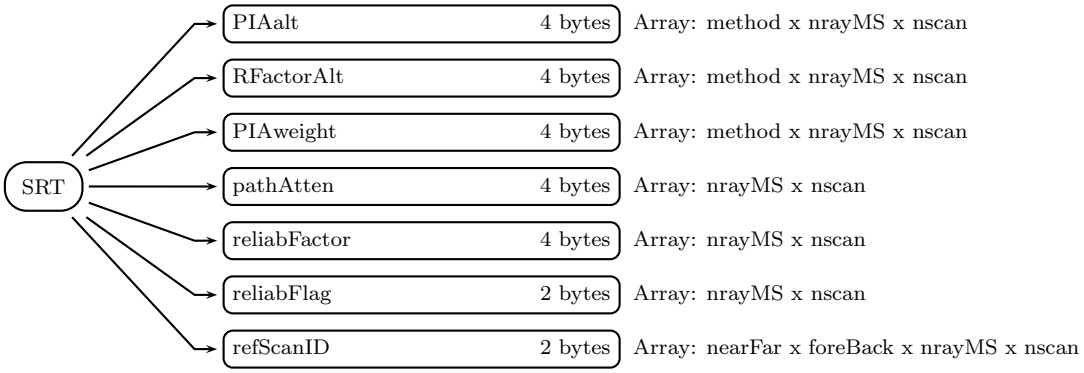


Figure 359: Data Format Structure for 2AKa, MS, SRT

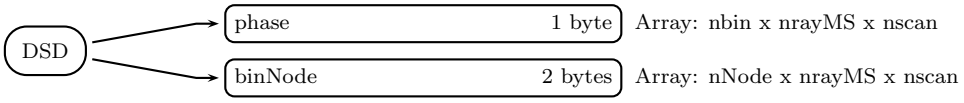


Figure 360: Data Format Structure for 2AKa, MS, DSD

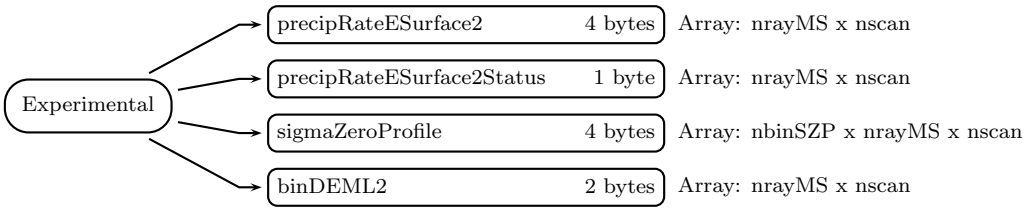


Figure 361: Data Format Structure for 2AKa, MS, Experimental

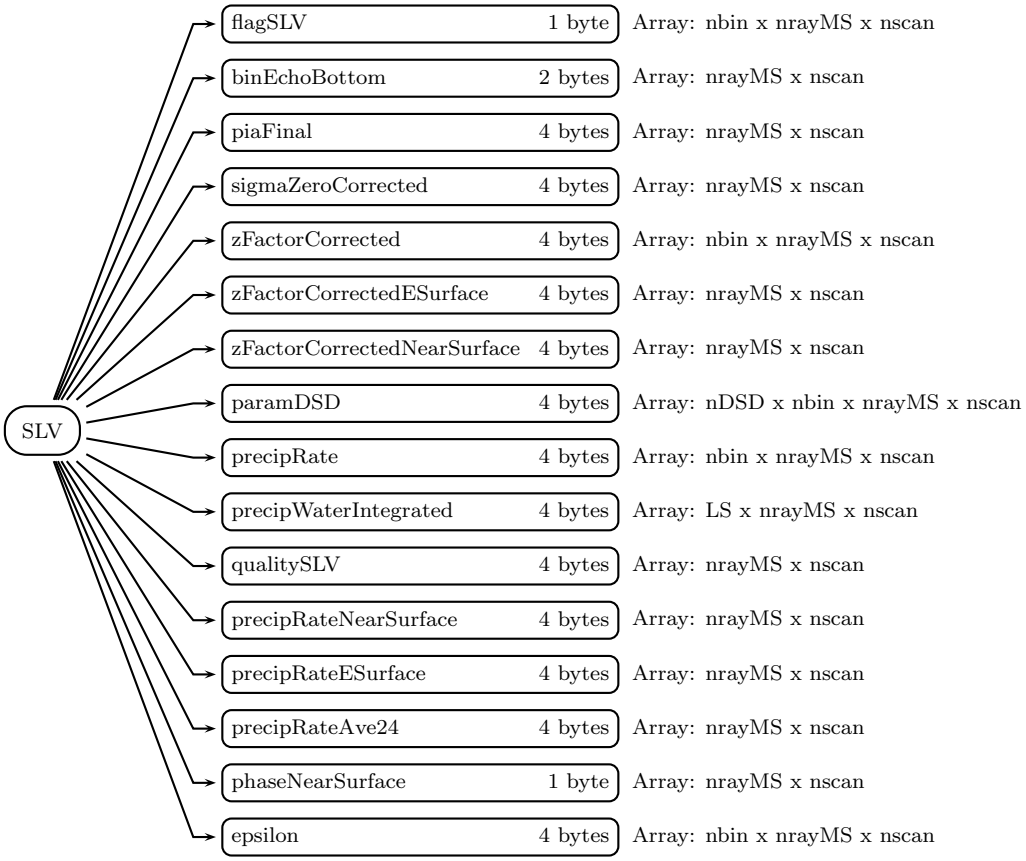


Figure 362: Data Format Structure for 2AKa, MS, SLV

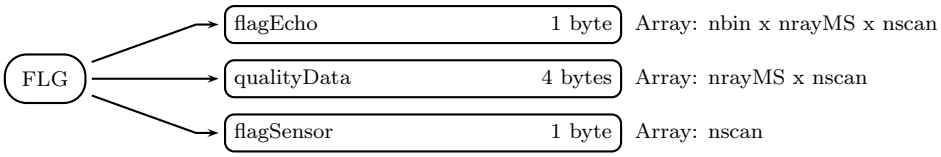


Figure 363: Data Format Structure for 2AKa, MS, FLG

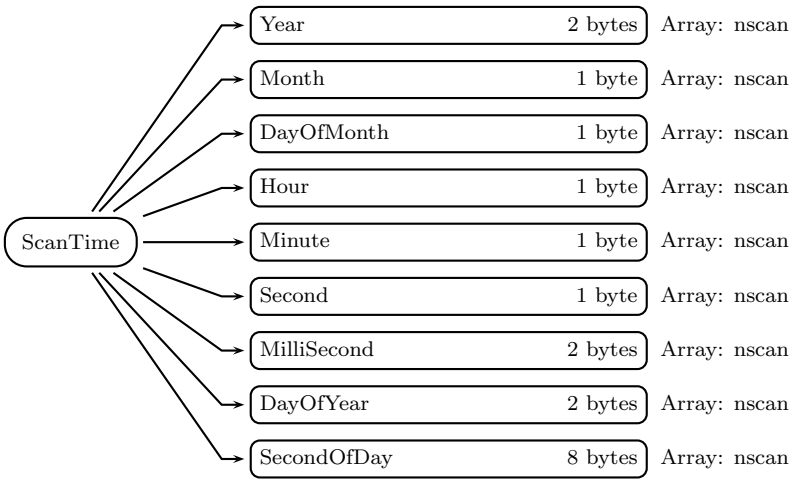


Figure 364: Data Format Structure for 2AKa, HS, ScanTime

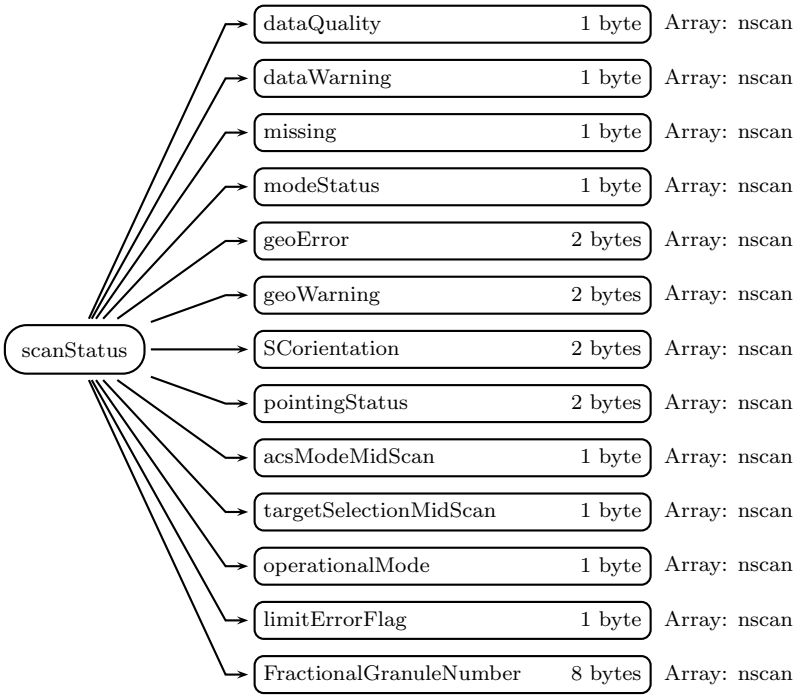


Figure 365: Data Format Structure for 2AKa, HS, scanStatus

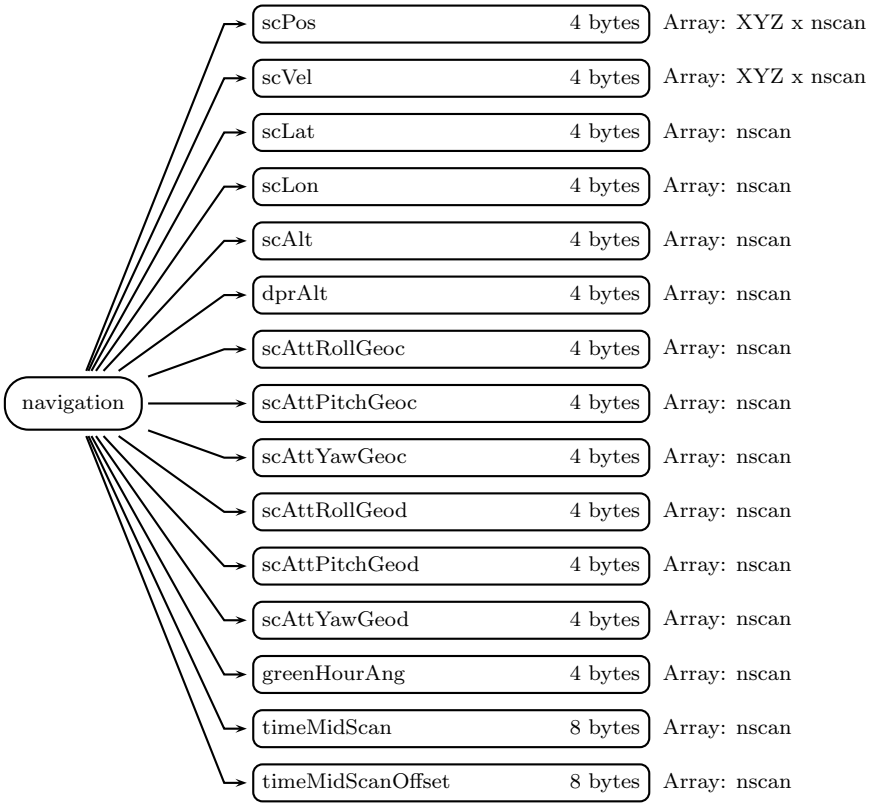


Figure 366: Data Format Structure for 2AKa, HS, navigation

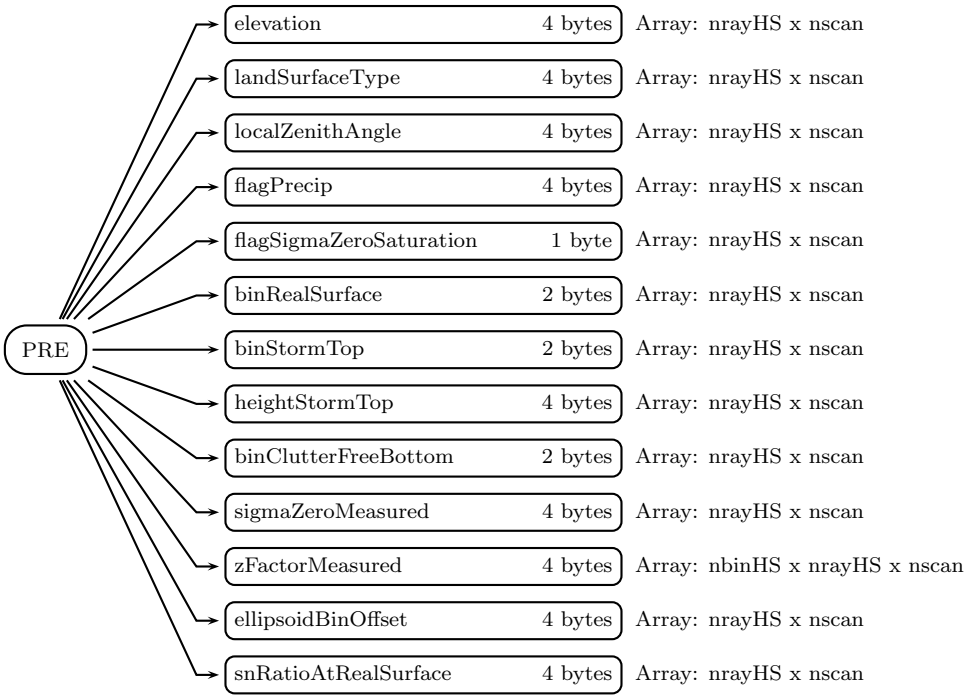


Figure 367: Data Format Structure for 2AKa, HS, PRE

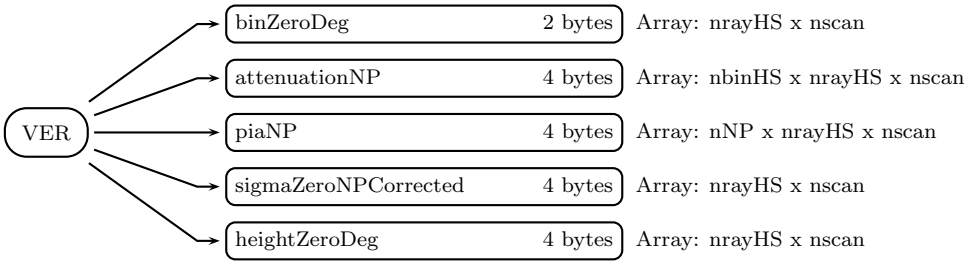


Figure 368: Data Format Structure for 2AKa, HS, VER

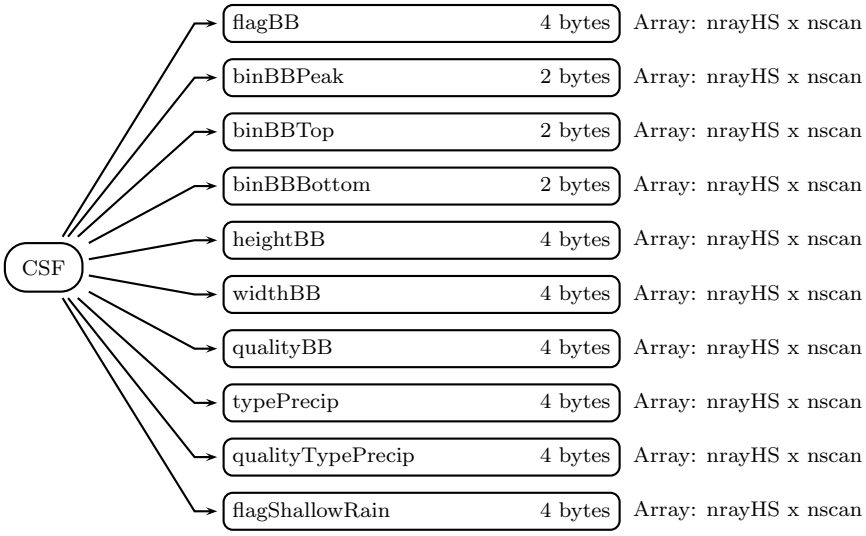


Figure 369: Data Format Structure for 2AKa, HS, CSF

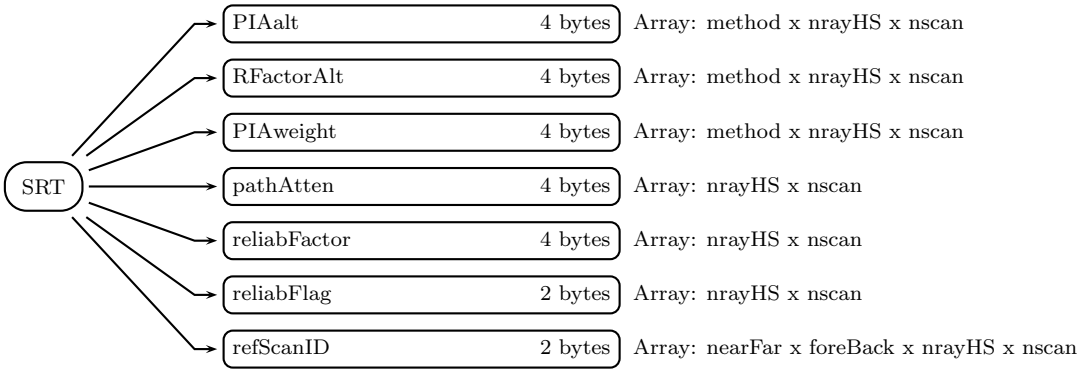


Figure 370: Data Format Structure for 2AKa, HS, SRT

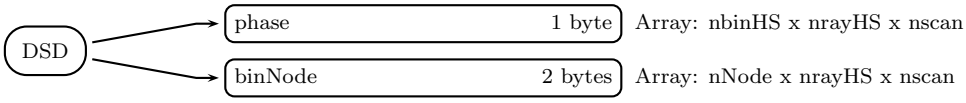


Figure 371: Data Format Structure for 2AKa, HS, DSD

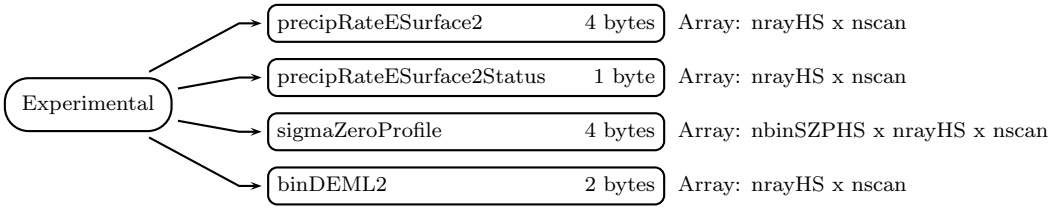


Figure 372: Data Format Structure for 2AKa, HS, Experimental

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

AlgorithmRuntimeInfo (Metadata):
AlgorithmRuntimeInfo contains text runtime information written by the algorithm. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

MS (Swath)

MS_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in MS)

A UTC time associated with the scan.

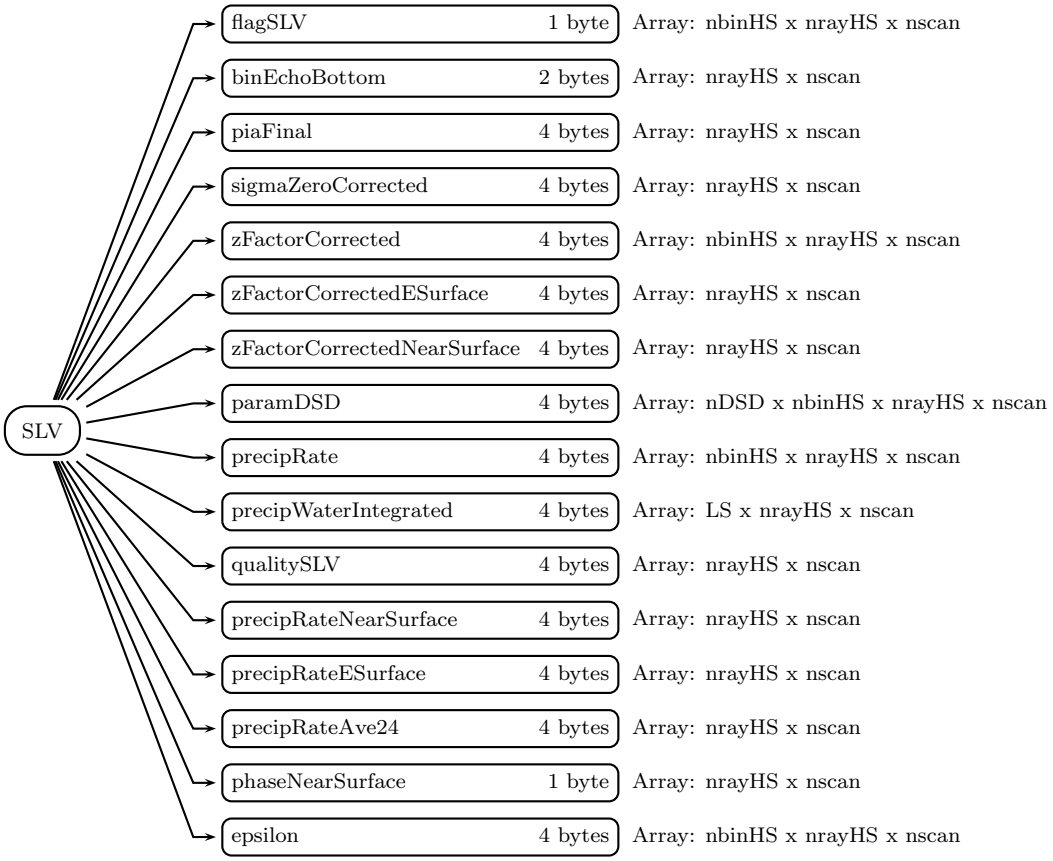


Figure 373: Data Format Structure for 2AKa, HS, SLV

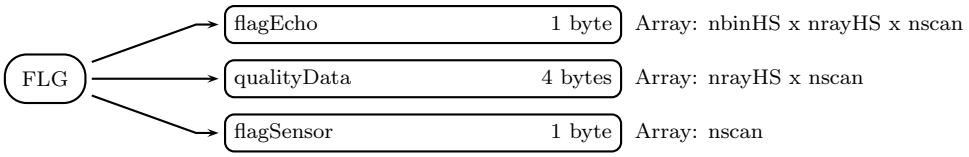


Figure 374: Data Format Structure for 2AKa, HS, FLG

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nrayMS x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nrayMS x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in MS)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nscan):
Flag of data warning for each scan.

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as

far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
```

```
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):

```
The operational mode of KuPR/KaPR stored in science telemetry.
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
```

```
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
7     Ku/Ka Standby VPRF Table OUT
8     Ku/Ka Standby Phase Out
9     Ku/Ka Standby Dump Out
10    Ku/Ka Standby (No Science Data)
11    Ku/Ka Independent Observation
12    Ku/Ka Independent External Calibration
13    Ku/Ka Independent Internal Calibration
14    Ku/Ka Independent SSPA Analysis
15    Ku/Ka Independent LNA Analysis
16    Ku/Ka Independent Health-Check
17    Ku/Ka Independent Standby VPRF Table OUT
18    Ku/Ka Independent Standby Phase Out
19    Ku/Ka Independent Standby Dump Out
20    Ku/Ka Independent Standby (No Science Data)
```

limitErrorFlag (1-byte integer, array size: nscan):

```
Bit flags for every ray with information
about echo power limit checks.
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group in MS)

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

PRE (Group in MS)

elevation (4-byte float, array size: nrayMS x nscan):
Elevation of the measurement point. It is a copy of DEMHmean of level 1B product. Values are in m. Special values are defined as:
-9999.9 Missing value

landSurfaceType (4-byte integer, array size: nrayMS x nscan):

```
Land surface type.

0 - 99     Ocean
100 - 199  Land
200 - 299  Coast
300 - 399  Inland water
-9999      Missing value
```

localZenithAngle (4-byte float, array size: nrayMS x nscan):
Local zenith angle of each ray. It is a copy of scLocalZenith of level 1B product. Values are in degree. Special values are defined as:
-9999.9 Missing value

flagPrecip (4-byte integer, array size: nrayMS x nscan):

```
Precipitation or no precipitation.

For L2 Ku and L2 Ka

0       No precipitation
1       Precipitation
-9999   Missing value


For L2 DPR

0       No precipitation by both Ku and Ka
1       Precipitation by Ka, no rain by Ku
10      Precipitation by Ku, no rain by Ka
11      Precipitation by both Ku and Ka
-9999   Missing value
```

flagSigmaZeroSaturation (1-byte char, array size: nrayMS x nscan):

```
A flag to show whether echoPower is under a saturated
level or not at a range bin with a calculation of
```

```
sigmaZeroMeasured.  Values are:

0 : normal (under saturated level)
1 : possible saturated level at real surface
2 : saturated level at real surface
```

binRealSurface (2-byte integer, array size: nrayMS x nscan):
Range bin number for real surface. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

binStormTop (2-byte integer, array size: nrayMS x nscan):
Range bin number for the storm top. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

heightStormTop (4-byte float, array size: nrayMS x nscan):
Height of storm top. Values are in m. Special values are defined as:
-9999.9 Missing value

binClutterFreeBottom (2-byte integer, array size: nrayMS x nscan):
Range bin number for clutter free bottom. Special values are defined as:
-9999 Missing value

sigmaZeroMeasured (4-byte float, array size: nrayMS x nscan):
Surface backscattering cross section without attenuation correction (as measured). Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorMeasured (4-byte float, array size: nbin x nrayMS x nscan):
Vertical profile of reflectivity factor without attenuation correction (as measured). Values are in dBZ. Special values are defined as:
-9999.9 Missing value

ellipsoidBinOffset (4-byte float, array size: nrayMS x nscan):
Distance between the ellipsoid and a center range bin of binEllipsoid defined by level 1B algorithm.

```
ellipsoidBinOffset =
    scRangeEllipsoid - { startBinRange + (binEllipsoid-1) x rangeBinSize}

scRangeEllipsoid : Distance between a sensor and the ellipsoid [m]
startBinRange : Distance between a sensor and a center
                of the highest observed range bin [m]
```

```
binEllipsoid : Range bin number of the Ellipsoid (1 - 260)
rangeBinSize : Range bin size [m]

-9999   Missing value
```

snRatioAtRealSurface (4-byte float, array size: nrayMS x nscan):
Signal/Noise ratio at real surface range bin.

```
snRatioAtRealSurface =
    10.*log10(echoPowertrueV[mW]/noisePowertrueV[mW])

-9999   Missing value
```

VER (Group in MS)

binZeroDeg (2-byte integer, array size: nrayMS x nscan):

```
Range bin number with 0 degrees C level.
For NS and MS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 176 at the Ellipsoid.
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
Special values are:
177: temperature at a surface is below 0 deg. C in Ku, KaMS, DPR(NS, MS).
89: temperature at a surface is below 0 deg. C in KaHS, DPR(HS).
```

attenuationNP (4-byte float, array size: nbin x nrayMS x nscan):
Vertical profile of attenuation by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB/km. Special values are defined as:
-9999.9 Missing value

piaNP (4-byte float, array size: nNP x nrayMS x nscan):
Path integrated attenuation caused by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroNPCorrected (4-byte float, array size: nrayMS x nscan):
Surface backscattering cross section with attenuation correction only for non-precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

heightZeroDeg (4-byte float, array size: nrayMS x nscan):
Height of freezing level (0 degrees C level) Values are in m. Special values are defined as:
-9999.9 Missing value

CSF (Group in MS)

flagBB (4-byte integer, array size: nrayMS x nscan):
Bright band (BB) exists or not.

```
0      BB not detected
1      BB detected
-1111  No rain value
-9999  Missing value
```

binBBPeak (2-byte integer, array size: nrayMS x nscan):
Range bin number for the peak of bright band. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

binBBTop (2-byte integer, array size: nrayMS x nscan):
Range bin number for the top of bright band. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

binBBBottom (2-byte integer, array size: nrayMS x nscan):
Range bin number for the bottom of bright band. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

heightBB (4-byte float, array size: nrayMS x nscan):
Height of bright band. Values are in m. Special values are defined as:
-9999.9 Missing value

widthBB (4-byte float, array size: nrayMS x nscan):
The width of bright band. Values are in m. Special values are defined as:
-9999.9 Missing value

qualityBB (4-byte integer, array size: nrayMS x nscan):

```
Quality of the bright band.

1      Good
0      BB not detected in the case of rain
-1111  No rain value
-9999  Missing value
```

typePrecip (4-byte integer, array size: nrayMS x nscan):
Precipitation type is expressed by an 8-digit number. The three major rain categories, stratiform, onvective, and other, can be obtained as follows:

```
When typePrecip is greater than zero,
Major rain type = typePrecip/10000000
     = 1    stratiform
     = 2    convective
     = 3    other

-1111  No rain value
-9999  Missing value
```

In the DPR product, rain type by the CSU's DFRm (measured dual frequency ratio) method is also included in typePrecip and can be obtained as follows:

```
DFRm rain type = (typePrecip%10000000)/1000000 in C
DFRm rain type = (MOD(typePrecip,10000000)/1000000 in FORTRAN

DFRm rain type
     = 1    stratiform
     = 2    convective
     = 4    transition
     = 9    DFRm method cannot be applicable (in this case
       the conventional method determines the major rain type)

-1111  No rain value
-9999  Missing value
```

qualityTypePrecip (4-byte integer, array size: nrayMS x nscan):

```
Quality of the precipitation type.

1      Good
-1111  No rain value
-9999  Missing value
```

flagShallowRain (4-byte integer, array size: nrayMS x nscan):

```
Type of shallow rain
0      No shallow rain
10     Shallow isolated (maybe)
11     Shallow isolated (certain)
20     Shallow non-isolated (maybe)
21     Shallow non-isolated (certain)
-1111  No rain value
-9999  Missing value
```

SRT (Group in MS)

PIAalt (4-byte float, array size: method x nrayMS x nscan):
The two-way path integrated attenuation (PIA) at from the each method estimate. The path-integrated attenuation from the jth method, where

PIAalt (j=1) = PIA_Ku from forward along-track spatial at kth angle bin
PIAalt (j=2) = PIA_Ku from backward along-track spatial at kth angle bin
PIAalt (j=3) = PIA_Ku from forward hybrid at kth angle bin
PIAalt (j=4) = PIA_Ku from backward hybrid at kth angle bin
PIAalt (j=5) = PIA_Ku from temporal reference at kth angle bin
PIAalt (j=6) = PIA_Ku from light-rain temporal reference at kth angle bin

Values are in dB. Special values are defined as:
-9999.9 Missing value

RFactorAlt (4-byte float, array size: method x nrayMS x nscan):
The reliability factors associated with the individual PIA estimates corresponding to PIAalt. Special values are defined as:
-9999.9 Missing value

PIAweight (4-byte float, array size: method x nrayMS x nscan):
The weights of the individual PIA_Ku estimates used in deriving the effective path attenuation estimate, pathAtten. The sum of the weights should equal one. Where j is method and sigma_j is the standard deviation of reference data for method j.

PIAweight_j = 1/sigma_j^2 * (1/Sum_j(1/sigma_j^2))

Special values are defined as:
-9999.9 Missing value

pathAtten (4-byte float, array size: nrayMS x nscan):
The effective 2-way path integrated attenuation. Values are in dB. Special values are defined as:
-9999.9 Missing value

reliabFactor (4-byte float, array size: nrayMS x nscan):
Reliability Factor for the effective PIA estimate, pathAtten. Special values are defined as:
-9999.9 Missing value

reliabFlag (2-byte integer, array size: nrayMS x nscan):
The reliability flag for the effective PIA estimate (pathAtten) based on the reliability factor (Rel_eff) in reliabFactor. Reliability Flag is:

= 1 if Rel_eff > 3 ; PIAeff estimate is considered reliable
= 2 if 3 ≥ Rel_eff > 1 ; PIAeff estimate is considered marginally reliable
= 3 if Rel_eff ≤ 1 ; PIAeff is unreliable
= 4 if SNR_at surface < 2dB; provides a lower bound to the path-attenuation
= 9 (no-rain case)

Special values are defined as:
-9999 Missing value

refScanID (2-byte integer, array size: nearFar x foreBack x nrayMS x nscan):
The number of scan lines between the current scan and the beginning (or end) of the along-track reference data at each angle bin. The values are computed by the equation: Current Scan Number - Reference Scan Number. The values are positive for the Forward estimates and negative for the Backward estimates. The Fortran indices for nearFar foreBack are:

```
1,1 - Forward - Near reference
2,1 - Forward - Far reference
1,2 - Backward - Near reference
2,2 - Backward - Far reference
```

Special values are defined as:
-9999 Missing value

DSD (Group in MS)

phase (1-byte char, array size: nbin x nrayMS x nscan):
Phase state of the precipitation. As an unsigned byte value this represents:

```
phase < 100 Temperature(C)=phase-100
phase > 200 Temperature(C)=phase-200
phase = 100 Top of the bright band
phase = 200 Bottom of the bright band
phase = 125 is used for the range bins between
                      the top and peak of bright band
phase = 175 is used for the range bins between
                      the peak and bottom of bright band

Integer values of phase/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

binNode (2-byte integer, array size: nNode x nrayMS x nscan):

```
The bin number of the 5 nodes defined as:

0 - Bin number of storm top.
1 - Stratiform: 500m above center of bright band.
    Convective: 750m above 0deg C level.
2 - Stratiform: center of bright band.
    Convective: 0deg C level.
3 - Stratiform: 500m below center of bright band.
    Convective: 750m below 0deg C level.
4 - Bin number of real surface equal to
    binRealSurface in PRE group.
For NS and MS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 176 at the Ellipsoid.
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
-9999 - Missing
```

Experimental (Group in MS)

precipRateESurface2 (4-byte float, array size: nrayMS x nscan):
Estimates Surface Precipitation using alternate method. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface2Status (1-byte char, array size: nrayMS x nscan):
Status of the estimated surface precipitation using alternate method. Special values are defined as:
255 Missing value

sigmaZeroProfile (4-byte float, array size: nbinSZP x nrayMS x nscan):
Surface backscattering cross section profile around the current ifov. Values are in dB. Special values are defined as:
-9999.9 Missing value

binDEML2 (2-byte integer, array size: nrayMS x nscan):
Range bin number of the digital elevation model surface estimate. Special values are defined as:
-9999 Missing value

SLV (Group in MS)

flagSLV (1-byte integer, array size: nbin x nrayMS x nscan):
Special values are defined as:
-99 Missing value

binEchoBottom (2-byte integer, array size: nrayMS x nscan):
For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

piaFinal (4-byte float, array size: nrayMS x nscan):
The final estimates of path integrated attenuation caused by precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroCorrected (4-byte float, array size: nrayMS x nscan):
Surface backscatter cross section with attenuation correction. Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorCorrected (4-byte float, array size: nbin x nrayMS x nscan):
Vertical profile of reflectivity factor with attenuation correction. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorCorrectedESurface (4-byte float, array size: nrayMS x nscan):
Reflectivity factor with attenuation correction at estimated surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorCorrectedNearSurface (4-byte float, array size: nrayMS x nscan):
Reflectivity factor with attenuation correction at near surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

paramDSD (4-byte float, array size: nDSD x nbin x nrayMS x nscan):
Parameters of the drop size distribution. The first index is dBNw; the second index is Dm in mm. Special values are defined as:
-9999.9 Missing value

precipRate (4-byte float, array size: nbin x nrayMS x nscan):
Precipitation rate. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipWaterIntegrated (4-byte float, array size: LS x nrayMS x nscan):
Precipitation water vertically integrated. Values are in g/m^2. Special values are defined as:
-9999.9 Missing value

qualitySLV (4-byte integer, array size: nrayMS x nscan):
A flag to show methods in which precipRateNearSurface is retrieved. Special values are defined as:
-9999 Missing value

precipRateNearSurface (4-byte float, array size: nrayMS x nscan):
Precipitation rate for the near surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface (4-byte float, array size: nrayMS x nscan):
Precipitation rate for the estimated surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateAve24 (4-byte float, array size: nrayMS x nscan):
Average of precipitation rate for 2 to 4km height. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

phaseNearSurface (1-byte char, array size: nrayMS x nscan):
Phase state of the precipitation at the Near-surface level. This is a copy of the phase in the DSD group at the Near-surface level. As an unsigned byte value this represents:

```
phaseNearSurface < 100 Temperature(C)=phaseNearSurface-100
phaseNearSurface > 200 Temperature(C)=phaseNearSurface-200
```

```
phaseNearSurface = 100 Top of the bright band
phaseNearSurface = 200 Bottom of the bright band
phaseNearSurface = 125 is used for the range bins between
                       the top and peak of bright band
phaseNearSurface = 175 is used for the range bins between
                       the peak and bottom of bright band

Integer values of phaseNearSurface/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

epsilon (4-byte float, array size: nbin x nrayMS x nscan):
Epsilon is the indication of the adjustment away from the initial drop size distribution, epsilon = 1 is no adjustment. Special values are defined as:
-9999.9 Missing value

FLG (Group in MS)

flagEcho (1-byte integer, array size: nbin x nrayMS x nscan):

```
Flag of precipitation and main/side lobe clutter
information of each range bin.

Bit  Meaning
0    For L2 Ku:  Precipitation judged by L2 Ku algorithm (copy of bit 2)
0    For L2 Ka:  Precipitation judged by L2 Ka algorithm (copy of bit 3)
0    For L2 DPR:  Precipitation judged by L2 DPR algorithm (copy of bit 1)
1    Precipitation judged by L2 DPR algorithm
2    Precipitation judged by L2 Ku algorithm
3    Precipitation judged by L2 Ka algorithm
4    Main lobe clutter judged by L2 Ku algorithm
5    Main lobe clutter judged by L2 Ka algorithm
6    Side lobe clutter judged by L2 Ku algorithm
7    Side lobe clutter judged by L2 Ka algorithm
```

qualityData (4-byte integer, array size: nrayMS x nscan):
Normal data gives "0". Non-zero values mean the kinds of errors. Special values are defined as:
-9999 Missing value

```
Flag of quality data.  Bit range from 8 to 23
contains flags by each module.  Each module flag
has 2 bits of information.

The 2 bit flag for each module has values:
[higher bit    lower bit]
[0 0]  Good
[0 1]  Warning but usable
[1 0]  NG or error

The bits of qualityData are assigned as follows:

Bit      Meaning
0 - 7    Copy of dataQuality in level 1B product
8 - 9    Flag by input module
10 - 11  Flag by preparation module
12 - 13  Flag by vertical module
14 - 15  Flag by classification module
16 - 17  Flag by SRT module
18 - 19  Flag by DSD module
20 - 21  Flag by solver module
22 - 23  Flag by output module
24 - 31  Spare
```

flagSensor (1-byte integer, array size: nscan):

```
Flag of input Ku/Ka data condition.

Value  Meaning
1      Valid
-99    Invalid (judged by dataQuality)
```

HS (Swath)

HS_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in HS)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nrayHS x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nrayHS x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in HS)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nscan):
Flag of data warning for each scan.

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as

far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
```

```
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):

```
The operational mode of KuPR/KaPR stored in science telemetry.
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
```

```
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
7     Ku/Ka Standby VPRF Table OUT
8     Ku/Ka Standby Phase Out
9     Ku/Ka Standby Dump Out
10    Ku/Ka Standby (No Science Data)
11    Ku/Ka Independent Observation
12    Ku/Ka Independent External Calibration
13    Ku/Ka Independent Internal Calibration
14    Ku/Ka Independent SSPA Analysis
15    Ku/Ka Independent LNA Analysis
16    Ku/Ka Independent Health-Check
17    Ku/Ka Independent Standby VPRF Table OUT
18    Ku/Ka Independent Standby Phase Out
19    Ku/Ka Independent Standby Dump Out
20    Ku/Ka Independent Standby (No Science Data)
```

limitErrorFlag (1-byte integer, array size: nscan):

```
Bit flags for every ray with information
about echo power limit checks.
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group in HS)

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

PRE (Group in HS)

elevation (4-byte float, array size: nrayHS x nscan):
Elevation of the measurement point. It is a copy of DEMHmean of level 1B product. Values are in m. Special values are defined as:
-9999.9 Missing value

landSurfaceType (4-byte integer, array size: nrayHS x nscan):

```
Land surface type.

0 - 99     Ocean
100 - 199  Land
200 - 299  Coast
300 - 399  Inland water
-9999      Missing value
```

localZenithAngle (4-byte float, array size: nrayHS x nscan):
Local zenith angle of each ray. It is a copy of scLocalZenith of level 1B product. Values are in degree. Special values are defined as:
-9999.9 Missing value

flagPrecip (4-byte integer, array size: nrayHS x nscan):

```
Precipitation or no precipitation.

For L2 Ku and L2 Ka

0       No precipitation
1       Precipitation
-9999   Missing value


For L2 DPR

0       No precipitation by both Ku and Ka
1       Precipitation by Ka, no rain by Ku
10      Precipitation by Ku, no rain by Ka
11      Precipitation by both Ku and Ka
-9999   Missing value
```

flagSigmaZeroSaturation (1-byte char, array size: nrayHS x nscan):

```
A flag to show whether echoPower is under a saturated
level or not at a range bin with a calculation of
```

```
sigmaZeroMeasured.  Values are:

0 : normal (under saturated level)
1 : possible saturated level at real surface
2 : saturated level at real surface
```

binRealSurface (2-byte integer, array size: nrayHS x nscan):
Range bin number for real surface. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

binStormTop (2-byte integer, array size: nrayHS x nscan):
Range bin number for the storm top. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

heightStormTop (4-byte float, array size: nrayHS x nscan):
Height of storm top. Values are in m. Special values are defined as:
-9999.9 Missing value

binClutterFreeBottom (2-byte integer, array size: nrayHS x nscan):
Range bin number for clutter free bottom. Special values are defined as:
-9999 Missing value

sigmaZeroMeasured (4-byte float, array size: nrayHS x nscan):
Surface backscattering cross section without attenuation correction (as measured). Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorMeasured (4-byte float, array size: nbinHS x nrayHS x nscan):
Vertical profile of reflectivity factor without attenuation correction (as measured). Values are in dBZ. Special values are defined as:
-9999.9 Missing value

ellipsoidBinOffset (4-byte float, array size: nrayHS x nscan):
Distance between the ellipsoid and a center range bin of binEllipsoid defined by level 1B algorithm.

```
ellipsoidBinOffset =
    scRangeEllipsoid - { startBinRange + (binEllipsoid-1) x rangeBinSize}

scRangeEllipsoid : Distance between a sensor and the ellipsoid [m]
startBinRange : Distance between a sensor and a center
                of the highest observed range bin [m]
```

```
binEllipsoid : Range bin number of the Ellipsoid (1 - 260)
rangeBinSize : Range bin size [m]

-9999   Missing value
```

snRatioAtRealSurface (4-byte float, array size: nrayHS x nscan):
Signal/Noise ratio at real surface range bin.

```
snRatioAtRealSurface =
    10.*log10(echoPowertrueV[mW]/noisePowertrueV[mW])

-9999   Missing value
```

VER (Group in HS)

binZeroDeg (2-byte integer, array size: nrayHS x nscan):

```
Range bin number with 0 degrees C level.
For NS and MS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 176 at the Ellipsoid.
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
Special values are:
177: temperature at a surface is below 0 deg. C in Ku, KaMS, DPR(NS, MS).
89: temperature at a surface is below 0 deg. C in KaHS, DPR(HS).
```

attenuationNP (4-byte float, array size: nbinHS x nrayHS x nscan):
Vertical profile of attenuation by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB/km. Special values are defined as:
-9999.9 Missing value

piaNP (4-byte float, array size: nNP x nrayHS x nscan):
Path integrated attenuation caused by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroNPCorrected (4-byte float, array size: nrayHS x nscan):
Surface backscattering cross section with attenuation correction only for non-precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

heightZeroDeg (4-byte float, array size: nrayHS x nscan):
Height of freezing level (0 degrees C level) Values are in m. Special values are defined as:
-9999.9 Missing value

CSF (Group in HS)

flagBB (4-byte integer, array size: nrayHS x nscan):
Bright band (BB) exists or not.

```
0      BB not detected
1      BB detected
-1111  No rain value
-9999  Missing value
```

binBBPeak (2-byte integer, array size: nrayHS x nscan):
Range bin number for the peak of bright band. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

binBBTop (2-byte integer, array size: nrayHS x nscan):
Range bin number for the top of bright band. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

binBBBottom (2-byte integer, array size: nrayHS x nscan):
Range bin number for the bottom of bright band. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

heightBB (4-byte float, array size: nrayHS x nscan):
Height of bright band. Values are in m. Special values are defined as:
-9999.9 Missing value

widthBB (4-byte float, array size: nrayHS x nscan):
The width of bright band. Values are in m. Special values are defined as:
-9999.9 Missing value

qualityBB (4-byte integer, array size: nrayHS x nscan):

```
Quality of the bright band.

1      Good
0      BB not detected in the case of rain
-1111  No rain value
-9999  Missing value
```

typePrecip (4-byte integer, array size: nrayHS x nscan):
Precipitation type is expressed by an 8-digit number. The three major rain categories, stratiform, onvective, and other, can be obtained as follows:

```
When typePrecip is greater than zero,
Major rain type = typePrecip/10000000
     = 1    stratiform
     = 2    convective
     = 3    other

-1111  No rain value
-9999  Missing value
```

In the DPR product, rain type by the CSU's DFRm (measured dual frequency ratio) method is also included in typePrecip and can be obtained as follows:

```
DFRm rain type = (typePrecip%10000000)/1000000 in C
DFRm rain type = (MOD(typePrecip,10000000)/1000000 in FORTRAN

DFRm rain type
     = 1    stratiform
     = 2    convective
     = 4    transition
     = 9    DFRm method cannot be applicable (in this case
       the conventional method determines the major rain type)

-1111  No rain value
-9999  Missing value
```

qualityTypePrecip (4-byte integer, array size: nrayHS x nscan):

```
Quality of the precipitation type.

1      Good
-1111  No rain value
-9999  Missing value
```

flagShallowRain (4-byte integer, array size: nrayHS x nscan):

```
Type of shallow rain
0      No shallow rain
10     Shallow isolated (maybe)
11     Shallow isolated (certain)
20     Shallow non-isolated (maybe)
21     Shallow non-isolated (certain)
-1111  No rain value
-9999  Missing value
```

SRT (Group in HS)

PIAalt (4-byte float, array size: method x nrayHS x nscan):
The two-way path integrated attenuation (PIA) at from the each method estimate. The path-integrated attenuation from the jth method, where

PIAalt (j=1) = PIA_Ku from forward along-track spatial at kth angle bin
PIAalt (j=2) = PIA_Ku from backward along-track spatial at kth angle bin
PIAalt (j=3) = PIA_Ku from forward hybrid at kth angle bin
PIAalt (j=4) = PIA_Ku from backward hybrid at kth angle bin
PIAalt (j=5) = PIA_Ku from temporal reference at kth angle bin
PIAalt (j=6) = PIA_Ku from light-rain temporal reference at kth angle bin

Values are in dB. Special values are defined as:
-9999.9 Missing value

RFactorAlt (4-byte float, array size: method x nrayHS x nscan):
The reliability factors associated with the individual PIA estimates corresponding to PIAalt. Special values are defined as:
-9999.9 Missing value

PIAweight (4-byte float, array size: method x nrayHS x nscan):
The weights of the individual PIA_Ku estimates used in deriving the effective path attenuation estimate, pathAtten. The sum of the weights should equal one. Where j is method and sigma_j is the standard deviation of reference data for method j.

PIAweight_j = 1/sigma_j^2 * (1/Sum_j(1/sigma_j^2))

Special values are defined as:
-9999.9 Missing value

pathAtten (4-byte float, array size: nrayHS x nscan):
The effective 2-way path integrated attenuation. Values are in dB. Special values are defined as:
-9999.9 Missing value

reliabFactor (4-byte float, array size: nrayHS x nscan):
Reliability Factor for the effective PIA estimate, pathAtten. Special values are defined as:
-9999.9 Missing value

reliabFlag (2-byte integer, array size: nrayHS x nscan):
The reliability flag for the effective PIA estimate (pathAtten) based on the reliability factor (Rel_eff) in reliabFactor. Reliability Flag is:

= 1 if Rel_eff > 3 ; PIAeff estimate is considered reliable
= 2 if 3 ≥ Rel_eff > 1 ; PIAeff estimate is considered marginally reliable
= 3 if Rel_eff ≤ 1 ; PIAeff is unreliable
= 4 if SNR_at surface < 2dB; provides a lower bound to the path-attenuation
= 9 (no-rain case)

Special values are defined as:
-9999 Missing value

refScanID (2-byte integer, array size: nearFar x foreBack x nrayHS x nscan):
The number of scan lines between the current scan and the beginning (or end) of the along-track reference data at each angle bin. The values are computed by the equation: Current Scan Number - Reference Scan Number. The values are positive for the Forward estimates and negative for the Backward estimates. The Fortran indices for nearFar foreBack are:

```
1,1 - Forward - Near reference
2,1 - Forward - Far reference
1,2 - Backward - Near reference
2,2 - Backward - Far reference
```

Special values are defined as:
-9999 Missing value

DSD (Group in HS)

phase (1-byte char, array size: nbinHS x nrayHS x nscan):
Phase state of the precipitation. As an unsigned byte value this represents:

```
phase < 100 Temperature(C)=phase-100
phase > 200 Temperature(C)=phase-200
phase = 100 Top of the bright band
phase = 200 Bottom of the bright band
phase = 125 is used for the range bins between
                      the top and peak of bright band
phase = 175 is used for the range bins between
                      the peak and bottom of bright band

Integer values of phase/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

binNode (2-byte integer, array size: nNode x nrayHS x nscan):

```
The bin number of the 5 nodes defined as:

0 - Bin number of storm top.
1 - Stratiform: 500m above center of bright band.
    Convective: 750m above 0deg C level.
2 - Stratiform: center of bright band.
    Convective: 0deg C level.
3 - Stratiform: 500m below center of bright band.
    Convective: 750m below 0deg C level.
4 - Bin number of real surface equal to
    binRealSurface in PRE group.
For NS and MS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 176 at the Ellipsoid.
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
-9999 - Missing
```

Experimental (Group in HS)

precipRateESurface2 (4-byte float, array size: nrayHS x nscan):
Estimates Surface Precipitation using alternate method. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface2Status (1-byte char, array size: nrayHS x nscan):
Status of the estimated surface precipitation using alternate method. Special values are defined as:
255 Missing value

sigmaZeroProfile (4-byte float, array size: nbinSZPHS x nrayHS x nscan):
Surface backscattering cross section profile around the current ifov. Values are in dB. Special values are defined as:
-9999.9 Missing value

binDEML2 (2-byte integer, array size: nrayHS x nscan):
Range bin number of the digital elevation model surface estimate. Special values are defined as:
-9999 Missing value

SLV (Group in HS)

flagSLV (1-byte integer, array size: nbinHS x nrayHS x nscan):
Special values are defined as:
-99 Missing value

binEchoBottom (2-byte integer, array size: nrayHS x nscan):
For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

piaFinal (4-byte float, array size: nrayHS x nscan):
The final estimates of path integrated attenuation caused by precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroCorrected (4-byte float, array size: nrayHS x nscan):
Surface backscatter cross section with attenuation correction. Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorCorrected (4-byte float, array size: nbinHS x nrayHS x nscan):
Vertical profile of reflectivity factor with attenuation correction. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorCorrectedESurface (4-byte float, array size: nrayHS x nscan):
Reflectivity factor with attenuation correction at estimated surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorCorrectedNearSurface (4-byte float, array size: nrayHS x nscan):
Reflectivity factor with attenuation correction at near surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

paramDSD (4-byte float, array size: nDSD x nbinHS x nrayHS x nscan):
Parameters of the drop size distribution. The first index is dBNw; the second index is Dm in mm. Special values are defined as:
-9999.9 Missing value

precipRate (4-byte float, array size: nbinHS x nrayHS x nscan):
Precipitation rate. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipWaterIntegrated (4-byte float, array size: LS x nrayHS x nscan):
Precipitation water vertically integrated. Values are in g/m^2. Special values are defined as:
-9999.9 Missing value

qualitySLV (4-byte integer, array size: nrayHS x nscan):
A flag to show methods in which precipRateNearSurface is retrieved. Special values are defined as:
-9999 Missing value

precipRateNearSurface (4-byte float, array size: nrayHS x nscan):
Precipitation rate for the near surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface (4-byte float, array size: nrayHS x nscan):
Precipitation rate for the estimated surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateAve24 (4-byte float, array size: nrayHS x nscan):
Average of precipitation rate for 2 to 4km height. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

phaseNearSurface (1-byte char, array size: nrayHS x nscan):
Phase state of the precipitation at the Near-surface level. This is a copy of the phase in the DSD group at the Near-surface level. As an unsigned byte value this represents:

```
phaseNearSurface < 100 Temperature(C)=phaseNearSurface-100
phaseNearSurface > 200 Temperature(C)=phaseNearSurface-200
```

```
phaseNearSurface = 100 Top of the bright band
phaseNearSurface = 200 Bottom of the bright band
phaseNearSurface = 125 is used for the range bins between
                       the top and peak of bright band
phaseNearSurface = 175 is used for the range bins between
                       the peak and bottom of bright band

Integer values of phaseNearSurface/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

epsilon (4-byte float, array size: nbinHS x nrayHS x nscan):
Epsilon is the indication of the adjustment away from the initial drop size distribution, epsilon = 1 is no adjustment. Special values are defined as:
-9999.9 Missing value

FLG (Group in HS)

flagEcho (1-byte integer, array size: nbinHS x nrayHS x nscan):

```
Flag of precipitation and main/side lobe clutter
information of each range bin.

Bit  Meaning
0    For L2 Ku:  Precipitation judged by L2 Ku algorithm (copy of bit 2)
0    For L2 Ka:  Precipitation judged by L2 Ka algorithm (copy of bit 3)
0    For L2 DPR:  Precipitation judged by L2 DPR algorithm (copy of bit 1)
1    Precipitation judged by L2 DPR algorithm
2    Precipitation judged by L2 Ku algorithm
3    Precipitation judged by L2 Ka algorithm
4    Main lobe clutter judged by L2 Ku algorithm
5    Main lobe clutter judged by L2 Ka algorithm
6    Side lobe clutter judged by L2 Ku algorithm
7    Side lobe clutter judged by L2 Ka algorithm
```

qualityData (4-byte integer, array size: nrayHS x nscan):
Normal data gives "0". Non-zero values mean the kinds of errors. Special values are defined as:
-9999 Missing value

```
Flag of quality data.  Bit range from 8 to 23
contains flags by each module.  Each module flag
has 2 bits of information.

The 2 bit flag for each module has values:
[higher bit    lower bit]
[0 0]  Good
[0 1]  Warning but usable
[1 0]  NG or error

The bits of qualityData are assigned as follows:

Bit      Meaning
0 - 7    Copy of dataQuality in level 1B product
8 - 9    Flag by input module
10 - 11  Flag by preparation module
12 - 13  Flag by vertical module
14 - 15  Flag by classification module
16 - 17  Flag by SRT module
18 - 19  Flag by DSD module
20 - 21  Flag by solver module
22 - 23  Flag by output module
24 - 31  Spare
```

flagSensor (1-byte integer, array size: nscan):

```
Flag of input Ku/Ka data condition.

Value  Meaning
1      Valid
-99    Invalid (judged by dataQuality)
```

C Structure Header file:

```
#ifndef _TK_2AKa_H_
#define _TK_2AKa_H_

#ifndef _L2AKa_HS_FLG_
#define _L2AKa_HS_FLG_

typedef struct {
    signed char flagEcho[24][88];
```

```
    int qualityData[24];
    signed char flagSensor;
} L2AKa_HS_FLG;

#endif

#ifndef _L2AKa_HS_SLV_
#define _L2AKa_HS_SLV_

typedef struct {
    signed char flagSLV[24][88];
    short binEchoBottom[24];
    float piaFinal[24];
    float sigmaZeroCorrected[24];
    float zFactorCorrected[24][88];
    float zFactorCorrectedESurface[24];
    float zFactorCorrectedNearSurface[24];
    float paramDSD[24][88][2];
    float precipRate[24][88];
    float precipWaterIntegrated[24][2];
    int qualitySLV[24];
    float precipRateNearSurface[24];
    float precipRateESurface[24];
    float precipRateAve24[24];
    unsigned char phaseNearSurface[24];
    float epsilon[24][88];
} L2AKa_HS_SLV;

#endif

#ifndef _L2AKa_HS_EXPERIMENTAL_
#define _L2AKa_HS_EXPERIMENTAL_

typedef struct {
    float precipRateESurface2[24];
    unsigned char precipRateESurface2Status[24];
    float sigmaZeroProfile[24][5];
    short binDEML2[24];
} L2AKa_HS_EXPERIMENTAL;

#endif

#ifndef _L2AKa_HS_DSD_
```

```
#define _L2AKa_HS_DSD_

typedef struct {
    unsigned char phase[24][88];
    short binNode[24][5];
} L2AKa_HS_DSD;

#endif

#ifndef _L2AKa_HS_SRT_
#define _L2AKa_HS_SRT_

typedef struct {
    float PIAalt[24][6];
    float RFactorAlt[24][6];
    float PIAweight[24][6];
    float pathAtten[24];
    float reliabFactor[24];
    short reliabFlag[24];
    short refScanID[24][2][2];
} L2AKa_HS_SRT;

#endif

#ifndef _L2AKa_HS_CSF_
#define _L2AKa_HS_CSF_

typedef struct {
    int flagBB[24];
    short binBBPeak[24];
    short binBBTop[24];
    short binBBBottom[24];
    float heightBB[24];
    float widthBB[24];
    int qualityBB[24];
    int typePrecip[24];
    int qualityTypePrecip[24];
    int flagShallowRain[24];
} L2AKa_HS_CSF;

#endif

#ifndef _L2AKa_HS_VER_
```

```
#define _L2AKa_HS_VER_

typedef struct {
    short binZeroDeg[24];
    float attenuationNP[24][88];
    float piaNP[24][4];
    float sigmaZeroNPCorrected[24];
    float heightZeroDeg[24];
} L2AKa_HS_VER;

#endif

#ifndef _L2AKa_HS_PRE_
#define _L2AKa_HS_PRE_

typedef struct {
    float elevation[24];
    int landSurfaceType[24];
    float localZenithAngle[24];
    int flagPrecip[24];
    unsigned char flagSigmaZeroSaturation[24];
    short binRealSurface[24];
    short binStormTop[24];
    float heightStormTop[24];
    short binClutterFreeBottom[24];
    float sigmaZeroMeasured[24];
    float zFactorMeasured[24][88];
    float ellipsoidBinOffset[24];
    float snRatioAtRealSurface[24];
} L2AKa_HS_PRE;

#endif

#ifndef _L2AKa_HS_SCANSTATUS_
#define _L2AKa_HS_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char dataWarning;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
```

```
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    signed char limitErrorFlag;
    double FractionalGranuleNumber;
} L2AKa_HS_SCANSTATUS;

#endif

#ifndef _L2AKa_HS_
#define _L2AKa_HS_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[24];
    float Longitude[24];
    L2AKa_HS_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L2AKa_HS_PRE PRE;
    L2AKa_HS_VER VER;
    L2AKa_HS_CSF CSF;
    L2AKa_HS_SRT SRT;
    L2AKa_HS_DSD DSD;
    L2AKa_HS_EXPERIMENTAL Experimental;
    L2AKa_HS_SLV SLV;
    L2AKa_HS_FLG FLG;
} L2AKa_HS;

#endif

#ifndef _L2AKa_MS_FLG_
#define _L2AKa_MS_FLG_

typedef struct {
    signed char flagEcho[25][176];
    int qualityData[25];
    signed char flagSensor;
} L2AKa_MS_FLG;

#endif
```

```
#ifndef _L2AKa_MS_SLV_
#define _L2AKa_MS_SLV_

typedef struct {
    signed char flagSLV[25][176];
    short binEchoBottom[25];
    float piaFinal[25];
    float sigmaZeroCorrected[25];
    float zFactorCorrected[25][176];
    float zFactorCorrectedESurface[25];
    float zFactorCorrectedNearSurface[25];
    float paramDSD[25][176][2];
    float precipRate[25][176];
    float precipWaterIntegrated[25][2];
    int qualitySLV[25];
    float precipRateNearSurface[25];
    float precipRateESurface[25];
    float precipRateAve24[25];
    unsigned char phaseNearSurface[25];
    float epsilon[25][176];
} L2AKa_MS_SLV;

#endif

#ifndef _L2AKa_MS_EXPERIMENTAL_
#define _L2AKa_MS_EXPERIMENTAL_

typedef struct {
    float precipRateESurface2[25];
    unsigned char precipRateESurface2Status[25];
    float sigmaZeroProfile[25][7];
    short binDEML2[25];
} L2AKa_MS_EXPERIMENTAL;

#endif

#ifndef _L2AKa_MS_DSD_
#define _L2AKa_MS_DSD_

typedef struct {
    unsigned char phase[25][176];
    short binNode[25][5];
} L2AKa_MS_DSD;
```

```
#endif

#ifndef _L2AKa_MS_SRT_
#define _L2AKa_MS_SRT_

typedef struct {
    float PIAalt[25][6];
    float RFactorAlt[25][6];
    float PIAweight[25][6];
    float pathAtten[25];
    float reliabFactor[25];
    short reliabFlag[25];
    short refScanID[25][2][2];
} L2AKa_MS_SRT;

#endif

#ifndef _L2AKa_MS_CSF_
#define _L2AKa_MS_CSF_

typedef struct {
    int flagBB[25];
    short binBBPeak[25];
    short binBBTop[25];
    short binBBBottom[25];
    float heightBB[25];
    float widthBB[25];
    int qualityBB[25];
    int typePrecip[25];
    int qualityTypePrecip[25];
    int flagShallowRain[25];
} L2AKa_MS_CSF;

#endif

#ifndef _L2AKa_MS_VER_
#define _L2AKa_MS_VER_

typedef struct {
    short binZeroDeg[25];
    float attenuationNP[25][176];
    float piaNP[25][4];
```

```
    float sigmaZeroNPCorrected[25];
    float heightZeroDeg[25];
} L2AKa_MS_VER;

#endif

#ifndef _L2AKa_MS_PRE_
#define _L2AKa_MS_PRE_

typedef struct {
    float elevation[25];
    int landSurfaceType[25];
    float localZenithAngle[25];
    int flagPrecip[25];
    unsigned char flagSigmaZeroSaturation[25];
    short binRealSurface[25];
    short binStormTop[25];
    float heightStormTop[25];
    short binClutterFreeBottom[25];
    float sigmaZeroMeasured[25];
    float zFactorMeasured[25][176];
    float ellipsoidBinOffset[25];
    float snRatioAtRealSurface[25];
} L2AKa_MS_PRE;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
```

```
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _L2AKa_MS_SCANSTATUS_
#define _L2AKa_MS_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char dataWarning;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    signed char limitErrorFlag;
    double FractionalGranuleNumber;
} L2AKa_MS_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;
```

```
#endif

#ifndef _L2AKa_MS_
#define _L2AKa_MS_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[25];
    float Longitude[25];
    L2AKa_MS_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L2AKa_MS_PRE PRE;
    L2AKa_MS_VER VER;
    L2AKa_MS_CSF CSF;
    L2AKa_MS_SRT SRT;
    L2AKa_MS_DSD DSD;
    L2AKa_MS_EXPERIMENTAL Experimental;
    L2AKa_MS_SLV SLV;
    L2AKa_MS_FLG FLG;
} L2AKa_MS;

#endif

#ifndef _L2AKa_SWATHS_
#define _L2AKa_SWATHS_

typedef struct {
    L2AKa_MS MS;
    L2AKa_HS HS;
} L2AKa_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L2AKa_HS_FLG/
    BYTE flagEcho(88,24)
    INTEGER*4 qualityData(24)
    BYTE flagSensor
END STRUCTURE
```

```
STRUCTURE /L2AKa_HS_SLV/
    BYTE flagSLV(88,24)
    INTEGER*2 binEchoBottom(24)
    REAL*4 piaFinal(24)
    REAL*4 sigmaZeroCorrected(24)
    REAL*4 zFactorCorrected(88,24)
    REAL*4 zFactorCorrectedESurface(24)
    REAL*4 zFactorCorrectedNearSurface(24)
    REAL*4 paramDSD(2,88,24)
    REAL*4 precipRate(88,24)
    REAL*4 precipWaterIntegrated(2,24)
    INTEGER*4 qualitySLV(24)
    REAL*4 precipRateNearSurface(24)
    REAL*4 precipRateESurface(24)
    REAL*4 precipRateAve24(24)
    CHARACTER phaseNearSurface(24)
    REAL*4 epsilon(88,24)
END STRUCTURE

STRUCTURE /L2AKa_HS_EXPERIMENTAL/
    REAL*4 precipRateESurface2(24)
    CHARACTER precipRateESurface2Status(24)
    REAL*4 sigmaZeroProfile(5,24)
    INTEGER*2 binDEML2(24)
END STRUCTURE

STRUCTURE /L2AKa_HS_DSD/
    CHARACTER phase(88,24)
    INTEGER*2 binNode(5,24)
END STRUCTURE

STRUCTURE /L2AKa_HS_SRT/
    REAL*4 PIAalt(6,24)
    REAL*4 RFactorAlt(6,24)
    REAL*4 PIAweight(6,24)
    REAL*4 pathAtten(24)
    REAL*4 reliabFactor(24)
    INTEGER*2 reliabFlag(24)
    INTEGER*2 refScanID(2,2,24)
END STRUCTURE

STRUCTURE /L2AKa_HS_CSF/
    INTEGER*4 flagBB(24)
```

```
    INTEGER*2 binBBPeak(24)
    INTEGER*2 binBBTop(24)
    INTEGER*2 binBBBottom(24)
    REAL*4 heightBB(24)
    REAL*4 widthBB(24)
    INTEGER*4 qualityBB(24)
    INTEGER*4 typePrecip(24)
    INTEGER*4 qualityTypePrecip(24)
    INTEGER*4 flagShallowRain(24)
END STRUCTURE

STRUCTURE /L2AKa_HS_VER/
    INTEGER*2 binZeroDeg(24)
    REAL*4 attenuationNP(88,24)
    REAL*4 piaNP(4,24)
    REAL*4 sigmaZeroNPCorrected(24)
    REAL*4 heightZeroDeg(24)
END STRUCTURE

STRUCTURE /L2AKa_HS_PRE/
    REAL*4 elevation(24)
    INTEGER*4 landSurfaceType(24)
    REAL*4 localZenithAngle(24)
    INTEGER*4 flagPrecip(24)
    CHARACTER flagSigmaZeroSaturation(24)
    INTEGER*2 binRealSurface(24)
    INTEGER*2 binStormTop(24)
    REAL*4 heightStormTop(24)
    INTEGER*2 binClutterFreeBottom(24)
    REAL*4 sigmaZeroMeasured(24)
    REAL*4 zFactorMeasured(88,24)
    REAL*4 ellipsoidBinOffset(24)
    REAL*4 snRatioAtRealSurface(24)
END STRUCTURE

STRUCTURE /L2AKa_HS_SCANSTATUS/
    BYTE dataQuality
    BYTE dataWarning
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
```

```
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    BYTE limitErrorFlag
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /L2AKa_HS/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(24)
    REAL*4 Longitude(24)
    RECORD /L2AKa_HS_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L2AKa_HS_PRE/ PRE
    RECORD /L2AKa_HS_VER/ VER
    RECORD /L2AKa_HS_CSF/ CSF
    RECORD /L2AKa_HS_SRT/ SRT
    RECORD /L2AKa_HS_DSD/ DSD
    RECORD /L2AKa_HS_EXPERIMENTAL/ Experimental
    RECORD /L2AKa_HS_SLV/ SLV
    RECORD /L2AKa_HS_FLG/ FLG
END STRUCTURE

STRUCTURE /L2AKa_MS_FLG/
    BYTE flagEcho(176,25)
    INTEGER*4 qualityData(25)
    BYTE flagSensor
END STRUCTURE

STRUCTURE /L2AKa_MS_SLV/
    BYTE flagSLV(176,25)
    INTEGER*2 binEchoBottom(25)
    REAL*4 piaFinal(25)
    REAL*4 sigmaZeroCorrected(25)
    REAL*4 zFactorCorrected(176,25)
    REAL*4 zFactorCorrectedESurface(25)
    REAL*4 zFactorCorrectedNearSurface(25)
    REAL*4 paramDSD(2,176,25)
    REAL*4 precipRate(176,25)
    REAL*4 precipWaterIntegrated(2,25)
    INTEGER*4 qualitySLV(25)
    REAL*4 precipRateNearSurface(25)
```

```
    REAL*4 precipRateESurface(25)
    REAL*4 precipRateAve24(25)
    CHARACTER phaseNearSurface(25)
    REAL*4 epsilon(176,25)
END STRUCTURE

STRUCTURE /L2AKa_MS_EXPERIMENTAL/
    REAL*4 precipRateESurface2(25)
    CHARACTER precipRateESurface2Status(25)
    REAL*4 sigmaZeroProfile(7,25)
    INTEGER*2 binDEML2(25)
END STRUCTURE

STRUCTURE /L2AKa_MS_DSD/
    CHARACTER phase(176,25)
    INTEGER*2 binNode(5,25)
END STRUCTURE

STRUCTURE /L2AKa_MS_SRT/
    REAL*4 PIAalt(6,25)
    REAL*4 RFactorAlt(6,25)
    REAL*4 PIAweight(6,25)
    REAL*4 pathAtten(25)
    REAL*4 reliabFactor(25)
    INTEGER*2 reliabFlag(25)
    INTEGER*2 refScanID(2,2,25)
END STRUCTURE

STRUCTURE /L2AKa_MS_CSF/
    INTEGER*4 flagBB(25)
    INTEGER*2 binBBPeak(25)
    INTEGER*2 binBBTop(25)
    INTEGER*2 binBBBottom(25)
    REAL*4 heightBB(25)
    REAL*4 widthBB(25)
    INTEGER*4 qualityBB(25)
    INTEGER*4 typePrecip(25)
    INTEGER*4 qualityTypePrecip(25)
    INTEGER*4 flagShallowRain(25)
END STRUCTURE

STRUCTURE /L2AKa_MS_VER/
    INTEGER*2 binZeroDeg(25)
```

```
    REAL*4 attenuationNP(176,25)
    REAL*4 piaNP(4,25)
    REAL*4 sigmaZeroNPCorrected(25)
    REAL*4 heightZeroDeg(25)
END STRUCTURE

STRUCTURE /L2AKa_MS_PRE/
    REAL*4 elevation(25)
    INTEGER*4 landSurfaceType(25)
    REAL*4 localZenithAngle(25)
    INTEGER*4 flagPrecip(25)
    CHARACTER flagSigmaZeroSaturation(25)
    INTEGER*2 binRealSurface(25)
    INTEGER*2 binStormTop(25)
    REAL*4 heightStormTop(25)
    INTEGER*2 binClutterFreeBottom(25)
    REAL*4 sigmaZeroMeasured(25)
    REAL*4 zFactorMeasured(176,25)
    REAL*4 ellipsoidBinOffset(25)
    REAL*4 snRatioAtRealSurface(25)
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L2AKa_MS_SCANSTATUS/
    BYTE dataQuality
    BYTE dataWarning
```

```
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    BYTE limitErrorFlag
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2AKa_MS/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(25)
    REAL*4 Longitude(25)
    RECORD /L2AKa_MS_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L2AKa_MS_PRE/ PRE
    RECORD /L2AKa_MS_VER/ VER
    RECORD /L2AKa_MS_CSF/ CSF
    RECORD /L2AKa_MS_SRT/ SRT
    RECORD /L2AKa_MS_DSD/ DSD
    RECORD /L2AKa_MS_EXPERIMENTAL/ Experimental
    RECORD /L2AKa_MS_SLV/ SLV
    RECORD /L2AKa_MS_FLG/ FLG
END STRUCTURE

STRUCTURE /L2AKa_SWATHS/
    RECORD /L2AKa_MS/ MS
```

```
    RECORD /L2AKa_HS/ HS
END STRUCTURE
```

5.31 2ADPR - DPR precipitation

The DPR Level-2A product, 2ADPR, "DPR precipitation," is written as a 3 swath structure. The swaths are NS, normal scans, MS, matched scans, and HS, high sensitivity scans. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nray	49	Number of angle bins in each NS scan.
nrayMS	25	Number of angle bins in each MS scan.
nrayHS	24	Number of angle bins in each HS scan.
nbin	176	Number of range bins in each NS and MS ray. Bin interval is 125 m.
nbinHS	88	Number of range bins in each HS ray. Bin interval is 250 m.
nbinSZP	7	Number of range bins for sigmaZeroProfile.
nbinSZPHS	5	Number of range bins for sigmaZeroProfile in each HS scan.
nNP	4	Number of NP kinds.
nearFar	2	Near reference, Far reference.
foreBack	2	Foreward, Backward.
method	6	Number of SRT methods.
nNode	5	Number of binNode.
nDSD	2	Number of DSD parameters. Parameters are dBNw and Dm (mm).
LS	2	Liquid, solid.

Figure 375 through Figure 411 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

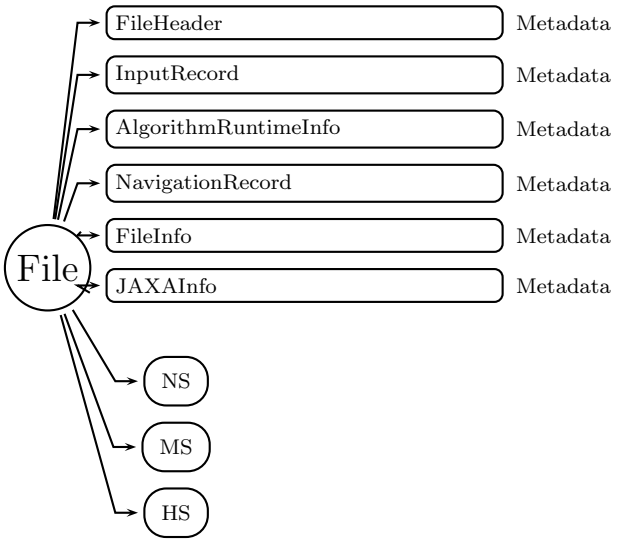


Figure 375: Data Format Structure for 2ADPR, DPR precipitation

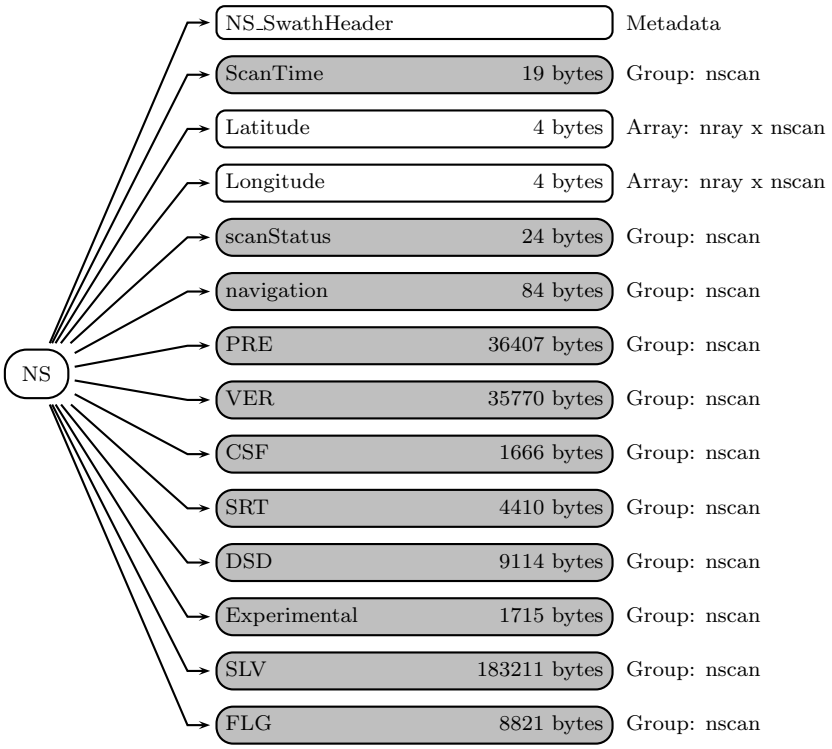


Figure 376: Data Format Structure for 2ADPR, NS

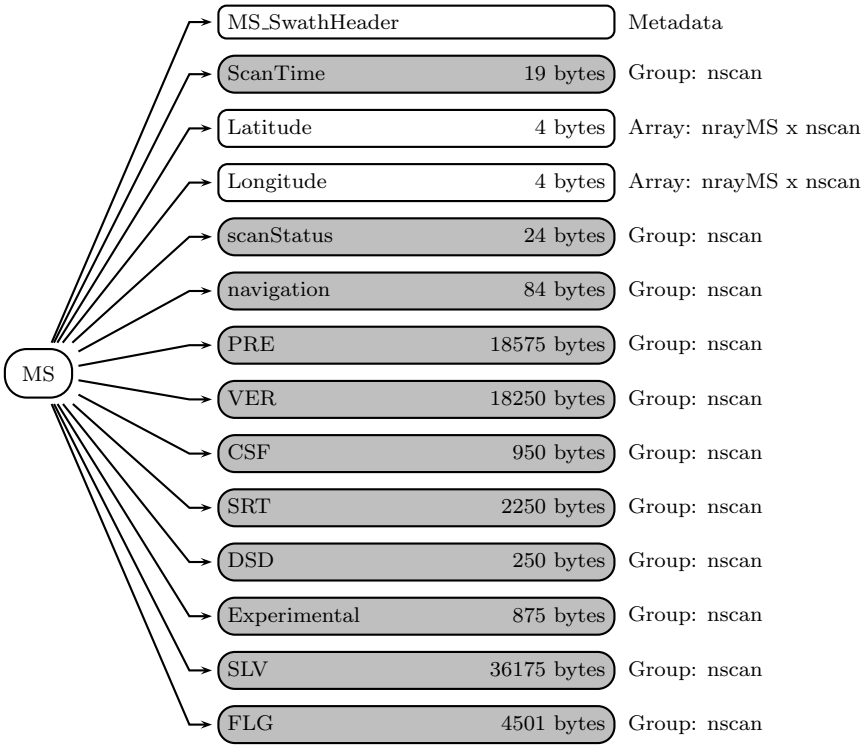


Figure 377: Data Format Structure for 2ADPR, MS

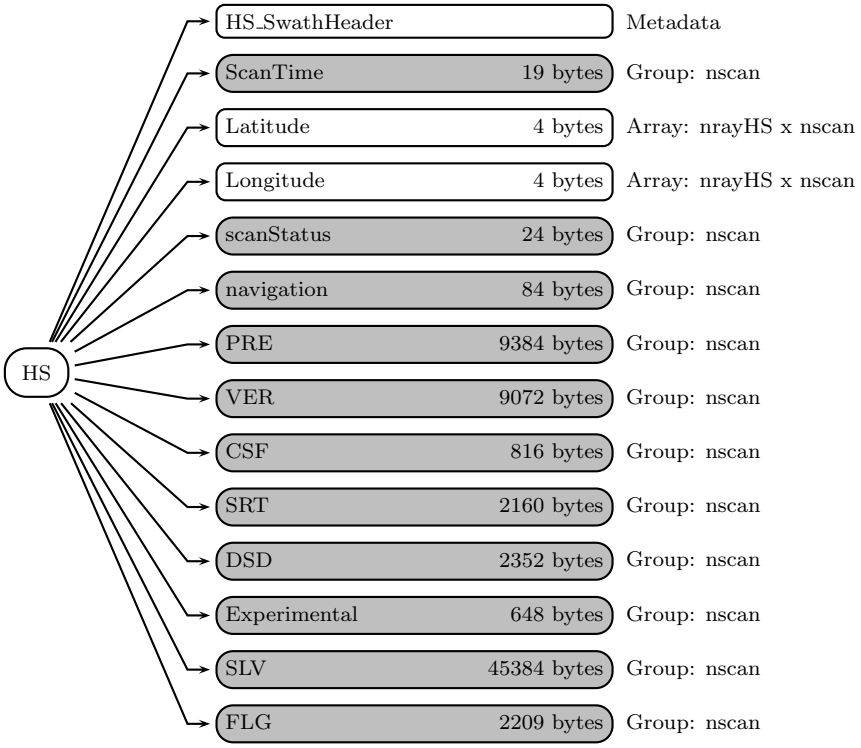


Figure 378: Data Format Structure for 2ADPR, HS

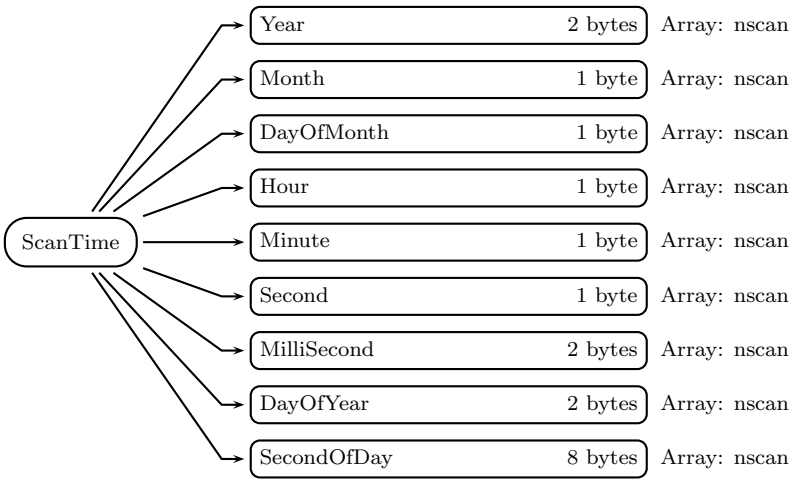


Figure 379: Data Format Structure for 2ADPR, NS, ScanTime

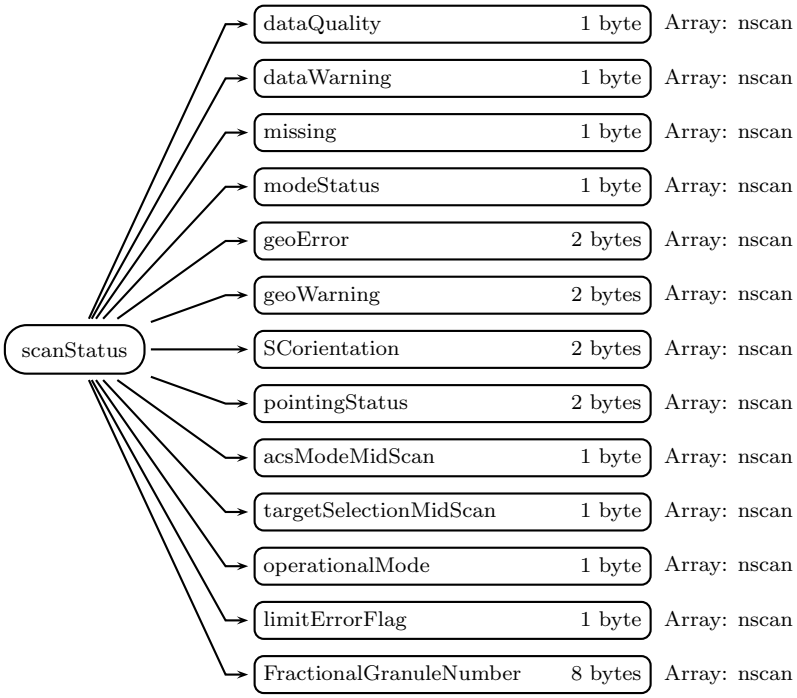


Figure 380: Data Format Structure for 2ADPR, NS, scanStatus

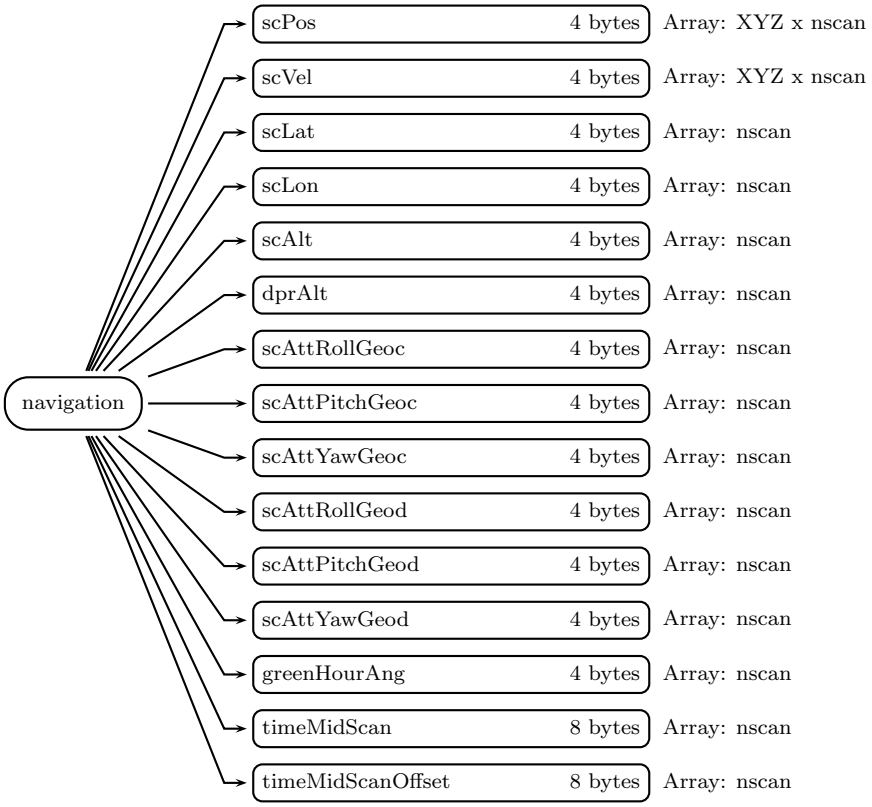


Figure 381: Data Format Structure for 2ADPR, NS, navigation

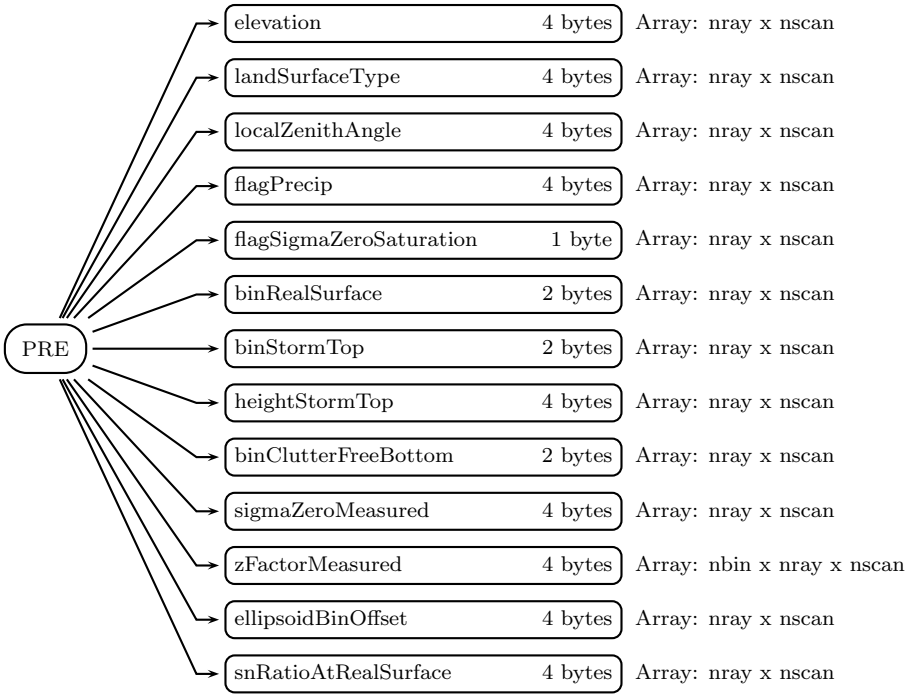


Figure 382: Data Format Structure for 2ADPR, NS, PRE

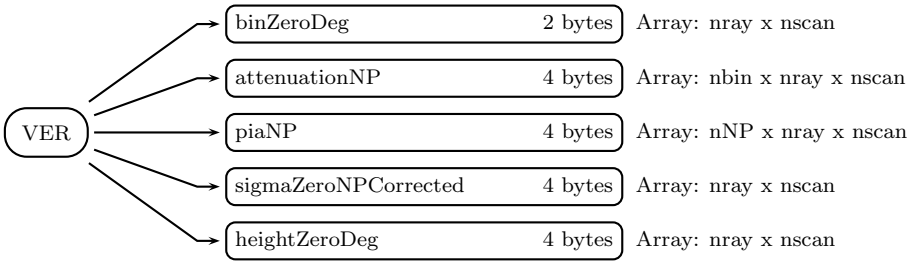


Figure 383: Data Format Structure for 2ADPR, NS, VER

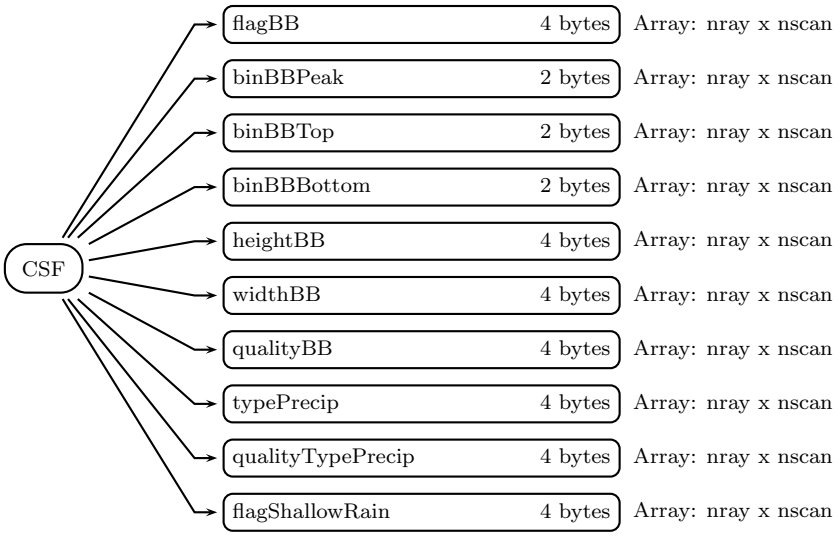


Figure 384: Data Format Structure for 2ADPR, NS, CSF

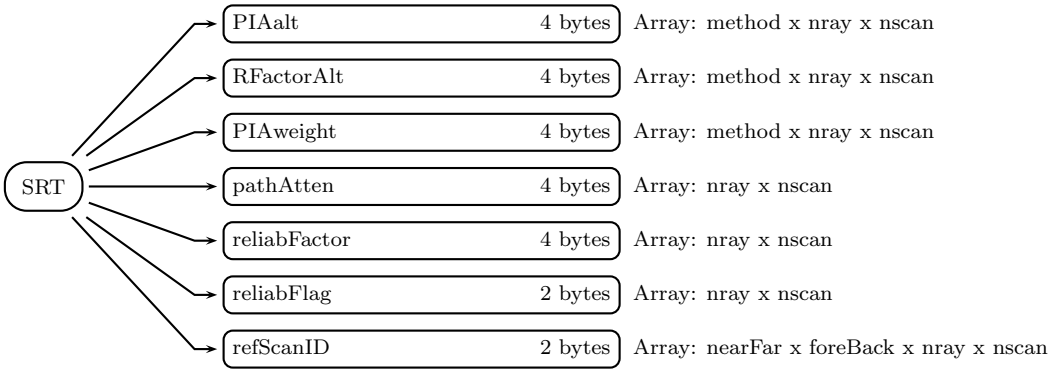


Figure 385: Data Format Structure for 2ADPR, NS, SRT

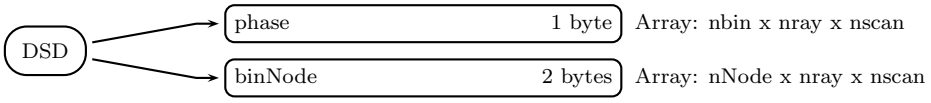


Figure 386: Data Format Structure for 2ADPR, NS, DSD

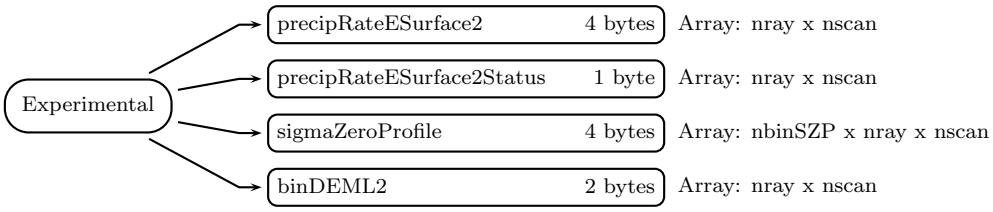


Figure 387: Data Format Structure for 2ADPR, NS, Experimental

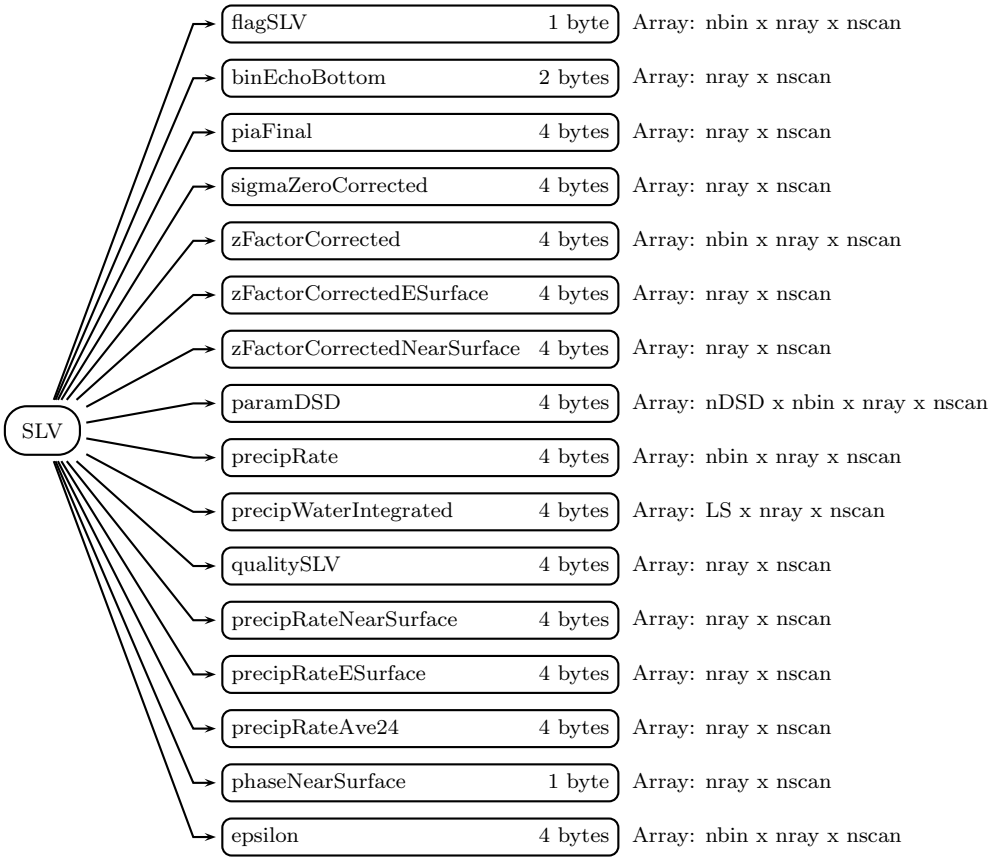


Figure 388: Data Format Structure for 2ADPR, NS, SLV

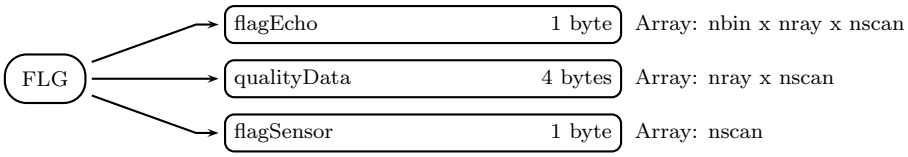


Figure 389: Data Format Structure for 2ADPR, NS, FLG

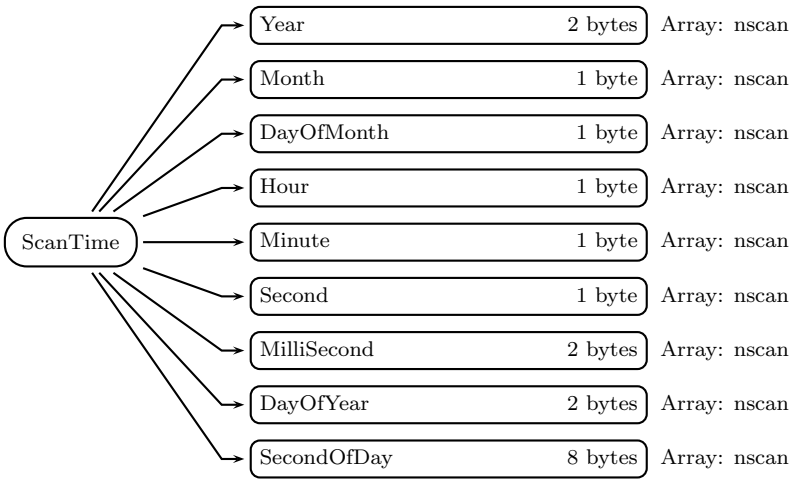


Figure 390: Data Format Structure for 2ADPR, MS, ScanTime

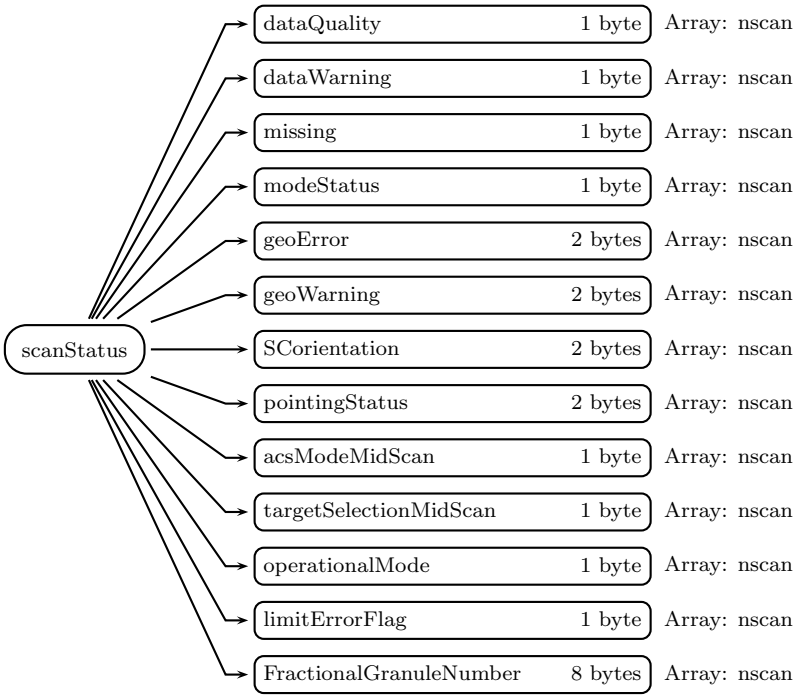


Figure 391: Data Format Structure for 2ADPR, MS, scanStatus

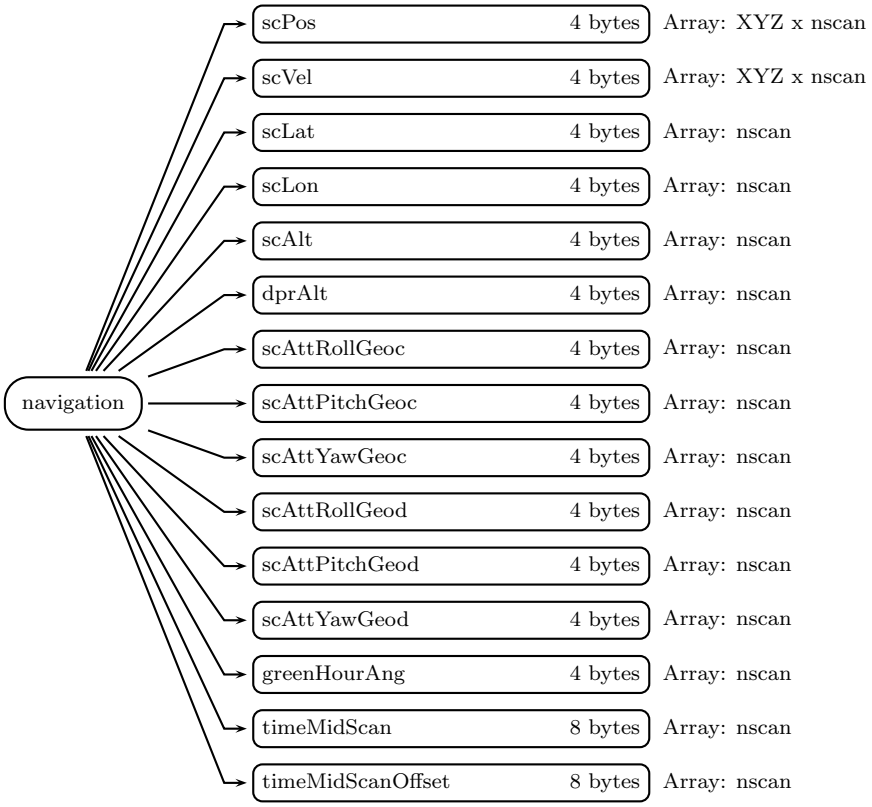


Figure 392: Data Format Structure for 2ADPR, MS, navigation

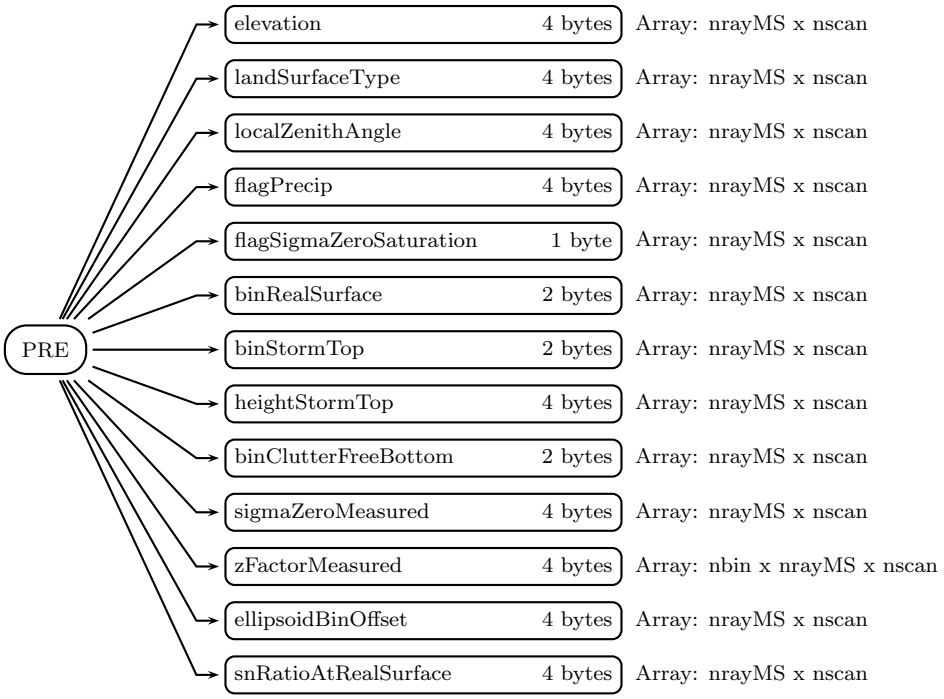


Figure 393: Data Format Structure for 2ADPR, MS, PRE

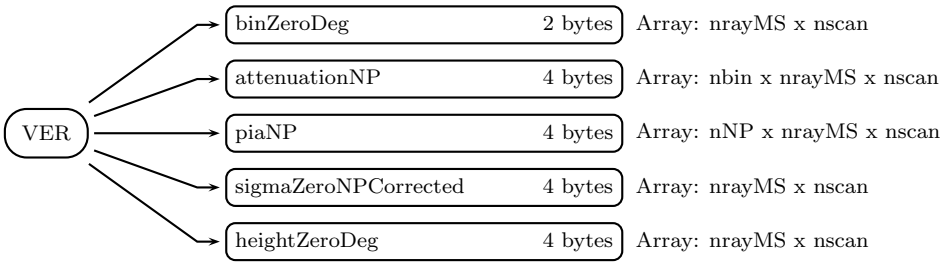


Figure 394: Data Format Structure for 2ADPR, MS, VER

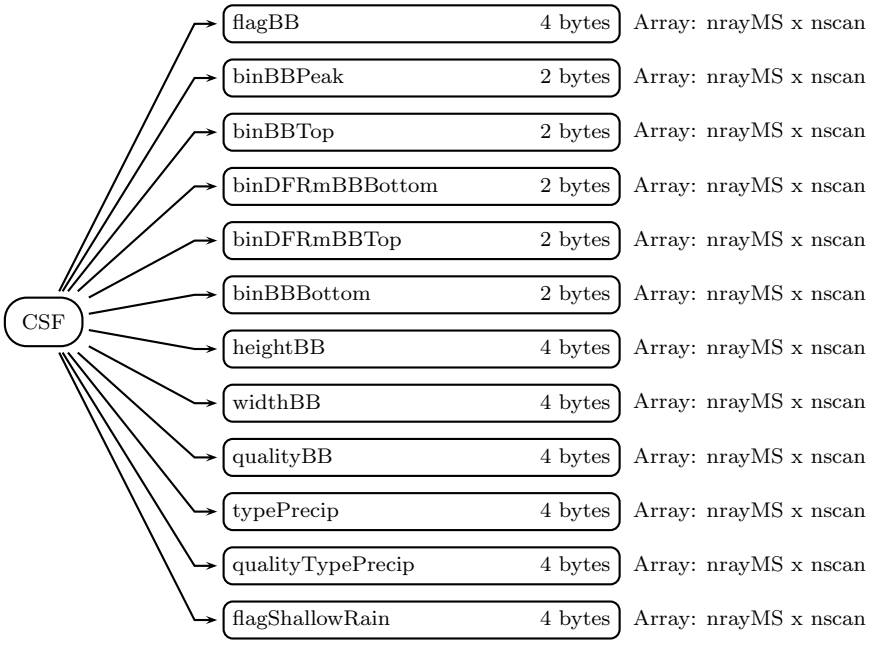


Figure 395: Data Format Structure for 2ADPR, MS, CSF

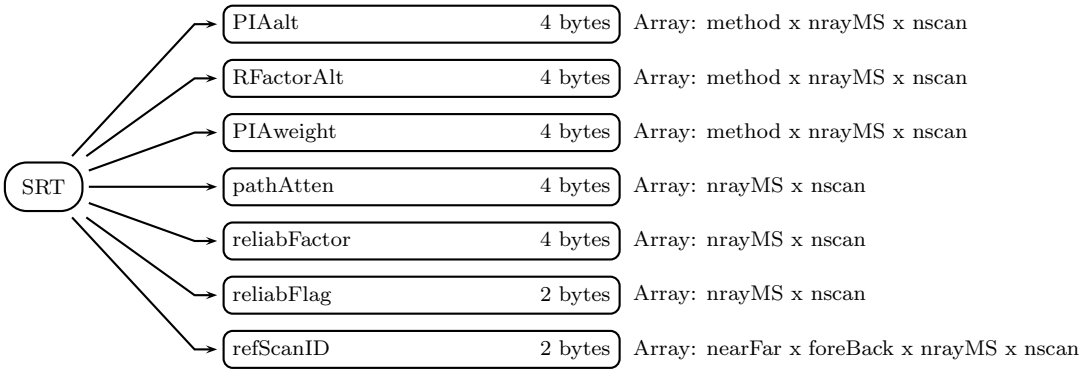


Figure 396: Data Format Structure for 2ADPR, MS, SRT

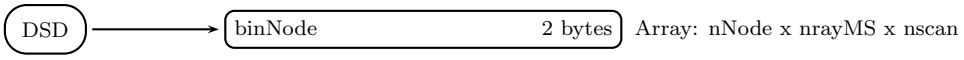


Figure 397: Data Format Structure for 2ADPR, MS, DSD

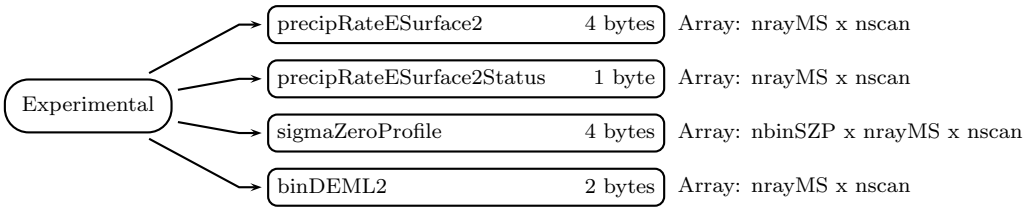


Figure 398: Data Format Structure for 2ADPR, MS, Experimental

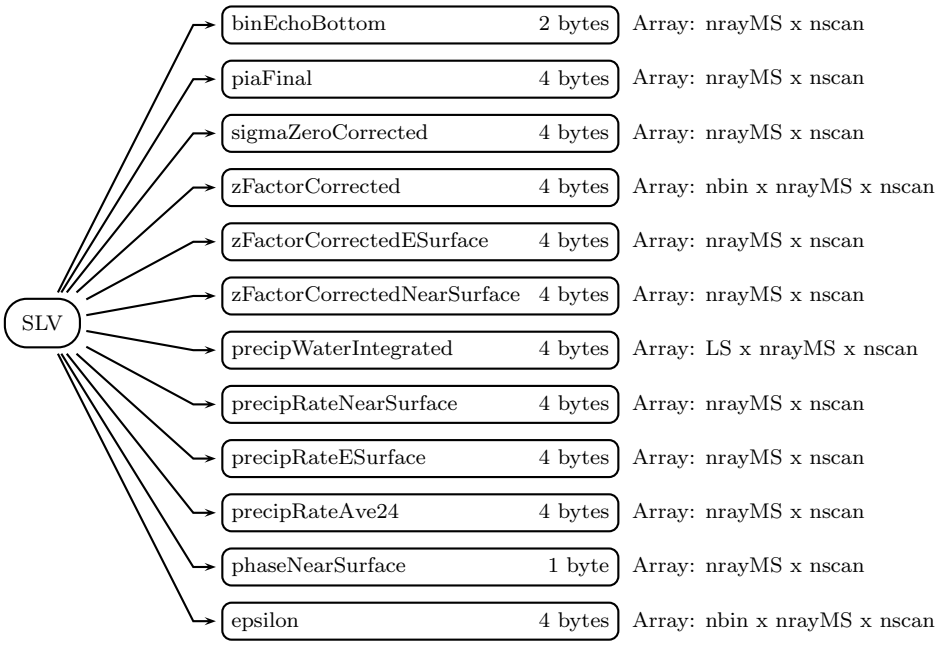


Figure 399: Data Format Structure for 2ADPR, MS, SLV

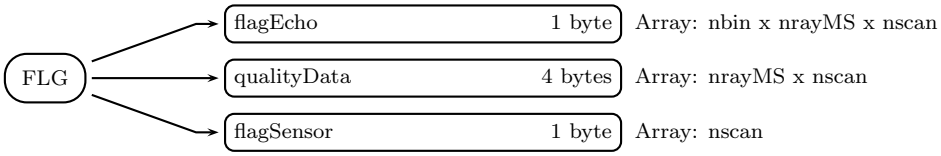


Figure 400: Data Format Structure for 2ADPR, MS, FLG

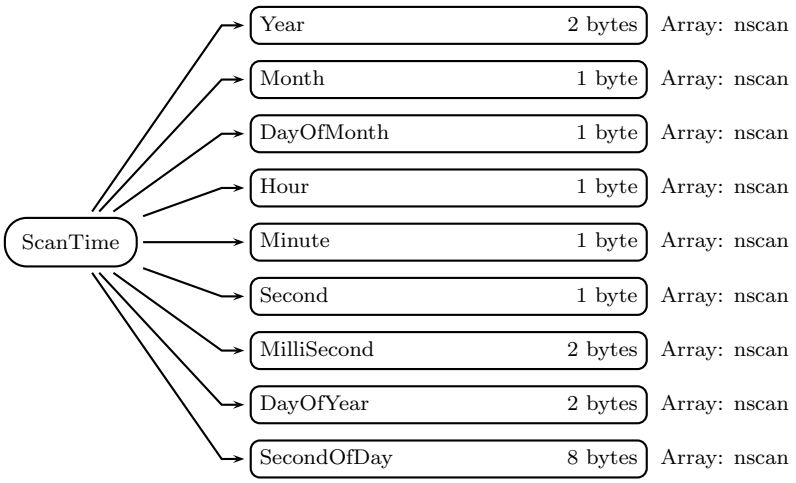


Figure 401: Data Format Structure for 2ADPR, HS, ScanTime

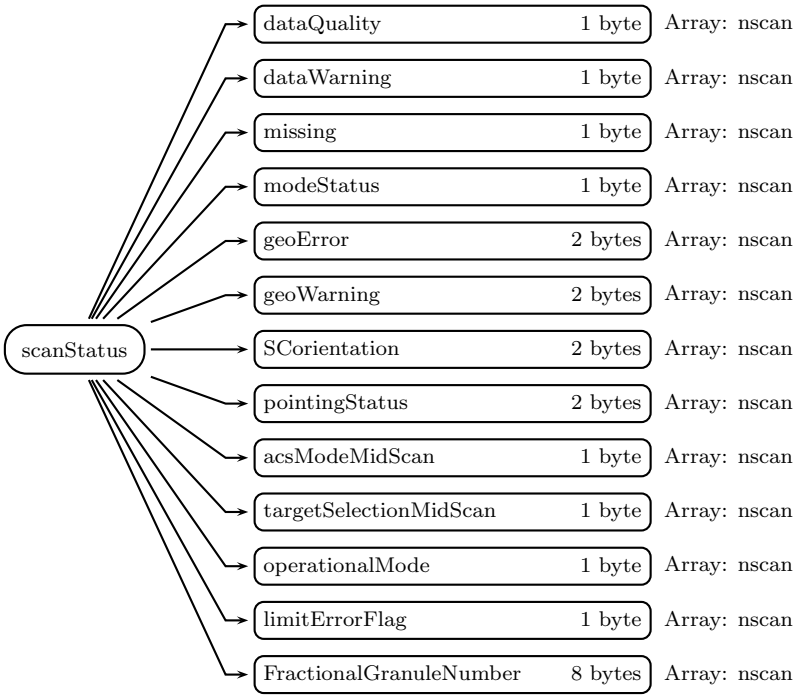


Figure 402: Data Format Structure for 2ADPR, HS, scanStatus

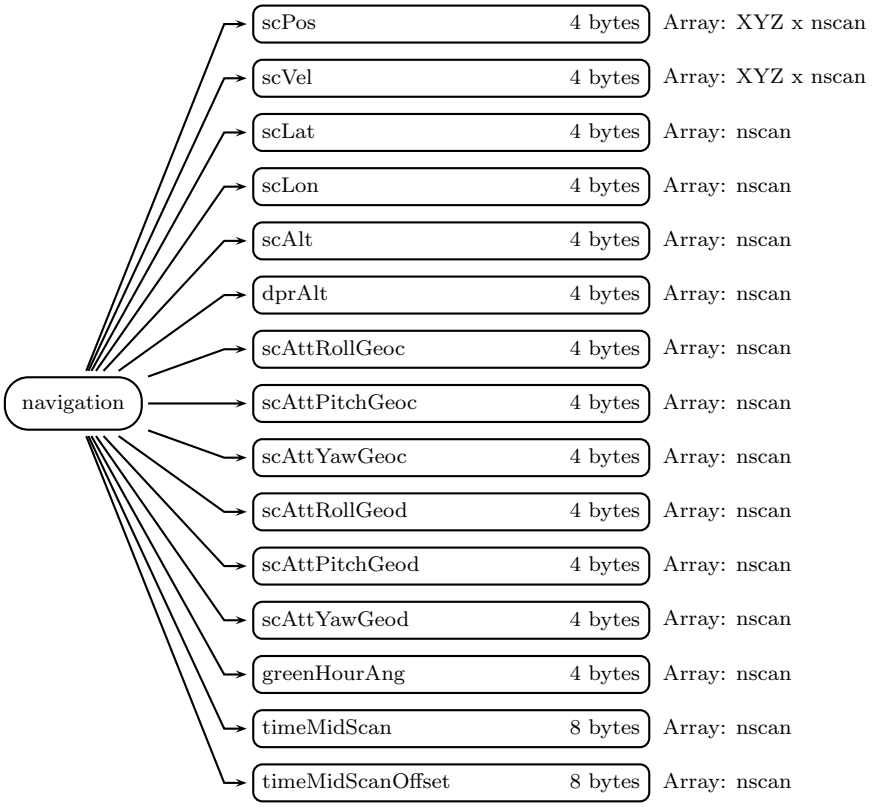


Figure 403: Data Format Structure for 2ADPR, HS, navigation

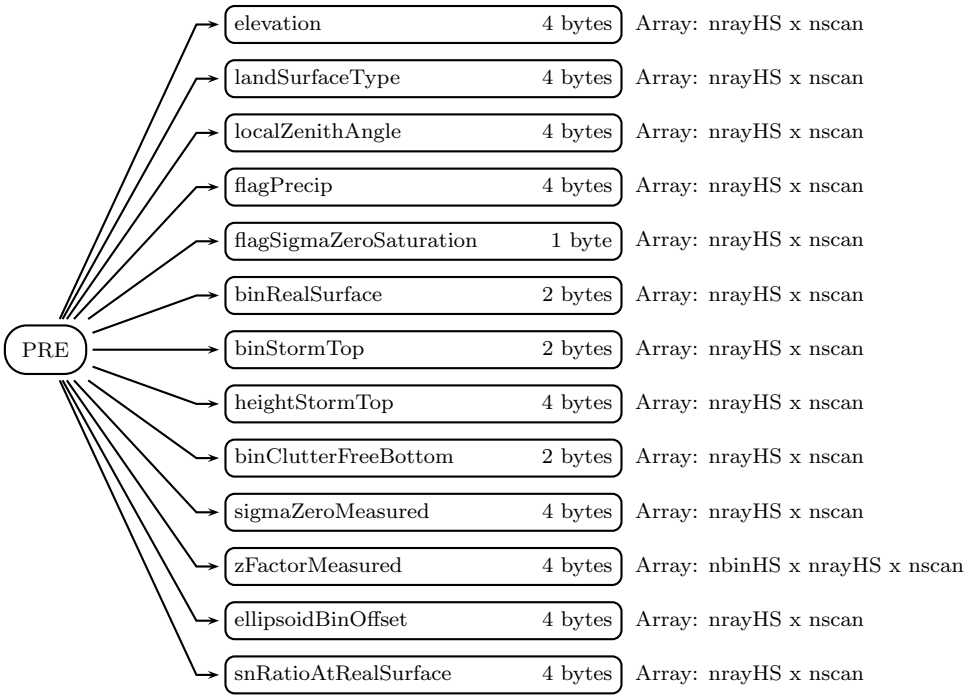


Figure 404: Data Format Structure for 2ADPR, HS, PRE

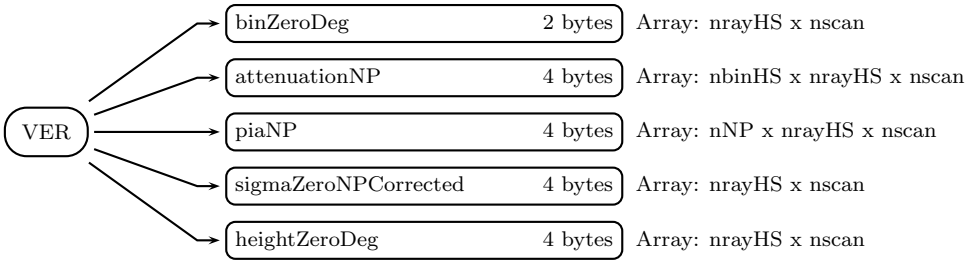


Figure 405: Data Format Structure for 2ADPR, HS, VER

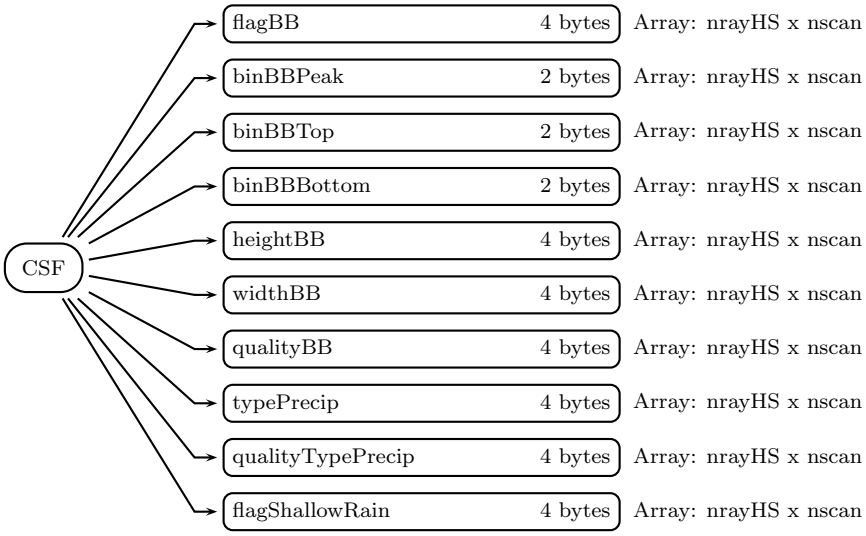


Figure 406: Data Format Structure for 2ADPR, HS, CSF

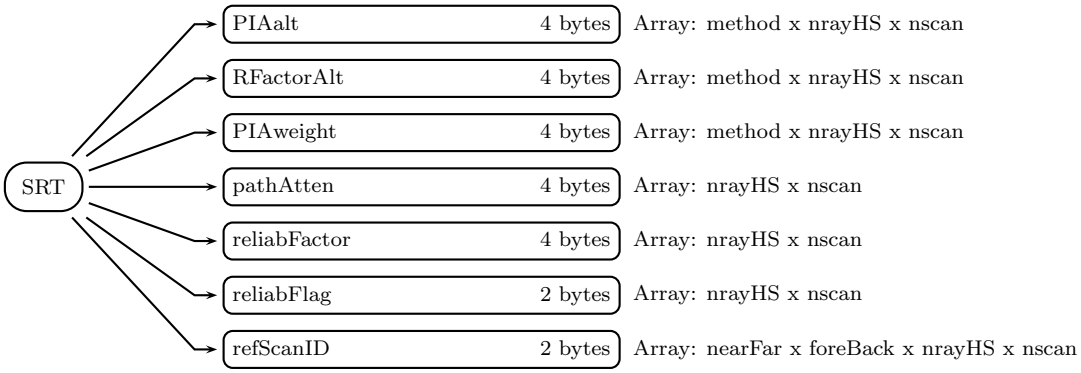


Figure 407: Data Format Structure for 2ADPR, HS, SRT

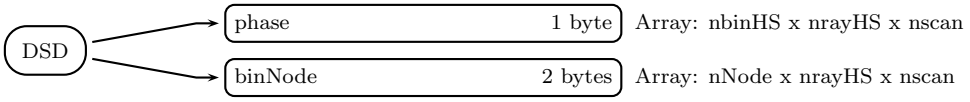


Figure 408: Data Format Structure for 2ADPR, HS, DSD

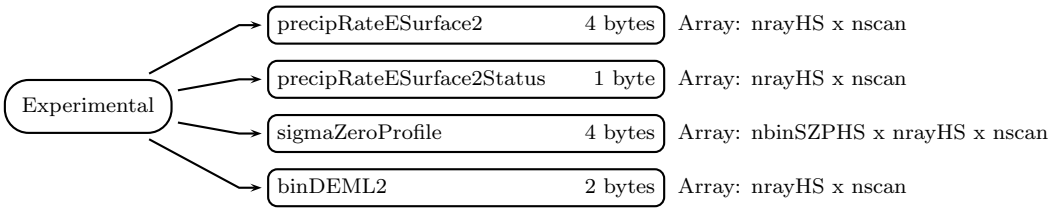


Figure 409: Data Format Structure for 2ADPR, HS, Experimental

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

AlgorithmRuntimeInfo (Metadata):
AlgorithmRuntimeInfo contains text runtime information written by the algorithm. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

NS (Swath)

NS_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

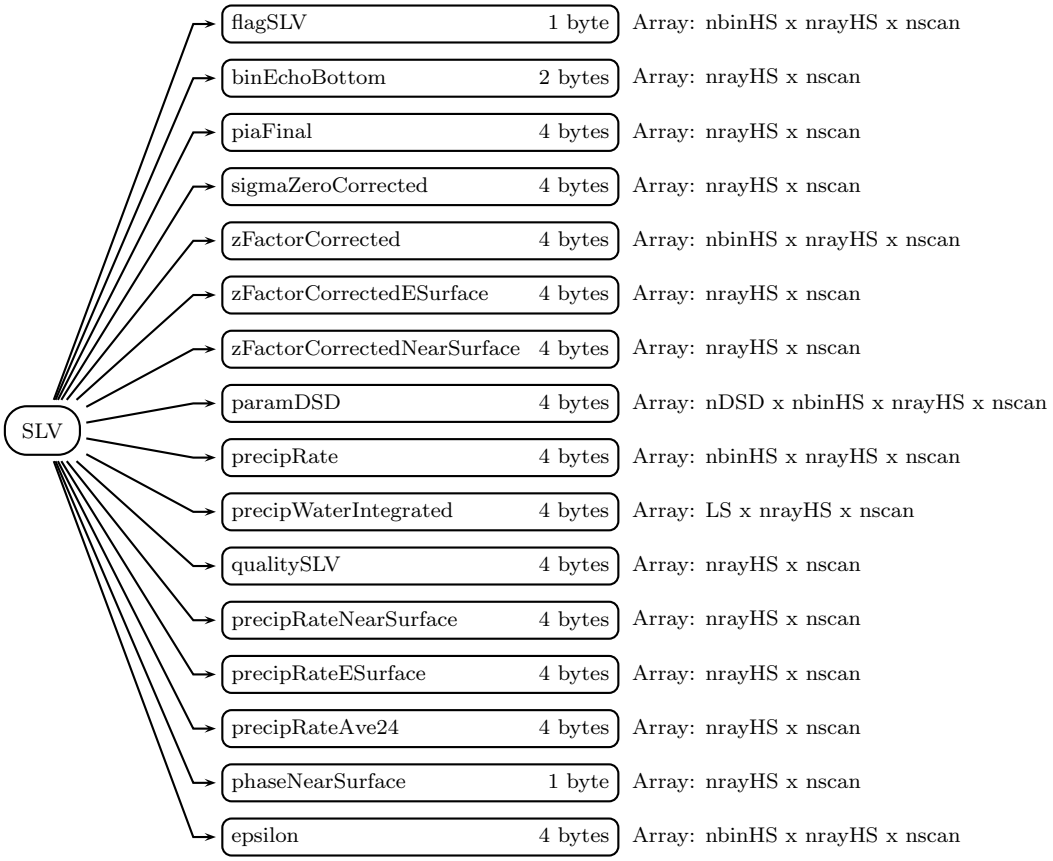


Figure 410: Data Format Structure for 2ADPR, HS, SLV

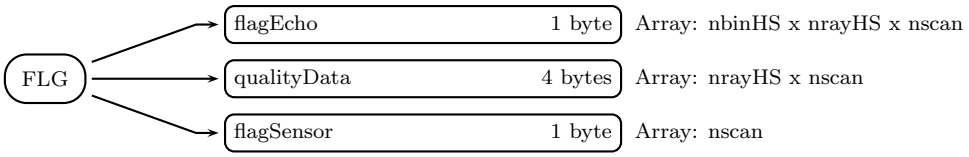


Figure 411: Data Format Structure for 2ADPR, HS, FLG

ScanTime (Group in NS)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nray x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nray x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod.

Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in NS)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nscan):
Flag of data warning for each scan.

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
```

```
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):

```
The operational mode of KuPR/KaPR stored in science telemetry.
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
7     Ku/Ka Standby VPRF Table OUT
8     Ku/Ka Standby Phase Out
9     Ku/Ka Standby Dump Out
10    Ku/Ka Standby (No Science Data)
11    Ku/Ka Independent Observation
12    Ku/Ka Independent External Calibration
13    Ku/Ka Independent Internal Calibration
14    Ku/Ka Independent SSPA Analysis
15    Ku/Ka Independent LNA Analysis
16    Ku/Ka Independent Health-Check
17    Ku/Ka Independent Standby VPRF Table OUT
18    Ku/Ka Independent Standby Phase Out
19    Ku/Ka Independent Standby Dump Out
20    Ku/Ka Independent Standby (No Science Data)
```

limitErrorFlag (1-byte integer, array size: nscan):

```
Bit flags for every ray with information
about echo power limit checks.
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group in NS)

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

PRE (Group in NS)

elevation (4-byte float, array size: nray x nscan):
Elevation of the measurement point. It is a copy of DEMHmean of level 1B product. Values are in m. Special values are defined as:
-9999.9 Missing value

landSurfaceType (4-byte integer, array size: nray x nscan):

```
Land surface type.

0 - 99     Ocean
100 - 199  Land
200 - 299  Coast
300 - 399  Inland water
-9999      Missing value
```

localZenithAngle (4-byte float, array size: nray x nscan):
Local zenith angle of each ray. It is a copy of scLocalZenith of level 1B product. Values are in degree. Special values are defined as:
-9999.9 Missing value

flagPrecip (4-byte integer, array size: nray x nscan):

```
Precipitation or no precipitation.

For L2 Ku and L2 Ka

0       No precipitation
1       Precipitation
-9999   Missing value


For L2 DPR

0       No precipitation by both Ku and Ka
1       Precipitation by Ka, no rain by Ku
10      Precipitation by Ku, no rain by Ka
11      Precipitation by both Ku and Ka
-9999   Missing value
```

flagSigmaZeroSaturation (1-byte char, array size: nray x nscan):

```
A flag to show whether echoPower is under a saturated
level or not at a range bin with a calculation of
sigmaZeroMeasured.  Values are:

0 : normal (under saturated level)
1 : possible saturated level at real surface
2 : saturated level at real surface
```

binRealSurface (2-byte integer, array size: nray x nscan):
Range bin number for real surface. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

binStormTop (2-byte integer, array size: nray x nscan):
Range bin number for the storm top. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

heightStormTop (4-byte float, array size: nray x nscan):
Height of storm top. Values are in m. Special values are defined as:
-9999.9 Missing value

binClutterFreeBottom (2-byte integer, array size: nray x nscan):
Range bin number for clutter free bottom. Special values are defined as:
-9999 Missing value

sigmaZeroMeasured (4-byte float, array size: nray x nscan):
Surface backscattering cross section without attenuation correction (as measured). Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorMeasured (4-byte float, array size: nbin x nray x nscan):
Vertical profile of reflectivity factor without attenuation correction (as measured). Values are in dBZ. Special values are defined as:
-9999.9 Missing value

ellipsoidBinOffset (4-byte float, array size: nray x nscan):
Distance between the ellipsoid and a center range bin of binEllipsoid defined by level 1B algorithm.

```
ellipsoidBinOffset =
```

```
    scRangeEllipsoid - { startBinRange + (binEllipsoid-1) x rangeBinSize}

scRangeEllipsoid : Distance between a sensor and the ellipsoid [m]
startBinRange : Distance between a sensor and a center
                of the highest observed range bin [m]
binEllipsoid : Range bin number of the Ellipsoid (1 - 260)
rangeBinSize : Range bin size [m]

-9999   Missing value
```

snRatioAtRealSurface (4-byte float, array size: nray x nscan):
Signal/Noise ratio at real surface range bin.

```
snRatioAtRealSurface =
    10.*log10(echoPowertrueV[mW]/noisePowertrueV[mW])

-9999   Missing value
```

VER (Group in NS)

binZeroDeg (2-byte integer, array size: nray x nscan):

```
Range bin number with 0 degrees C level.
For NS and MS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 176 at the Ellipsoid.
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
Special values are:
177: temperature at a surface is below 0 deg. C in Ku, KaMS, DPR(NS, MS).
89: temperature at a surface is below 0 deg. C in KaHS, DPR(HS).
```

attenuationNP (4-byte float, array size: nbin x nray x nscan):
Vertical profile of attenuation by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB/km. Special values are defined as:
-9999.9 Missing value

piaNP (4-byte float, array size: nNP x nray x nscan):
Path integrated attenuation caused by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroNPCorrected (4-byte float, array size: nray x nscan):
Surface backscattering cross section with attenuation correction only for non-precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

heightZeroDeg (4-byte float, array size: nray x nscan):
Height of freezing level (0 degrees C level) Values are in m. Special values are defined as:
-9999.9 Missing value

CSF (Group in NS)

flagBB (4-byte integer, array size: nray x nscan):
Bright band (BB) exists or not.

```
0      BB not detected
1      BB detected
-1111  No rain value
-9999  Missing value
```

binBBPeak (2-byte integer, array size: nray x nscan):
Range bin number for the peak of bright band. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

binBBTop (2-byte integer, array size: nray x nscan):
Range bin number for the top of bright band. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

binBBBottom (2-byte integer, array size: nray x nscan):
Range bin number for the bottom of bright band. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

heightBB (4-byte float, array size: nray x nscan):
Height of bright band. Values are in m. Special values are defined as:
-9999.9 Missing value

widthBB (4-byte float, array size: nray x nscan):
The width of bright band. Values are in m. Special values are defined as:
-9999.9 Missing value

qualityBB (4-byte integer, array size: nray x nscan):

```
Quality of the bright band.

1      Good
0      BB not detected in the case of rain
-1111  No rain value
-9999  Missing value
```

typePrecip (4-byte integer, array size: nray x nscan):
Precipitation type is expressed by an 8-digit number. The three major rain categories, stratiform, onvective, and other, can be obtained as follows:

```
When typePrecip is greater than zero,
Major rain type = typePrecip/10000000
     = 1    stratiform
     = 2    convective
     = 3    other

-1111  No rain value
-9999  Missing value
```

In the DPR product, rain type by the CSU's DFRm (measured dual frequency ratio) method is also included in typePrecip and can be obtained as follows:

```
DFRm rain type = (typePrecip%10000000)/1000000 in C
DFRm rain type = (MOD(typePrecip,10000000)/1000000 in FORTRAN

DFRm rain type
     = 1    stratiform
     = 2    convective
     = 4    transition
     = 9    DFRm method cannot be applicable (in this case
       the conventional method determines the major rain type)

-1111  No rain value
-9999  Missing value
```

qualityTypePrecip (4-byte integer, array size: nray x nscan):

```
Quality of the precipitation type.

1      Good
-1111  No rain value
-9999  Missing value
```

flagShallowRain (4-byte integer, array size: nray x nscan):

```
Type of shallow rain
0      No shallow rain
10     Shallow isolated (maybe)
11     Shallow isolated (certain)
20     Shallow non-isolated (maybe)
21     Shallow non-isolated (certain)
-1111  No rain value
-9999  Missing value
```

SRT (Group in NS)

PIAalt (4-byte float, array size: method x nray x nscan):
The two-way path integrated attenuation (PIA) at from the each method estimate. The path-integrated attenuation from the jth method, where

PIAalt (j=1) = PIA_Ku from forward along-track spatial at kth angle bin
PIAalt (j=2) = PIA_Ku from backward along-track spatial at kth angle bin
PIAalt (j=3) = PIA_Ku from forward hybrid at kth angle bin
PIAalt (j=4) = PIA_Ku from backward hybrid at kth angle bin
PIAalt (j=5) = PIA_Ku from temporal reference at kth angle bin
PIAalt (j=6) = PIA_Ku from light-rain temporal reference at kth angle bin

Values are in dB. Special values are defined as:
-9999.9 Missing value

RFactorAlt (4-byte float, array size: method x nray x nscan):
The reliability factors associated with the individual PIA estimates corresponding to PIAalt. Special values are defined as:
-9999.9 Missing value

PIAweight (4-byte float, array size: method x nray x nscan):
The weights of the individual PIA_Ku estimates used in deriving the effective path attenuation estimate, pathAtten. The sum of the weights should equal one. Where j is method and sigma_j is the standard deviation of reference data for method j.

PIAweight_j = 1/sigma_j^2 * (1/Sum_j(1/sigma_j^2))

Special values are defined as:
-9999.9 Missing value

pathAtten (4-byte float, array size: nray x nscan):
The effective 2-way path integrated attenuation. Values are in dB. Special values are defined as:
-9999.9 Missing value

reliabFactor (4-byte float, array size: nray x nscan):
Reliability Factor for the effective PIA estimate, pathAtten. Special values are defined as:
-9999.9 Missing value

reliabFlag (2-byte integer, array size: nray x nscan):
The reliability flag for the effective PIA estimate (pathAtten) based on the reliability factor (Rel_eff) in reliabFactor. Reliability Flag is:

= 1 if Rel_eff > 3 ; PIAeff estimate is considered reliable
= 2 if 3 ≥ Rel_eff > 1 ; PIAeff estimate is considered marginally reliable
= 3 if Rel_eff ≤ 1 ; PIAeff is unreliable
= 4 if SNR_at surface < 2dB; provides a lower bound to the path-attenuation
= 9 (no-rain case)

Special values are defined as:
-9999 Missing value

refScanID (2-byte integer, array size: nearFar x foreBack x nray x nscan):
The number of scan lines between the current scan and the beginning (or end) of the along-track reference data at each angle bin. The values are computed by the equation: Current Scan Number - Reference Scan Number. The values are positive for the Forward estimates and negative for the Backward estimates. The Fortran indices for nearFar foreBack are:

```
1,1 - Forward - Near reference
2,1 - Forward - Far reference
1,2 - Backward - Near reference
2,2 - Backward - Far reference
```

Special values are defined as:
-9999 Missing value

DSD (Group in NS)

phase (1-byte char, array size: nbin x nray x nscan):
Phase state of the precipitation. As an unsigned byte value this represents:

```
phase < 100 Temperature(C)=phase-100
phase > 200 Temperature(C)=phase-200
phase = 100 Top of the bright band
phase = 200 Bottom of the bright band
phase = 125 is used for the range bins between
                       the top and peak of bright band
phase = 175 is used for the range bins between
                       the peak and bottom of bright band

Integer values of phase/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

binNode (2-byte integer, array size: nNode x nray x nscan):

```
The bin number of the 5 nodes defined as:

0 - Bin number of storm top.
1 - Stratiform: 500m above center of bright band.
    Convective: 750m above 0deg C level.
2 - Stratiform: center of bright band.
    Convective: 0deg C level.
3 - Stratiform: 500m below center of bright band.
    Convective: 750m below 0deg C level.
4 - Bin number of real surface equal to
    binRealSurface in PRE group.
For NS and MS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 176 at the Ellipsoid.
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
-9999 - Missing
```

Experimental (Group in NS)

precipRateESurface2 (4-byte float, array size: nray x nscan):
Estimates Surface Precipitation using alternate method. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface2Status (1-byte char, array size: nray x nscan):
Status of the estimated surface precipitation using alternate method. Special values are defined as:
255 Missing value

sigmaZeroProfile (4-byte float, array size: nbinSZP x nray x nscan):
Surface backscattering cross section profile around the current ifov. Values are in dB. Special values are defined as:
-9999.9 Missing value

binDEML2 (2-byte integer, array size: nray x nscan):
Range bin number of the digital elevation model surface estimate. Special values are defined as:
-9999 Missing value

SLV (Group in NS)

flagSLV (1-byte integer, array size: nbin x nray x nscan):
Special values are defined as:
-99 Missing value

binEchoBottom (2-byte integer, array size: nray x nscan):
For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

piaFinal (4-byte float, array size: nray x nscan):
The final estimates of path integrated attenuation caused by precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroCorrected (4-byte float, array size: nray x nscan):
Surface backscatter cross section with attenuation correction. Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorCorrected (4-byte float, array size: nbin x nray x nscan):
Vertical profile of reflectivity factor with attenuation correction. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorCorrectedESurface (4-byte float, array size: nray x nscan):
Reflectivity factor with attenuation correction at estimated surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorCorrectedNearSurface (4-byte float, array size: nray x nscan):
Reflectivity factor with attenuation correction at near surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

paramDSD (4-byte float, array size: nDSD x nbin x nray x nscan):
Parameters of the drop size distribution. The first index is dBNw; the second index is Dm in mm. Special values are defined as:
-9999.9 Missing value

precipRate (4-byte float, array size: nbin x nray x nscan):
Precipitation rate. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipWaterIntegrated (4-byte float, array size: LS x nray x nscan):
Precipitation water vertically integrated. Values are in g/m^2. Special values are defined as:
-9999.9 Missing value

qualitySLV (4-byte integer, array size: nray x nscan):
A flag to show methods in which precipRateNearSurface is retrieved. Special values are defined as:
-9999 Missing value

precipRateNearSurface (4-byte float, array size: nray x nscan):
Precipitation rate for the near surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface (4-byte float, array size: nray x nscan):
Precipitation rate for the estimated surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateAve24 (4-byte float, array size: nray x nscan):
Average of precipitation rate for 2 to 4km height. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

phaseNearSurface (1-byte char, array size: nray x nscan):
Phase state of the precipitation at the Near-surface level. This is a copy of the phase in the DSD group at the Near-surface level. As an unsigned byte value this represents:

```
phaseNearSurface < 100 Temperature(C)=phaseNearSurface-100
phaseNearSurface > 200 Temperature(C)=phaseNearSurface-200
phaseNearSurface = 100 Top of the bright band
phaseNearSurface = 200 Bottom of the bright band
phaseNearSurface = 125 is used for the range bins between
                       the top and peak of bright band
phaseNearSurface = 175 is used for the range bins between
                       the peak and bottom of bright band

Integer values of phaseNearSurface/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

epsilon (4-byte float, array size: nbin x nray x nscan):
Epsilon is the indication of the adjustment away from the initial drop size distribution, epsilon = 1 is no adjustment. Special values are defined as:
-9999.9 Missing value

FLG (Group in NS)

flagEcho (1-byte integer, array size: nbin x nray x nscan):

```
Flag of precipitation and main/side lobe clutter
information of each range bin.

Bit  Meaning
0    For L2 Ku:  Precipitation judged by L2 Ku algorithm (copy of bit 2)
0    For L2 Ka:  Precipitation judged by L2 Ka algorithm (copy of bit 3)
0    For L2 DPR:  Precipitation judged by L2 DPR algorithm (copy of bit 1)
1    Precipitation judged by L2 DPR algorithm
2    Precipitation judged by L2 Ku algorithm
3    Precipitation judged by L2 Ka algorithm
4    Main lobe clutter judged by L2 Ku algorithm
5    Main lobe clutter judged by L2 Ka algorithm
```

```
6    Side lobe clutter judged by L2 Ku algorithm
7    Side lobe clutter judged by L2 Ka algorithm
```

qualityData (4-byte integer, array size: nray x nscan):
Normal data gives "0". Non-zero values mean the kinds of errors. Special values are defined as:
-9999 Missing value

```
Flag of quality data.  Bit range from 8 to 23
contains flags by each module.  Each module flag
has 2 bits of information.

The 2 bit flag for each module has values:
[higher bit    lower bit]
[0 0]  Good
[0 1]  Warning but usable
[1 0]  NG or error

The bits of qualityData are assigned as follows:

Bit      Meaning
0 - 7    Copy of dataQuality in level 1B product
8 - 9    Flag by input module
10 - 11  Flag by preparation module
12 - 13  Flag by vertical module
14 - 15  Flag by classification module
16 - 17  Flag by SRT module
18 - 19  Flag by DSD module
20 - 21  Flag by solver module
22 - 23  Flag by output module
24 - 31  Spare
```

flagSensor (1-byte integer, array size: nscan):

```
Flag of input Ku/Ka data condition.

Value  Meaning
1      Valid
-99    Invalid (judged by dataQuality)
```

MS (Swath)

MS_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in MS)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nrayMS x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are

defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nrayMS x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in MS)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nscan):
Flag of data warning for each scan.

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
```

```
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
```

```
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
```

```
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):

```
The operational mode of KuPR/KaPR stored in science telemetry.
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
7     Ku/Ka Standby VPRF Table OUT
8     Ku/Ka Standby Phase Out
9     Ku/Ka Standby Dump Out
10    Ku/Ka Standby (No Science Data)
11    Ku/Ka Independent Observation
12    Ku/Ka Independent External Calibration
13    Ku/Ka Independent Internal Calibration
14    Ku/Ka Independent SSPA Analysis
15    Ku/Ka Independent LNA Analysis
16    Ku/Ka Independent Health-Check
17    Ku/Ka Independent Standby VPRF Table OUT
18    Ku/Ka Independent Standby Phase Out
19    Ku/Ka Independent Standby Dump Out
20    Ku/Ka Independent Standby (No Science Data)
```

limitErrorFlag (1-byte integer, array size: nscan):

```
Bit flags for every ray with information
about echo power limit checks.
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group in MS)

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

PRE (Group in MS)

elevation (4-byte float, array size: nrayMS x nscan):
Elevation of the measurement point. It is a copy of DEMHmean of level 1B product. Values are in m. Special values are defined as:
-9999.9 Missing value

landSurfaceType (4-byte integer, array size: nrayMS x nscan):

```
Land surface type.

0 - 99     Ocean
100 - 199  Land
200 - 299  Coast
300 - 399  Inland water
-9999      Missing value
```

localZenithAngle (4-byte float, array size: nrayMS x nscan):
Local zenith angle of each ray. It is a copy of scLocalZenith of level 1B product. Values are in degree. Special values are defined as:
-9999.9 Missing value

flagPrecip (4-byte integer, array size: nrayMS x nscan):

```
Precipitation or no precipitation.

For L2 Ku and L2 Ka

0       No precipitation
1       Precipitation
-9999   Missing value


For L2 DPR

0       No precipitation by both Ku and Ka
1       Precipitation by Ka, no rain by Ku
10      Precipitation by Ku, no rain by Ka
11      Precipitation by both Ku and Ka
-9999   Missing value
```

flagSigmaZeroSaturation (1-byte char, array size: nrayMS x nscan):

```
A flag to show whether echoPower is under a saturated
level or not at a range bin with a calculation of
sigmaZeroMeasured.  Values are:

0 : normal (under saturated level)
1 : possible saturated level at real surface
2 : saturated level at real surface
```

binRealSurface (2-byte integer, array size: nrayMS x nscan):
Range bin number for real surface. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

binStormTop (2-byte integer, array size: nrayMS x nscan):
Range bin number for the storm top. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

heightStormTop (4-byte float, array size: nrayMS x nscan):
Height of storm top. Values are in m. Special values are defined as:
-9999.9 Missing value

binClutterFreeBottom (2-byte integer, array size: nrayMS x nscan):
Range bin number for clutter free bottom. Special values are defined as:
-9999 Missing value

sigmaZeroMeasured (4-byte float, array size: nrayMS x nscan):
Surface backscattering cross section without attenuation correction (as measured). Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorMeasured (4-byte float, array size: nbin x nrayMS x nscan):
Vertical profile of reflectivity factor without attenuation correction (as measured). Values are in dBZ. Special values are defined as:
-9999.9 Missing value

ellipsoidBinOffset (4-byte float, array size: nrayMS x nscan):
Distance between the ellipsoid and a center range bin of binEllipsoid defined by level 1B algorithm.

```
ellipsoidBinOffset =
```

```
    scRangeEllipsoid - { startBinRange + (binEllipsoid-1) x rangeBinSize}

scRangeEllipsoid : Distance between a sensor and the ellipsoid [m]
startBinRange : Distance between a sensor and a center
                of the highest observed range bin [m]
binEllipsoid : Range bin number of the Ellipsoid (1 - 260)
rangeBinSize : Range bin size [m]

-9999   Missing value
```

snRatioAtRealSurface (4-byte float, array size: nrayMS x nscan):
Signal/Noise ratio at real surface range bin.

```
snRatioAtRealSurface =
    10.*log10(echoPowertrueV[mW]/noisePowertrueV[mW])

-9999   Missing value
```

VER (Group in MS)

binZeroDeg (2-byte integer, array size: nrayMS x nscan):

```
Range bin number with 0 degrees C level.
For NS and MS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 176 at the Ellipsoid.
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
Special values are:
177: temperature at a surface is below 0 deg. C in Ku, KaMS, DPR(NS, MS).
89: temperature at a surface is below 0 deg. C in KaHS, DPR(HS).
```

attenuationNP (4-byte float, array size: nbin x nrayMS x nscan):
Vertical profile of attenuation by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB/km. Special values are defined as:
-9999.9 Missing value

piaNP (4-byte float, array size: nNP x nrayMS x nscan):
Path integrated attenuation caused by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroNPCorrected (4-byte float, array size: nrayMS x nscan):
Surface backscattering cross section with attenuation correction only for non-precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

heightZeroDeg (4-byte float, array size: nrayMS x nscan):
Height of freezing level (0 degrees C level) Values are in m. Special values are defined as:
-9999.9 Missing value

CSF (Group in MS)

flagBB (4-byte integer, array size: nrayMS x nscan):
Bright band (BB) exists or not.

```
0      BB not detected
1      BB detected
-1111  No rain value
-9999  Missing value
```

binBBPeak (2-byte integer, array size: nrayMS x nscan):
Range bin number for the peak of bright band. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

binBBTop (2-byte integer, array size: nrayMS x nscan):
Range bin number for the top of bright band. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

binDFRmBBBottom (2-byte integer, array size: nrayMS x nscan):
Range bin number for the bottom of bright band detected by the DFRm method. Special values are defined as:
-9999 Missing value

binDFRmBBTop (2-byte integer, array size: nrayMS x nscan):
Range bin number for the top of bright band detected by the DFRm method. Special

values are defined as:
-9999 Missing value

binBBBottom (2-byte integer, array size: nrayMS x nscan):
Range bin number for the bottom of bright band. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

heightBB (4-byte float, array size: nrayMS x nscan):
Height of bright band. Values are in m. Special values are defined as:
-9999.9 Missing value

widthBB (4-byte float, array size: nrayMS x nscan):
The width of bright band. Values are in m. Special values are defined as:
-9999.9 Missing value

qualityBB (4-byte integer, array size: nrayMS x nscan):

```
Quality of the bright band.

1      Good
0      BB not detected in the case of rain
-1111  No rain value
-9999  Missing value
```

typePrecip (4-byte integer, array size: nrayMS x nscan):
Precipitation type is expressed by an 8-digit number. The three major rain categories, stratiform, onvective, and other, can be obtained as follows:

```
When typePrecip is greater than zero,
Major rain type = typePrecip/10000000
     = 1    stratiform
     = 2    convective
     = 3    other

-1111  No rain value
-9999  Missing value
```

In the DPR product, rain type by the CSU's DFRm (measured dual frequency ratio) method is also included in typePrecip and can be obtained as follows:

```
DFRm rain type = (typePrecip%10000000)/1000000 in C
DFRm rain type = (MOD(typePrecip,10000000)/1000000 in FORTRAN
```

```
DFRm rain type
     = 1    stratiform
     = 2    convective
     = 4    transition
     = 9    DFRm method cannot be applicable (in this case
       the conventional method determines the major rain type)

-1111  No rain value
-9999  Missing value
```

qualityTypePrecip (4-byte integer, array size: nrayMS x nscan):

```
Quality of the precipitation type.

1      Good
-1111  No rain value
-9999  Missing value
```

flagShallowRain (4-byte integer, array size: nrayMS x nscan):

```
Type of shallow rain
0      No shallow rain
10     Shallow isolated (maybe)
11     Shallow isolated (certain)
20     Shallow non-isolated (maybe)
21     Shallow non-isolated (certain)
-1111  No rain value
-9999  Missing value
```

SRT (Group in MS)

PIAalt (4-byte float, array size: method x nrayMS x nscan):
The two-way path integrated attenuation (PIA) at from the each method estimate. The path-integrated attenuation from the jth method, where

PIAalt (j=1) = PIA_Ku from forward along-track spatial at kth angle bin
PIAalt (j=2) = PIA_Ku from backward along-track spatial at kth angle bin
PIAalt (j=3) = PIA_Ku from forward hybrid at kth angle bin
PIAalt (j=4) = PIA_Ku from backward hybrid at kth angle bin
PIAalt (j=5) = PIA_Ku from temporal reference at kth angle bin
PIAalt (j=6) = PIA_Ku from light-rain temporal reference at kth angle bin

Values are in dB. Special values are defined as:
-9999.9 Missing value

RFactorAlt (4-byte float, array size: method x nrayMS x nscan):
The reliability factors associated with the individual PIA estimates corresponding to PIAalt. Special values are defined as:
-9999.9 Missing value

PIAweight (4-byte float, array size: method x nrayMS x nscan):
The weights of the individual PIA_Ku estimates used in deriving the effective path attenuation estimate, pathAtten. The sum of the weights should equal one. Where j is method and sigma_j is the standard deviation of reference data for method j.

PIAweight_j = 1/sigma_j^2 * (1/Sum_j(1/sigma_j^2))

Special values are defined as:
-9999.9 Missing value

pathAtten (4-byte float, array size: nrayMS x nscan):
The effective 2-way path integrated attenuation. Values are in dB. Special values are defined as:
-9999.9 Missing value

reliabFactor (4-byte float, array size: nrayMS x nscan):
Reliability Factor for the effective PIA estimate, pathAtten. Special values are defined as:
-9999.9 Missing value

reliabFlag (2-byte integer, array size: nrayMS x nscan):
The reliability flag for the effective PIA estimate (pathAtten) based on the reliability factor (Rel_eff) in reliabFactor. Reliability Flag is:

= 1 if Rel_eff > 3 ; PIAeff estimate is considered reliable
= 2 if 3 ≥ Rel_eff > 1 ; PIAeff estimate is considered marginally reliable
= 3 if Rel_eff ≤ 1 ; PIAeff is unreliable
= 4 if SNR_at surface < 2dB; provides a lower bound to the path-attenuation
= 9 (no-rain case)

Special values are defined as:
-9999 Missing value

refScanID (2-byte integer, array size: nearFar x foreBack x nrayMS x nscan):
The number of scan lines between the current scan and the beginning (or end) of the along-track reference data at each angle bin. The values are computed by the equation: Current Scan Number - Reference Scan Number. The values are positive for the Forward estimates and negative for the Backward estimates. The Fortran indices for nearFar foreBack are:

```
1,1 - Forward - Near reference
2,1 - Forward - Far reference
1,2 - Backward - Near reference
```

```
2,2 - Backward - Far reference
```

Special values are defined as:
-9999 Missing value

DSD (Group in MS)

binNode (2-byte integer, array size: nNode x nrayMS x nscan):

```
The bin number of the 5 nodes defined as:

0 - Bin number of storm top.
1 - Stratiform: 500m above center of bright band.
    Convective: 750m above 0deg C level.
2 - Stratiform: center of bright band.
    Convective: 0deg C level.
3 - Stratiform: 500m below center of bright band.
    Convective: 750m below 0deg C level.
4 - Bin number of real surface equal to
    binRealSurface in PRE group.
For NS and MS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 176 at the Ellipsoid.
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
-9999 - Missing
```

Experimental (Group in MS)

precipRateESurface2 (4-byte float, array size: nrayMS x nscan):
Estimates Surface Precipitation using alternate method. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface2Status (1-byte char, array size: nrayMS x nscan):
Status of the estimated surface precipitation using alternate method. Special values are

defined as:
255 Missing value

sigmaZeroProfile (4-byte float, array size: nbinSZP x nrayMS x nscan):
Surface backscattering cross section profile around the current ifov. Values are in dB. Special values are defined as:
-9999.9 Missing value

binDEML2 (2-byte integer, array size: nrayMS x nscan):
Range bin number of the digital elevation model surface estimate. Special values are defined as:
-9999 Missing value

SLV (Group in MS)

binEchoBottom (2-byte integer, array size: nrayMS x nscan):
For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

piaFinal (4-byte float, array size: nrayMS x nscan):
The final estimates of path integrated attenuation caused by precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroCorrected (4-byte float, array size: nrayMS x nscan):
Surface backscatter cross section with attenuation correction. Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorCorrected (4-byte float, array size: nbin x nrayMS x nscan):
Vertical profile of reflectivity factor with attenuation correction. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorCorrectedESurface (4-byte float, array size: nrayMS x nscan):
Reflectivity factor with attenuation correction at estimated surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorCorrectedNearSurface (4-byte float, array size: nrayMS x nscan):
Reflectivity factor with attenuation correction at near surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

precipWaterIntegrated (4-byte float, array size: LS x nrayMS x nscan):
Precipitation water vertically integrated. Values are in g/m^2. Special values are defined as:
-9999.9 Missing value

precipRateNearSurface (4-byte float, array size: nrayMS x nscan):
Precipitation rate for the near surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface (4-byte float, array size: nrayMS x nscan):
Precipitation rate for the estimated surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateAve24 (4-byte float, array size: nrayMS x nscan):
Average of precipitation rate for 2 to 4km height. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

phaseNearSurface (1-byte char, array size: nrayMS x nscan):
Phase state of the precipitation at the Near-surface level. This is a copy of the phase in the DSD group at the Near-surface level. As an unsigned byte value this represents:

```
phaseNearSurface < 100 Temperature(C)=phaseNearSurface-100
phaseNearSurface > 200 Temperature(C)=phaseNearSurface-200
phaseNearSurface = 100 Top of the bright band
phaseNearSurface = 200 Bottom of the bright band
phaseNearSurface = 125 is used for the range bins between
                       the top and peak of bright band
phaseNearSurface = 175 is used for the range bins between
                       the peak and bottom of bright band

Integer values of phaseNearSurface/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

epsilon (4-byte float, array size: nbin x nrayMS x nscan):
Epsilon is the indication of the adjustment away from the initial drop size distribution, epsilon = 1 is no adjustment. Special values are defined as:
-9999.9 Missing value

FLG (Group in MS)

flagEcho (1-byte integer, array size: nbin x nrayMS x nscan):

```
Flag of precipitation and main/side lobe clutter
information of each range bin.

Bit  Meaning
0    For L2 Ku:  Precipitation judged by L2 Ku algorithm (copy of bit 2)
0    For L2 Ka:  Precipitation judged by L2 Ka algorithm (copy of bit 3)
0    For L2 DPR:  Precipitation judged by L2 DPR algorithm (copy of bit 1)
1    Precipitation judged by L2 DPR algorithm
2    Precipitation judged by L2 Ku algorithm
3    Precipitation judged by L2 Ka algorithm
4    Main lobe clutter judged by L2 Ku algorithm
5    Main lobe clutter judged by L2 Ka algorithm
6    Side lobe clutter judged by L2 Ku algorithm
7    Side lobe clutter judged by L2 Ka algorithm
```

qualityData (4-byte integer, array size: nrayMS x nscan):
Normal data gives "0". Non-zero values mean the kinds of errors. Special values are defined as:
-9999 Missing value

```
Flag of quality data.  Bit range from 8 to 23
contains flags by each module.  Each module flag
has 2 bits of information.

The 2 bit flag for each module has values:
[higher bit    lower bit]
[0 0]  Good
[0 1]  Warning but usable
[1 0]  NG or error

The bits of qualityData are assigned as follows:

Bit      Meaning
0 - 7    Copy of dataQuality in level 1B product
8 - 9    Flag by input module
10 - 11  Flag by preparation module
12 - 13  Flag by vertical module
14 - 15  Flag by classification module
16 - 17  Flag by SRT module
```

```
18 - 19  Flag by DSD module
20 - 21  Flag by solver module
22 - 23  Flag by output module
24 - 31  Spare
```

flagSensor (1-byte integer, array size: nscan):

```
Flag of input Ku/Ka data condition.

Value  Meaning
1      Valid
-99    Invalid (judged by dataQuality)
```

HS (Swath)

HS_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in HS)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nrayHS x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nrayHS x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in HS)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nscan):
Flag of data warning for each scan.

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment withing packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken

down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
```

```
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
```

```
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):

```
The operational mode of KuPR/KaPR stored in science telemetry.
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
7     Ku/Ka Standby VPRF Table OUT
8     Ku/Ka Standby Phase Out
9     Ku/Ka Standby Dump Out
10    Ku/Ka Standby (No Science Data)
11    Ku/Ka Independent Observation
12    Ku/Ka Independent External Calibration
13    Ku/Ka Independent Internal Calibration
14    Ku/Ka Independent SSPA Analysis
15    Ku/Ka Independent LNA Analysis
16    Ku/Ka Independent Health-Check
17    Ku/Ka Independent Standby VPRF Table OUT
18    Ku/Ka Independent Standby Phase Out
19    Ku/Ka Independent Standby Dump Out
20    Ku/Ka Independent Standby (No Science Data)
```

limitErrorFlag (1-byte integer, array size: nscan):

```
Bit flags for every ray with information
about echo power limit checks.
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group in HS)

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from

DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

PRE (Group in HS)

elevation (4-byte float, array size: nrayHS x nscan):
Elevation of the measurement point. It is a copy of DEMHmean of level 1B product. Values are in m. Special values are defined as:
-9999.9 Missing value

landSurfaceType (4-byte integer, array size: nrayHS x nscan):

```
Land surface type.

0 - 99     Ocean
100 - 199  Land
200 - 299  Coast
300 - 399  Inland water
-9999      Missing value
```

localZenithAngle (4-byte float, array size: nrayHS x nscan):
Local zenith angle of each ray. It is a copy of scLocalZenith of level 1B product. Values are in degree. Special values are defined as:
-9999.9 Missing value

flagPrecip (4-byte integer, array size: nrayHS x nscan):

```
Precipitation or no precipitation.

For L2 Ku and L2 Ka

0       No precipitation
1       Precipitation
-9999   Missing value


For L2 DPR

0       No precipitation by both Ku and Ka
1       Precipitation by Ka, no rain by Ku
10      Precipitation by Ku, no rain by Ka
11      Precipitation by both Ku and Ka
-9999   Missing value
```

flagSigmaZeroSaturation (1-byte char, array size: nrayHS x nscan):

```
A flag to show whether echoPower is under a saturated
level or not at a range bin with a calculation of
sigmaZeroMeasured.  Values are:

0 : normal (under saturated level)
1 : possible saturated level at real surface
2 : saturated level at real surface
```

binRealSurface (2-byte integer, array size: nrayHS x nscan):
Range bin number for real surface. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

binStormTop (2-byte integer, array size: nrayHS x nscan):
Range bin number for the storm top. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

heightStormTop (4-byte float, array size: nrayHS x nscan):
Height of storm top. Values are in m. Special values are defined as:
-9999.9 Missing value

binClutterFreeBottom (2-byte integer, array size: nrayHS x nscan):
Range bin number for clutter free bottom. Special values are defined as:
-9999 Missing value

sigmaZeroMeasured (4-byte float, array size: nrayHS x nscan):
Surface backscattering cross section without attenuation correction (as measured). Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorMeasured (4-byte float, array size: nbinHS x nrayHS x nscan):
Vertical profile of reflectivity factor without attenuation correction (as measured). Values are in dBZ. Special values are defined as:
-9999.9 Missing value

ellipsoidBinOffset (4-byte float, array size: nrayHS x nscan):
Distance between the ellipsoid and a center range bin of binEllipsoid defined by level 1B algorithm.

```
ellipsoidBinOffset =
    scRangeEllipsoid - { startBinRange + (binEllipsoid-1) x rangeBinSize}

scRangeEllipsoid : Distance between a sensor and the ellipsoid [m]
startBinRange : Distance between a sensor and a center
                of the highest observed range bin [m]
binEllipsoid : Range bin number of the Ellipsoid (1 - 260)
rangeBinSize : Range bin size [m]

-9999   Missing value
```

snRatioAtRealSurface (4-byte float, array size: nrayHS x nscan):
Signal/Noise ratio at real surface range bin.

```
snRatioAtRealSurface =
    10.*log10(echoPowertrueV[mW]/noisePowertrueV[mW])

-9999   Missing value
```

VER (Group in HS)

binZeroDeg (2-byte integer, array size: nrayHS x nscan):

```
Range bin number with 0 degrees C level.
For NS and MS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 176 at the Ellipsoid.
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
Special values are:
177: temperature at a surface is below 0 deg. C in Ku, KaMS, DPR(NS, MS).
89: temperature at a surface is below 0 deg. C in KaHS, DPR(HS).
```

attenuationNP (4-byte float, array size: nbinHS x nrayHS x nscan):
Vertical profile of attenuation by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB/km. Special values are defined as:
-9999.9 Missing value

piaNP (4-byte float, array size: nNP x nrayHS x nscan):
Path integrated attenuation caused by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroNPCorrected (4-byte float, array size: nrayHS x nscan):
Surface backscattering cross section with attenuation correction only for non-precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

heightZeroDeg (4-byte float, array size: nrayHS x nscan):
Height of freezing level (0 degrees C level) Values are in m. Special values are defined as:
-9999.9 Missing value

CSF (Group in HS)

flagBB (4-byte integer, array size: nrayHS x nscan):
Bright band (BB) exists or not.

```
0      BB not detected
1      BB detected
-1111  No rain value
-9999  Missing value
```

binBBPeak (2-byte integer, array size: nrayHS x nscan):
Range bin number for the peak of bright band. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

binBBTop (2-byte integer, array size: nrayHS x nscan):
Range bin number for the top of bright band. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

binBBBottom (2-byte integer, array size: nrayHS x nscan):
Range bin number for the bottom of bright band. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

heightBB (4-byte float, array size: nrayHS x nscan):
Height of bright band. Values are in m. Special values are defined as:
-9999.9 Missing value

widthBB (4-byte float, array size: nrayHS x nscan):
The width of bright band. Values are in m. Special values are defined as:
-9999.9 Missing value

qualityBB (4-byte integer, array size: nrayHS x nscan):

```
Quality of the bright band.

1      Good
0      BB not detected in the case of rain
-1111  No rain value
-9999  Missing value
```

typePrecip (4-byte integer, array size: nrayHS x nscan):
Precipitation type is expressed by an 8-digit number. The three major rain categories, stratiform, onvective, and other, can be obtained as follows:

```
When typePrecip is greater than zero,
Major rain type = typePrecip/10000000
     = 1    stratiform
     = 2    convective
```

```
     = 3    other

-1111  No rain value
-9999  Missing value
```

In the DPR product, rain type by the CSU's DFRm (measured dual frequency ratio) method is also included in typePrecip and can be obtained as follows:

```
DFRm rain type = (typePrecip%10000000)/1000000 in C
DFRm rain type = (MOD(typePrecip,10000000)/1000000 in FORTRAN

DFRm rain type
     = 1    stratiform
     = 2    convective
     = 4    transition
     = 9    DFRm method cannot be applicable (in this case
       the conventional method determines the major rain type)

-1111  No rain value
-9999  Missing value
```

qualityTypePrecip (4-byte integer, array size: nrayHS x nscan):

```
Quality of the precipitation type.

1      Good
-1111  No rain value
-9999  Missing value
```

flagShallowRain (4-byte integer, array size: nrayHS x nscan):

```
Type of shallow rain
0      No shallow rain
10     Shallow isolated (maybe)
11     Shallow isolated (certain)
20     Shallow non-isolated (maybe)
21     Shallow non-isolated (certain)
-1111  No rain value
-9999  Missing value
```

SRT (Group in HS)

PIAalt (4-byte float, array size: method x nrayHS x nscan):
The two-way path integrated attenuation (PIA) at from the each method estimate. The path-integrated attenuation from the jth method, where

PIAalt (j=1) = PIA_Ku from forward along-track spatial at kth angle bin
PIAalt (j=2) = PIA_Ku from backward along-track spatial at kth angle bin
PIAalt (j=3) = PIA_Ku from forward hybrid at kth angle bin
PIAalt (j=4) = PIA_Ku from backward hybrid at kth angle bin
PIAalt (j=5) = PIA_Ku from temporal reference at kth angle bin
PIAalt (j=6) = PIA_Ku from light-rain temporal reference at kth angle bin

Values are in dB. Special values are defined as:
-9999.9 Missing value

RFactorAlt (4-byte float, array size: method x nrayHS x nscan):
The reliability factors associated with the individual PIA estimates corresponding to PIAalt. Special values are defined as:
-9999.9 Missing value

PIAweight (4-byte float, array size: method x nrayHS x nscan):
The weights of the individual PIA_Ku estimates used in deriving the effective path attenuation estimate, pathAtten. The sum of the weights should equal one. Where j is method and sigma_j is the standard deviation of reference data for method j.

PIAweight_j = 1/sigma_j^2 * (1/Sum_j(1/sigma_j^2))

Special values are defined as:
-9999.9 Missing value

pathAtten (4-byte float, array size: nrayHS x nscan):
The effective 2-way path integrated attenuation. Values are in dB. Special values are defined as:
-9999.9 Missing value

reliabFactor (4-byte float, array size: nrayHS x nscan):
Reliability Factor for the effective PIA estimate, pathAtten. Special values are defined as:
-9999.9 Missing value

reliabFlag (2-byte integer, array size: nrayHS x nscan):
The reliability flag for the effective PIA estimate (pathAtten) based on the reliability factor (Rel_eff) in reliabFactor. Reliability Flag is:

= 1 if Rel_eff $>$ 3 ; PIAeff estimate is considered reliable
= 2 if 3 $\geq$ Rel_eff $>$ 1 ; PIAeff estimate is considered marginally reliable
= 3 if Rel_eff $\leq$ 1 ; PIAeff is unreliable
= 4 if SNR_at surface $<$ 2dB; provides a lower bound to the path-attenuation
= 9 (no-rain case)

Special values are defined as:
-9999 Missing value

refScanID (2-byte integer, array size: nearFar x foreBack x nrayHS x nscan):
The number of scan lines between the current scan and the beginning (or end) of the along-track reference data at each angle bin. The values are computed by the equation: Current Scan Number - Reference Scan Number. The values are positive for the Forward estimates and negative for the Backward estimates. The Fortran indices for nearFar foreBack are:

```
1,1 - Forward - Near reference
2,1 - Forward - Far reference
1,2 - Backward - Near reference
2,2 - Backward - Far reference
```

Special values are defined as:
-9999 Missing value

DSD (Group in HS)

phase (1-byte char, array size: nbinHS x nrayHS x nscan):
Phase state of the precipitation. As an unsigned byte value this represents:

```
phase < 100 Temperature(C)=phase-100
phase > 200 Temperature(C)=phase-200
phase = 100 Top of the bright band
phase = 200 Bottom of the bright band
phase = 125 is used for the range bins between
                        the top and peak of bright band
phase = 175 is used for the range bins between
                        the peak and bottom of bright band

Integer values of phase/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

binNode (2-byte integer, array size: nNode x nrayHS x nscan):

```
The bin number of the 5 nodes defined as:

0 - Bin number of storm top.
1 - Stratiform: 500m above center of bright band.
    Convective: 750m above 0deg C level.
2 - Stratiform: center of bright band.
    Convective: 0deg C level.
3 - Stratiform: 500m below center of bright band.
    Convective: 750m below 0deg C level.
4 - Bin number of real surface equal to
    binRealSurface in PRE group.
For NS and MS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 176 at the Ellipsoid.
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
-9999 - Missing
```

Experimental (Group in HS)

precipRateESurface2 (4-byte float, array size: nrayHS x nscan):
Estimates Surface Precipitation using alternate method. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface2Status (1-byte char, array size: nrayHS x nscan):
Status of the estimated surface precipitation using alternate method. Special values are defined as:
255 Missing value

sigmaZeroProfile (4-byte float, array size: nbinSZPHS x nrayHS x nscan):
Surface backscattering cross section profile around the current ifov. Values are in dB. Special values are defined as:
-9999.9 Missing value

binDEML2 (2-byte integer, array size: nrayHS x nscan):
Range bin number of the digital elevation model surface estimate. Special values are defined as:
-9999 Missing value

SLV (Group in HS)

flagSLV (1-byte integer, array size: nbinHS x nrayHS x nscan):
Special values are defined as:
-99 Missing value

binEchoBottom (2-byte integer, array size: nrayHS x nscan):
For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

piaFinal (4-byte float, array size: nrayHS x nscan):
The final estimates of path integrated attenuation caused by precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroCorrected (4-byte float, array size: nrayHS x nscan):
Surface backscatter cross section with attenuation correction. Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorCorrected (4-byte float, array size: nbinHS x nrayHS x nscan):
Vertical profile of reflectivity factor with attenuation correction. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorCorrectedESurface (4-byte float, array size: nrayHS x nscan):
Reflectivity factor with attenuation correction at estimated surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorCorrectedNearSurface (4-byte float, array size: nrayHS x nscan):
Reflectivity factor with attenuation correction at near surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

paramDSD (4-byte float, array size: nDSD x nbinHS x nrayHS x nscan):
Parameters of the drop size distribution. The first index is dBNw; the second index is Dm in mm. Special values are defined as:
-9999.9 Missing value

precipRate (4-byte float, array size: nbinHS x nrayHS x nscan):
Precipitation rate. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipWaterIntegrated (4-byte float, array size: LS x nrayHS x nscan):
Precipitation water vertically integrated. Values are in g/m^2. Special values are defined as:
-9999.9 Missing value

qualitySLV (4-byte integer, array size: nrayHS x nscan):
A flag to show methods in which precipRateNearSurface is retrieved. Special values are defined as:
-9999 Missing value

precipRateNearSurface (4-byte float, array size: nrayHS x nscan):
Precipitation rate for the near surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface (4-byte float, array size: nrayHS x nscan):
Precipitation rate for the estimated surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateAve24 (4-byte float, array size: nrayHS x nscan):
Average of precipitation rate for 2 to 4km height. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

phaseNearSurface (1-byte char, array size: nrayHS x nscan):
Phase state of the precipitation at the Near-surface level. This is a copy of the phase in the DSD group at the Near-surface level. As an unsigned byte value this represents:

```
phaseNearSurface < 100 Temperature(C)=phaseNearSurface-100
phaseNearSurface > 200 Temperature(C)=phaseNearSurface-200
phaseNearSurface = 100 Top of the bright band
phaseNearSurface = 200 Bottom of the bright band
phaseNearSurface = 125 is used for the range bins between
                       the top and peak of bright band
phaseNearSurface = 175 is used for the range bins between
                       the peak and bottom of bright band

Integer values of phaseNearSurface/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

epsilon (4-byte float, array size: nbinHS x nrayHS x nscan):
Epsilon is the indication of the adjustment away from the initial drop size distribution,

epsilon = 1 is no adjustment. Special values are defined as:
-9999.9 Missing value

FLG (Group in HS)

flagEcho (1-byte integer, array size: nbinHS x nrayHS x nscan):

```
Flag of precipitation and main/side lobe clutter
information of each range bin.

Bit  Meaning
0    For L2 Ku:  Precipitation judged by L2 Ku algorithm (copy of bit 2)
0    For L2 Ka:  Precipitation judged by L2 Ka algorithm (copy of bit 3)
0    For L2 DPR:  Precipitation judged by L2 DPR algorithm (copy of bit 1)
1    Precipitation judged by L2 DPR algorithm
2    Precipitation judged by L2 Ku algorithm
3    Precipitation judged by L2 Ka algorithm
4    Main lobe clutter judged by L2 Ku algorithm
5    Main lobe clutter judged by L2 Ka algorithm
6    Side lobe clutter judged by L2 Ku algorithm
7    Side lobe clutter judged by L2 Ka algorithm
```

qualityData (4-byte integer, array size: nrayHS x nscan):
Normal data gives "0". Non-zero values mean the kinds of errors. Special values are defined as:
-9999 Missing value

```
Flag of quality data.  Bit range from 8 to 23
contains flags by each module.  Each module flag
has 2 bits of information.

The 2 bit flag for each module has values:
[higher bit    lower bit]
[0 0]  Good
[0 1]  Warning but usable
[1 0]  NG or error

The bits of qualityData are assigned as follows:

Bit      Meaning
0 - 7    Copy of dataQuality in level 1B product
```

```
8 - 9    Flag by input module
10 - 11  Flag by preparation module
12 - 13  Flag by vertical module
14 - 15  Flag by classification module
16 - 17  Flag by SRT module
18 - 19  Flag by DSD module
20 - 21  Flag by solver module
22 - 23  Flag by output module
24 - 31  Spare
```

flagSensor (1-byte integer, array size: nscan):

```
Flag of input Ku/Ka data condition.

Value  Meaning
1      Valid
-99    Invalid (judged by dataQuality)
```

C Structure Header file:

```
#ifndef _TK_2ADPR_H_
#define _TK_2ADPR_H_

#ifndef _L2ADPR_HS_FLG_
#define _L2ADPR_HS_FLG_

typedef struct {
    signed char flagEcho[24][88];
    int qualityData[24];
    signed char flagSensor;
} L2ADPR_HS_FLG;

#endif

#ifndef _L2ADPR_HS_SLV_
#define _L2ADPR_HS_SLV_

typedef struct {
    signed char flagSLV[24][88];
    short binEchoBottom[24];
    float piaFinal[24];
    float sigmaZeroCorrected[24];
```

```
    float zFactorCorrected[24][88];
    float zFactorCorrectedESurface[24];
    float zFactorCorrectedNearSurface[24];
    float paramDSD[24][88][2];
    float precipRate[24][88];
    float precipWaterIntegrated[24][2];
    int qualitySLV[24];
    float precipRateNearSurface[24];
    float precipRateESurface[24];
    float precipRateAve24[24];
    unsigned char phaseNearSurface[24];
    float epsilon[24][88];
} L2ADPR_HS_SLV;

#endif

#ifndef _L2ADPR_HS_EXPERIMENTAL_
#define _L2ADPR_HS_EXPERIMENTAL_

typedef struct {
    float precipRateESurface2[24];
    unsigned char precipRateESurface2Status[24];
    float sigmaZeroProfile[24][5];
    short binDEML2[24];
} L2ADPR_HS_EXPERIMENTAL;

#endif

#ifndef _L2ADPR_HS_DSD_
#define _L2ADPR_HS_DSD_

typedef struct {
    unsigned char phase[24][88];
    short binNode[24][5];
} L2ADPR_HS_DSD;

#endif

#ifndef _L2ADPR_HS_SRT_
#define _L2ADPR_HS_SRT_

typedef struct {
    float PIAalt[24][6];
```

```
    float RFactorAlt[24][6];
    float PIAweight[24][6];
    float pathAtten[24];
    float reliabFactor[24];
    short reliabFlag[24];
    short refScanID[24][2][2];
} L2ADPR_HS_SRT;

#endif

#ifndef _L2ADPR_HS_CSF_
#define _L2ADPR_HS_CSF_

typedef struct {
    int flagBB[24];
    short binBBPeak[24];
    short binBBTop[24];
    short binBBBottom[24];
    float heightBB[24];
    float widthBB[24];
    int qualityBB[24];
    int typePrecip[24];
    int qualityTypePrecip[24];
    int flagShallowRain[24];
} L2ADPR_HS_CSF;

#endif

#ifndef _L2ADPR_HS_VER_
#define _L2ADPR_HS_VER_

typedef struct {
    short binZeroDeg[24];
    float attenuationNP[24][88];
    float piaNP[24][4];
    float sigmaZeroNPCorrected[24];
    float heightZeroDeg[24];
} L2ADPR_HS_VER;

#endif

#ifndef _L2ADPR_HS_PRE_
#define _L2ADPR_HS_PRE_
```

```
typedef struct {
    float elevation[24];
    int landSurfaceType[24];
    float localZenithAngle[24];
    int flagPrecip[24];
    unsigned char flagSigmaZeroSaturation[24];
    short binRealSurface[24];
    short binStormTop[24];
    float heightStormTop[24];
    short binClutterFreeBottom[24];
    float sigmaZeroMeasured[24];
    float zFactorMeasured[24][88];
    float ellipsoidBinOffset[24];
    float snRatioAtRealSurface[24];
} L2ADPR_HS_PRE;

#endif

#ifndef _L2ADPR_HS_SCANSTATUS_
#define _L2ADPR_HS_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char dataWarning;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    signed char limitErrorFlag;
    double FractionalGranuleNumber;
} L2ADPR_HS_SCANSTATUS;

#endif

#ifndef _L2ADPR_HS_
#define _L2ADPR_HS_
```

```
typedef struct {
    SCANTIME ScanTime;
    float Latitude[24];
    float Longitude[24];
    L2ADPR_HS_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L2ADPR_HS_PRE PRE;
    L2ADPR_HS_VER VER;
    L2ADPR_HS_CSF CSF;
    L2ADPR_HS_SRT SRT;
    L2ADPR_HS_DSD DSD;
    L2ADPR_HS_EXPERIMENTAL Experimental;
    L2ADPR_HS_SLV SLV;
    L2ADPR_HS_FLG FLG;
} L2ADPR_HS;

#endif

#ifndef _L2ADPR_MS_FLG_
#define _L2ADPR_MS_FLG_

typedef struct {
    signed char flagEcho[25][176];
    int qualityData[25];
    signed char flagSensor;
} L2ADPR_MS_FLG;

#endif

#ifndef _L2ADPR_MS_SLV_
#define _L2ADPR_MS_SLV_

typedef struct {
    short binEchoBottom[25];
    float piaFinal[25];
    float sigmaZeroCorrected[25];
    float zFactorCorrected[25][176];
    float zFactorCorrectedESurface[25];
    float zFactorCorrectedNearSurface[25];
    float precipWaterIntegrated[25][2];
    float precipRateNearSurface[25];
    float precipRateESurface[25];
    float precipRateAve24[25];
```

```
    unsigned char phaseNearSurface[25];
    float epsilon[25][176];
} L2ADPR_MS_SLV;

#endif

#ifndef _L2ADPR_MS_EXPERIMENTAL_
#define _L2ADPR_MS_EXPERIMENTAL_

typedef struct {
    float precipRateESurface2[25];
    unsigned char precipRateESurface2Status[25];
    float sigmaZeroProfile[25][7];
    short binDEML2[25];
} L2ADPR_MS_EXPERIMENTAL;

#endif

#ifndef _L2ADPR_MS_DSD_
#define _L2ADPR_MS_DSD_

typedef struct {
    short binNode[25][5];
} L2ADPR_MS_DSD;

#endif

#ifndef _L2ADPR_MS_SRT_
#define _L2ADPR_MS_SRT_

typedef struct {
    float PIAalt[25][6];
    float RFactorAlt[25][6];
    float PIAweight[25][6];
    float pathAtten[25];
    float reliabFactor[25];
    short reliabFlag[25];
    short refScanID[25][2][2];
} L2ADPR_MS_SRT;

#endif

#ifndef _L2ADPR_MS_CSF_
```

```
#define _L2ADPR_MS_CSF_

typedef struct {
    int flagBB[25];
    short binBBPeak[25];
    short binBBTop[25];
    short binDFRmBBBottom[25];
    short binDFRmBBTop[25];
    short binBBBottom[25];
    float heightBB[25];
    float widthBB[25];
    int qualityBB[25];
    int typePrecip[25];
    int qualityTypePrecip[25];
    int flagShallowRain[25];
} L2ADPR_MS_CSF;

#endif

#ifndef _L2ADPR_MS_VER_
#define _L2ADPR_MS_VER_

typedef struct {
    short binZeroDeg[25];
    float attenuationNP[25][176];
    float piaNP[25][4];
    float sigmaZeroNPCorrected[25];
    float heightZeroDeg[25];
} L2ADPR_MS_VER;

#endif

#ifndef _L2ADPR_MS_PRE_
#define _L2ADPR_MS_PRE_

typedef struct {
    float elevation[25];
    int landSurfaceType[25];
    float localZenithAngle[25];
    int flagPrecip[25];
    unsigned char flagSigmaZeroSaturation[25];
    short binRealSurface[25];
    short binStormTop[25];
```

```
    float heightStormTop[25];
    short binClutterFreeBottom[25];
    float sigmaZeroMeasured[25];
    float zFactorMeasured[25][176];
    float ellipsoidBinOffset[25];
    float snRatioAtRealSurface[25];
} L2ADPR_MS_PRE;

#endif

#ifndef _L2ADPR_MS_SCANSTATUS_
#define _L2ADPR_MS_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char dataWarning;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    signed char limitErrorFlag;
    double FractionalGranuleNumber;
} L2ADPR_MS_SCANSTATUS;

#endif

#ifndef _L2ADPR_MS_
#define _L2ADPR_MS_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[25];
    float Longitude[25];
    L2ADPR_MS_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L2ADPR_MS_PRE PRE;
    L2ADPR_MS_VER VER;
    L2ADPR_MS_CSF CSF;
```

```
    L2ADPR_MS_SRT SRT;
    L2ADPR_MS_DSD DSD;
    L2ADPR_MS_EXPERIMENTAL Experimental;
    L2ADPR_MS_SLV SLV;
    L2ADPR_MS_FLG FLG;
} L2ADPR_MS;

#endif

#ifndef _L2ADPR_NS_FLG_
#define _L2ADPR_NS_FLG_

typedef struct {
    signed char flagEcho[49][176];
    int qualityData[49];
    signed char flagSensor;
} L2ADPR_NS_FLG;

#endif

#ifndef _L2ADPR_NS_SLV_
#define _L2ADPR_NS_SLV_

typedef struct {
    signed char flagSLV[49][176];
    short binEchoBottom[49];
    float piaFinal[49];
    float sigmaZeroCorrected[49];
    float zFactorCorrected[49][176];
    float zFactorCorrectedESurface[49];
    float zFactorCorrectedNearSurface[49];
    float paramDSD[49][176][2];
    float precipRate[49][176];
    float precipWaterIntegrated[49][2];
    int qualitySLV[49];
    float precipRateNearSurface[49];
    float precipRateESurface[49];
    float precipRateAve24[49];
    unsigned char phaseNearSurface[49];
    float epsilon[49][176];
} L2ADPR_NS_SLV;

#endif
```

```
#ifndef _L2ADPR_NS_EXPERIMENTAL_
#define _L2ADPR_NS_EXPERIMENTAL_

typedef struct {
    float precipRateESurface2[49];
    unsigned char precipRateESurface2Status[49];
    float sigmaZeroProfile[49][7];
    short binDEML2[49];
} L2ADPR_NS_EXPERIMENTAL;

#endif

#ifndef _L2ADPR_NS_DSD_
#define _L2ADPR_NS_DSD_

typedef struct {
    unsigned char phase[49][176];
    short binNode[49][5];
} L2ADPR_NS_DSD;

#endif

#ifndef _L2ADPR_NS_SRT_
#define _L2ADPR_NS_SRT_

typedef struct {
    float PIAalt[49][6];
    float RFactorAlt[49][6];
    float PIAweight[49][6];
    float pathAtten[49];
    float reliabFactor[49];
    short reliabFlag[49];
    short refScanID[49][2][2];
} L2ADPR_NS_SRT;

#endif

#ifndef _L2ADPR_NS_CSF_
#define _L2ADPR_NS_CSF_

typedef struct {
    int flagBB[49];
```

```
    short binBBPeak[49];
    short binBBTop[49];
    short binBBBottom[49];
    float heightBB[49];
    float widthBB[49];
    int qualityBB[49];
    int typePrecip[49];
    int qualityTypePrecip[49];
    int flagShallowRain[49];
} L2ADPR_NS_CSF;

#endif

#ifndef _L2ADPR_NS_VER_
#define _L2ADPR_NS_VER_

typedef struct {
    short binZeroDeg[49];
    float attenuationNP[49][176];
    float piaNP[49][4];
    float sigmaZeroNPCorrected[49];
    float heightZeroDeg[49];
} L2ADPR_NS_VER;

#endif

#ifndef _L2ADPR_NS_PRE_
#define _L2ADPR_NS_PRE_

typedef struct {
    float elevation[49];
    int landSurfaceType[49];
    float localZenithAngle[49];
    int flagPrecip[49];
    unsigned char flagSigmaZeroSaturation[49];
    short binRealSurface[49];
    short binStormTop[49];
    float heightStormTop[49];
    short binClutterFreeBottom[49];
    float sigmaZeroMeasured[49];
    float zFactorMeasured[49][176];
    float ellipsoidBinOffset[49];
    float snRatioAtRealSurface[49];
```

```
} L2ADPR_NS_PRE;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _L2ADPR_NS_SCANSTATUS_
#define _L2ADPR_NS_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char dataWarning;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    signed char limitErrorFlag;
```

```
    double FractionalGranuleNumber;
} L2ADPR_NS_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2ADPR_NS_
#define _L2ADPR_NS_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[49];
    float Longitude[49];
    L2ADPR_NS_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L2ADPR_NS_PRE PRE;
    L2ADPR_NS_VER VER;
    L2ADPR_NS_CSF CSF;
    L2ADPR_NS_SRT SRT;
    L2ADPR_NS_DSD DSD;
    L2ADPR_NS_EXPERIMENTAL Experimental;
    L2ADPR_NS_SLV SLV;
    L2ADPR_NS_FLG FLG;
} L2ADPR_NS;

#endif
```

```
#ifndef _L2ADPR_SWATHS_
#define _L2ADPR_SWATHS_

typedef struct {
    L2ADPR_NS NS;
    L2ADPR_MS MS;
    L2ADPR_HS HS;
} L2ADPR_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L2ADPR_HS_FLG/
    BYTE flagEcho(88,24)
    INTEGER*4 qualityData(24)
    BYTE flagSensor
END STRUCTURE

STRUCTURE /L2ADPR_HS_SLV/
    BYTE flagSLV(88,24)
    INTEGER*2 binEchoBottom(24)
    REAL*4 piaFinal(24)
    REAL*4 sigmaZeroCorrected(24)
    REAL*4 zFactorCorrected(88,24)
    REAL*4 zFactorCorrectedESurface(24)
    REAL*4 zFactorCorrectedNearSurface(24)
    REAL*4 paramDSD(2,88,24)
    REAL*4 precipRate(88,24)
    REAL*4 precipWaterIntegrated(2,24)
    INTEGER*4 qualitySLV(24)
    REAL*4 precipRateNearSurface(24)
    REAL*4 precipRateESurface(24)
    REAL*4 precipRateAve24(24)
    CHARACTER phaseNearSurface(24)
    REAL*4 epsilon(88,24)
END STRUCTURE

STRUCTURE /L2ADPR_HS_EXPERIMENTAL/
    REAL*4 precipRateESurface2(24)
    CHARACTER precipRateESurface2Status(24)
```

```
    REAL*4 sigmaZeroProfile(5,24)
    INTEGER*2 binDEML2(24)
END STRUCTURE

STRUCTURE /L2ADPR_HS_DSD/
    CHARACTER phase(88,24)
    INTEGER*2 binNode(5,24)
END STRUCTURE

STRUCTURE /L2ADPR_HS_SRT/
    REAL*4 PIAalt(6,24)
    REAL*4 RFactorAlt(6,24)
    REAL*4 PIAweight(6,24)
    REAL*4 pathAtten(24)
    REAL*4 reliabFactor(24)
    INTEGER*2 reliabFlag(24)
    INTEGER*2 refScanID(2,2,24)
END STRUCTURE

STRUCTURE /L2ADPR_HS_CSF/
    INTEGER*4 flagBB(24)
    INTEGER*2 binBBPeak(24)
    INTEGER*2 binBBTop(24)
    INTEGER*2 binBBBottom(24)
    REAL*4 heightBB(24)
    REAL*4 widthBB(24)
    INTEGER*4 qualityBB(24)
    INTEGER*4 typePrecip(24)
    INTEGER*4 qualityTypePrecip(24)
    INTEGER*4 flagShallowRain(24)
END STRUCTURE

STRUCTURE /L2ADPR_HS_VER/
    INTEGER*2 binZeroDeg(24)
    REAL*4 attenuationNP(88,24)
    REAL*4 piaNP(4,24)
    REAL*4 sigmaZeroNPCorrected(24)
    REAL*4 heightZeroDeg(24)
END STRUCTURE

STRUCTURE /L2ADPR_HS_PRE/
    REAL*4 elevation(24)
    INTEGER*4 landSurfaceType(24)
```

```
    REAL*4 localZenithAngle(24)
    INTEGER*4 flagPrecip(24)
    CHARACTER flagSigmaZeroSaturation(24)
    INTEGER*2 binRealSurface(24)
    INTEGER*2 binStormTop(24)
    REAL*4 heightStormTop(24)
    INTEGER*2 binClutterFreeBottom(24)
    REAL*4 sigmaZeroMeasured(24)
    REAL*4 zFactorMeasured(88,24)
    REAL*4 ellipsoidBinOffset(24)
    REAL*4 snRatioAtRealSurface(24)
END STRUCTURE

STRUCTURE /L2ADPR_HS_SCANSTATUS/
    BYTE dataQuality
    BYTE dataWarning
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    BYTE limitErrorFlag
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /L2ADPR_HS/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(24)
    REAL*4 Longitude(24)
    RECORD /L2ADPR_HS_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L2ADPR_HS_PRE/ PRE
    RECORD /L2ADPR_HS_VER/ VER
    RECORD /L2ADPR_HS_CSF/ CSF
    RECORD /L2ADPR_HS_SRT/ SRT
    RECORD /L2ADPR_HS_DSD/ DSD
    RECORD /L2ADPR_HS_EXPERIMENTAL/ Experimental
    RECORD /L2ADPR_HS_SLV/ SLV
    RECORD /L2ADPR_HS_FLG/ FLG
```

```
END STRUCTURE

STRUCTURE /L2ADPR_MS_FLG/
    BYTE flagEcho(176,25)
    INTEGER*4 qualityData(25)
    BYTE flagSensor
END STRUCTURE

STRUCTURE /L2ADPR_MS_SLV/
    INTEGER*2 binEchoBottom(25)
    REAL*4 piaFinal(25)
    REAL*4 sigmaZeroCorrected(25)
    REAL*4 zFactorCorrected(176,25)
    REAL*4 zFactorCorrectedESurface(25)
    REAL*4 zFactorCorrectedNearSurface(25)
    REAL*4 precipWaterIntegrated(2,25)
    REAL*4 precipRateNearSurface(25)
    REAL*4 precipRateESurface(25)
    REAL*4 precipRateAve24(25)
    CHARACTER phaseNearSurface(25)
    REAL*4 epsilon(176,25)
END STRUCTURE

STRUCTURE /L2ADPR_MS_EXPERIMENTAL/
    REAL*4 precipRateESurface2(25)
    CHARACTER precipRateESurface2Status(25)
    REAL*4 sigmaZeroProfile(7,25)
    INTEGER*2 binDEML2(25)
END STRUCTURE

STRUCTURE /L2ADPR_MS_DSD/
    INTEGER*2 binNode(5,25)
END STRUCTURE

STRUCTURE /L2ADPR_MS_SRT/
    REAL*4 PIAalt(6,25)
    REAL*4 RFactorAlt(6,25)
    REAL*4 PIAweight(6,25)
    REAL*4 pathAtten(25)
    REAL*4 reliabFactor(25)
    INTEGER*2 reliabFlag(25)
    INTEGER*2 refScanID(2,2,25)
END STRUCTURE
```

```
STRUCTURE /L2ADPR_MS_CSF/
    INTEGER*4 flagBB(25)
    INTEGER*2 binBBPeak(25)
    INTEGER*2 binBBTop(25)
    INTEGER*2 binDFRmBBBottom(25)
    INTEGER*2 binDFRmBBTop(25)
    INTEGER*2 binBBBottom(25)
    REAL*4 heightBB(25)
    REAL*4 widthBB(25)
    INTEGER*4 qualityBB(25)
    INTEGER*4 typePrecip(25)
    INTEGER*4 qualityTypePrecip(25)
    INTEGER*4 flagShallowRain(25)
END STRUCTURE

STRUCTURE /L2ADPR_MS_VER/
    INTEGER*2 binZeroDeg(25)
    REAL*4 attenuationNP(176,25)
    REAL*4 piaNP(4,25)
    REAL*4 sigmaZeroNPCorrected(25)
    REAL*4 heightZeroDeg(25)
END STRUCTURE

STRUCTURE /L2ADPR_MS_PRE/
    REAL*4 elevation(25)
    INTEGER*4 landSurfaceType(25)
    REAL*4 localZenithAngle(25)
    INTEGER*4 flagPrecip(25)
    CHARACTER flagSigmaZeroSaturation(25)
    INTEGER*2 binRealSurface(25)
    INTEGER*2 binStormTop(25)
    REAL*4 heightStormTop(25)
    INTEGER*2 binClutterFreeBottom(25)
    REAL*4 sigmaZeroMeasured(25)
    REAL*4 zFactorMeasured(176,25)
    REAL*4 ellipsoidBinOffset(25)
    REAL*4 snRatioAtRealSurface(25)
END STRUCTURE

STRUCTURE /L2ADPR_MS_SCANSTATUS/
    BYTE dataQuality
    BYTE dataWarning
```

```
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    BYTE limitErrorFlag
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /L2ADPR_MS/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(25)
    REAL*4 Longitude(25)
    RECORD /L2ADPR_MS_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L2ADPR_MS_PRE/ PRE
    RECORD /L2ADPR_MS_VER/ VER
    RECORD /L2ADPR_MS_CSF/ CSF
    RECORD /L2ADPR_MS_SRT/ SRT
    RECORD /L2ADPR_MS_DSD/ DSD
    RECORD /L2ADPR_MS_EXPERIMENTAL/ Experimental
    RECORD /L2ADPR_MS_SLV/ SLV
    RECORD /L2ADPR_MS_FLG/ FLG
END STRUCTURE

STRUCTURE /L2ADPR_NS_FLG/
    BYTE flagEcho(176,49)
    INTEGER*4 qualityData(49)
    BYTE flagSensor
END STRUCTURE

STRUCTURE /L2ADPR_NS_SLV/
    BYTE flagSLV(176,49)
    INTEGER*2 binEchoBottom(49)
    REAL*4 piaFinal(49)
    REAL*4 sigmaZeroCorrected(49)
    REAL*4 zFactorCorrected(176,49)
    REAL*4 zFactorCorrectedESurface(49)
    REAL*4 zFactorCorrectedNearSurface(49)
```

```
    REAL*4 paramDSD(2,176,49)
    REAL*4 precipRate(176,49)
    REAL*4 precipWaterIntegrated(2,49)
    INTEGER*4 qualitySLV(49)
    REAL*4 precipRateNearSurface(49)
    REAL*4 precipRateESurface(49)
    REAL*4 precipRateAve24(49)
    CHARACTER phaseNearSurface(49)
    REAL*4 epsilon(176,49)
END STRUCTURE

STRUCTURE /L2ADPR_NS_EXPERIMENTAL/
    REAL*4 precipRateESurface2(49)
    CHARACTER precipRateESurface2Status(49)
    REAL*4 sigmaZeroProfile(7,49)
    INTEGER*2 binDEML2(49)
END STRUCTURE

STRUCTURE /L2ADPR_NS_DSD/
    CHARACTER phase(176,49)
    INTEGER*2 binNode(5,49)
END STRUCTURE

STRUCTURE /L2ADPR_NS_SRT/
    REAL*4 PIAalt(6,49)
    REAL*4 RFactorAlt(6,49)
    REAL*4 PIAweight(6,49)
    REAL*4 pathAtten(49)
    REAL*4 reliabFactor(49)
    INTEGER*2 reliabFlag(49)
    INTEGER*2 refScanID(2,2,49)
END STRUCTURE

STRUCTURE /L2ADPR_NS_CSF/
    INTEGER*4 flagBB(49)
    INTEGER*2 binBBPeak(49)
    INTEGER*2 binBBTop(49)
    INTEGER*2 binBBBottom(49)
    REAL*4 heightBB(49)
    REAL*4 widthBB(49)
    INTEGER*4 qualityBB(49)
    INTEGER*4 typePrecip(49)
    INTEGER*4 qualityTypePrecip(49)
```

```
    INTEGER*4 flagShallowRain(49)
END STRUCTURE

STRUCTURE /L2ADPR_NS_VER/
    INTEGER*2 binZeroDeg(49)
    REAL*4 attenuationNP(176,49)
    REAL*4 piaNP(4,49)
    REAL*4 sigmaZeroNPCorrected(49)
    REAL*4 heightZeroDeg(49)
END STRUCTURE

STRUCTURE /L2ADPR_NS_PRE/
    REAL*4 elevation(49)
    INTEGER*4 landSurfaceType(49)
    REAL*4 localZenithAngle(49)
    INTEGER*4 flagPrecip(49)
    CHARACTER flagSigmaZeroSaturation(49)
    INTEGER*2 binRealSurface(49)
    INTEGER*2 binStormTop(49)
    REAL*4 heightStormTop(49)
    INTEGER*2 binClutterFreeBottom(49)
    REAL*4 sigmaZeroMeasured(49)
    REAL*4 zFactorMeasured(176,49)
    REAL*4 ellipsoidBinOffset(49)
    REAL*4 snRatioAtRealSurface(49)
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
```

```
END STRUCTURE

STRUCTURE /L2ADPR_NS_SCANSTATUS/
    BYTE dataQuality
    BYTE dataWarning
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    BYTE limitErrorFlag
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2ADPR_NS/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(49)
    REAL*4 Longitude(49)
    RECORD /L2ADPR_NS_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L2ADPR_NS_PRE/ PRE
    RECORD /L2ADPR_NS_VER/ VER
    RECORD /L2ADPR_NS_CSF/ CSF
    RECORD /L2ADPR_NS_SRT/ SRT
    RECORD /L2ADPR_NS_DSD/ DSD
    RECORD /L2ADPR_NS_EXPERIMENTAL/ Experimental
    RECORD /L2ADPR_NS_SLV/ SLV
```

```
    RECORD /L2ADPR_NS_FLG/ FLG
END STRUCTURE

STRUCTURE /L2ADPR_SWATHS/
    RECORD /L2ADPR_NS/ NS
    RECORD /L2ADPR_MS/ MS
    RECORD /L2ADPR_HS/ HS
END STRUCTURE
```

5.32 3GPROF - GPROF Profiling

3GPROF, "GPROF Profiling", produces global 0.25^o x 0.25^o gridded means using Level 2 Gprof data. Vertical hydrometeor profiles and surface rainfall means are computed. Various pixel counts are also reported. The PI is Joyce Chou. The product can be monthly or daily. The following sections describe the structure and contents of the format.

Dimension definitions:

nlat	720	Number of 0.25^o grid intervals of latitude from 90°N to 90°S.
nlon	1440	Number of 0.25^o grid intervals of longitude from 180°W to 180°E.
nlayer	28	Number of profiling layers. The top of each layer is 0.5, 1.0, 1.5, ..., 9.5, 10.0, 11.0, ..., 18.0 km. The layer tops are heights above the earth's surface.

Figure 412 through Figure 413 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

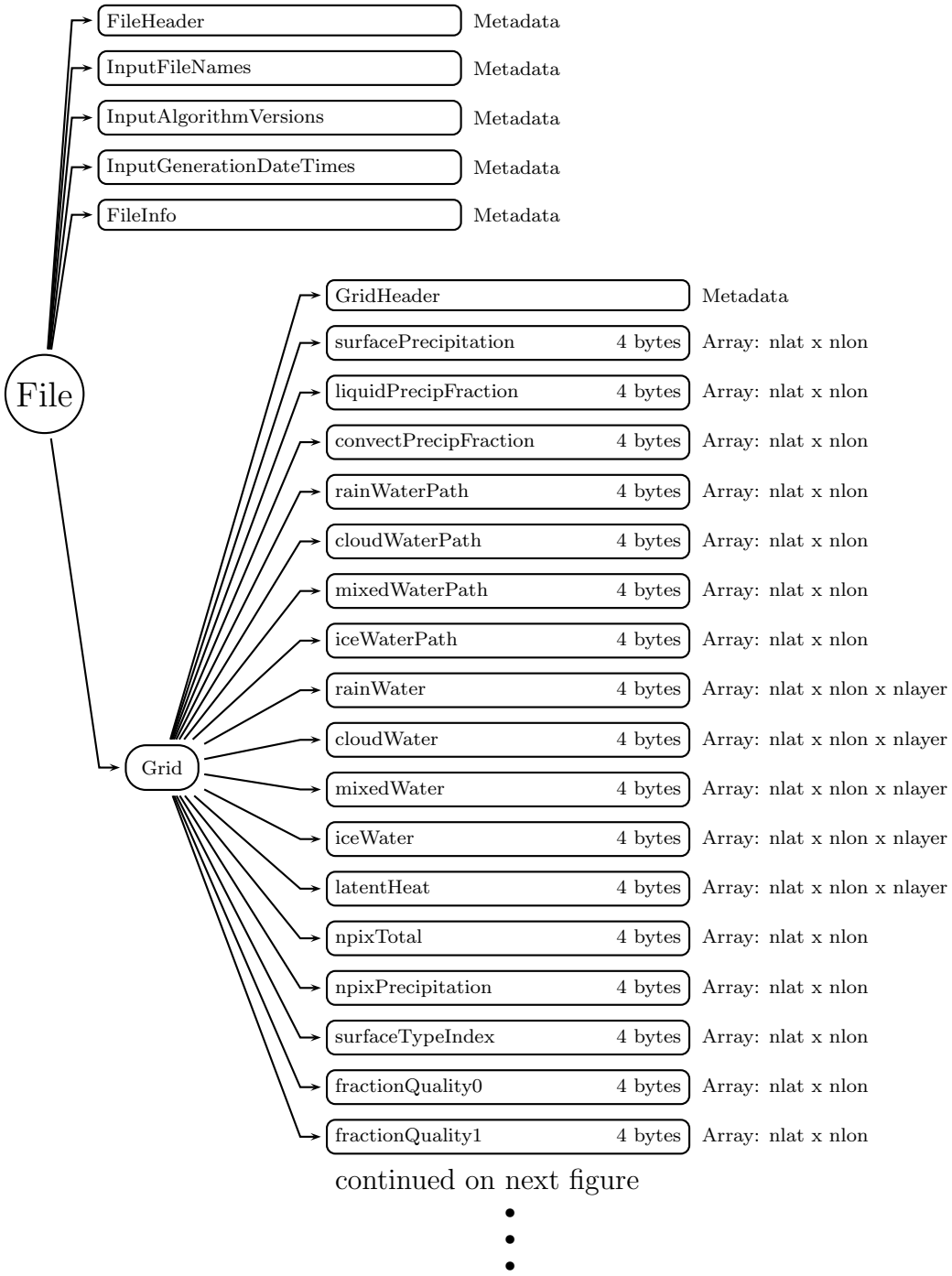
FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputFileNames (Metadata):
InputFileNames contains a list of input file names for this granule. See Metadata for GPM Products for details.

InputAlgorithmVersions (Metadata):
InputAlgorithmVersions contains a list of input algorithm versions for this granule. See Metadata for GPM Products for details.

InputGenerationDateTimes (Metadata):
InputGenerationDateTimes contains a list of input generation datetimes. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.



continued on next figure

Figure 412: Data Format Structure for 3GPROF, GPROF Profiling

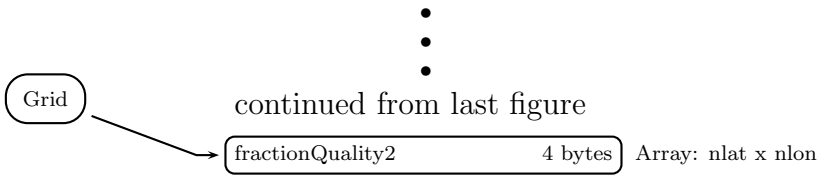


Figure 413: Data Format Structure for 3GPROF, GPROF Profiling

Grid (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

surfacePrecipitation (4-byte float, array size: nlat x nlon):
The monthly mean of the instantaneous precipitation rate at the surface for each grid. Values range from 0 to 3000 mm/hr. Special values are defined as:
-9999.9 Missing value

liquidPrecipFraction (4-byte float, array size: nlat x nlon):
The fraction of the total surface precipitation over the accumulation period that is liquid (i.e. rain). Over the tropics this will typically be one, while over higher latitudes where frozen precipitation is more prevalent it will vary from zero to one. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

convectPrecipFraction (4-byte float, array size: nlat x nlon):
The fraction of the total surface precipitation over the accumulation period from pixels identified as convective. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

rainWaterPath (4-byte float, array size: nlat x nlon):
The monthly mean of the total integrated rain water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

cloudWaterPath (4-byte float, array size: nlat x nlon):
The monthly mean of the total integrated cloud water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

mixedWaterPath (4-byte float, array size: nlat x nlon):
The monthly mean of the total integrated mixed phase water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

iceWaterPath (4-byte float, array size: nlat x nlon):
The monthly mean of the total integrated ice water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

rainWater (4-byte float, array size: nlat x nlon x nlayer):
The monthly mean of the rain water content for each grid at each vertical layer. Values range from 0 to 10 g/m^3. Special values are defined as:
-9999.9 Missing value

cloudWater (4-byte float, array size: nlat x nlon x nlayer):
The monthly mean of the cloud liquid water content for each grid at each vertical layer. Values range from 0 to 10 g/m^3. Special values are defined as:
-9999.9 Missing value

mixedWater (4-byte float, array size: nlat x nlon x nlayer):
The monthly mean of the mixed precipitation liquid water content for each grid at each vertical layer. Values range from 0 to 10 g/m^3. Special values are defined as:
-9999.9 Missing value

iceWater (4-byte float, array size: nlat x nlon x nlayer):
The monthly mean of the precipitation ice liquid water content for each grid at each vertical layer. Values range from 0 to 10 g/m^3. Special values are defined as:
-9999.9 Missing value

latentHeat (4-byte float, array size: nlat x nlon x nlayer):
The monthly mean of the latent heating release for each grid at each vertical layer. Values range from -256 to 256 C/hr. Special values are defined as:
-9999.9 Missing value

npixTotal (4-byte integer, array size: nlat x nlon):
The monthly number of pixels with pixelStatus equal to zero for each grid. The major effect of the pixelStatus requirement is to remove sea ice. npixTotal is used to compute the monthly means described above. Values range from 0 to 10000. Special values are defined as:
-9999 Missing value

npixPrecipitation (4-byte integer, array size: nlat x nlon):
The monthly number of pixels with surfacePrecipitation greater than 0 for each grid. For ocean, a pixel is also required to have probabilityOfPrecip greater than 50 percent. Values range from 0 to 10000. Special values are defined as:
-9999 Missing value

surfaceTypeIndex (4-byte integer, array size: nlat x nlon):
Indicates the type of surface (Range 0 - 99).

```
Codes include
1  : Ocean
2  : Sea-Ice
```

```
  (3-12 are 'land classification')
  3  : Maximum Vegetation
  4  : High Vegetation
  5  : Moderate Vegetation
  6  : Low Vegetation
  7  : Minimal Vegetation
  8  : Maximum Snow
  9  : Moderate Snow
  10 : Low Snow
  11 : Minimal Snow
  12 : Standing Water and Rivers
  13 : Water/Land Coast Boundary
  14 : Water/Ice Boundary
  15 : Land/Ice Boundary
 -99 : Missing value
```

fractionQuality0 (4-byte float, array size: nlat x nlon):
The fraction of the retrieved pixels in a given grid box identified as good retrievals. For regions where there are no retrieval issues this will be 1.0. Areas with surface screening or contamination issues with questionable retrievals during the accumulation period will have values less than one and should thus be used with caution for any quantitative analysis. Values range from 0 to 1 percent. Special values are defined as:
-9999.9 Missing value

fractionQuality1 (4-byte float, array size: nlat x nlon):
The fraction of total pixels with qualityFlag equal to 1 (medium quality) for each grid. Values range from 0 to 1 percent. Special values are defined as:
-9999.9 Missing value

fractionQuality2 (4-byte float, array size: nlat x nlon):
The fraction of total pixels with qualityFlag equal to 2 (low quality) for each grid. Values range from 0 to 1 percent. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_3GPROF_H_
#define _TK_3GPROF_H_

#ifndef _L3GPROF_GRID_
#define _L3GPROF_GRID_

typedef struct {
    float surfacePrecipitation[1440][720];
    float liquidPrecipFraction[1440][720];
```

```
    float convectPrecipFraction[1440][720];
    float rainWaterPath[1440][720];
    float cloudWaterPath[1440][720];
    float mixedWaterPath[1440][720];
    float iceWaterPath[1440][720];
    float rainWater[28][1440][720];
    float cloudWater[28][1440][720];
    float mixedWater[28][1440][720];
    float iceWater[28][1440][720];
    float latentHeat[28][1440][720];
    int npixTotal[1440][720];
    int npixPrecipitation[1440][720];
    int surfaceTypeIndex[1440][720];
    float fractionQuality0[1440][720];
    float fractionQuality1[1440][720];
    float fractionQuality2[1440][720];
} L3GPROF_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3GPROF_GRID/
    REAL*4 surfacePrecipitation(720,1440)
    REAL*4 liquidPrecipFraction(720,1440)
    REAL*4 convectPrecipFraction(720,1440)
    REAL*4 rainWaterPath(720,1440)
    REAL*4 cloudWaterPath(720,1440)
    REAL*4 mixedWaterPath(720,1440)
    REAL*4 iceWaterPath(720,1440)
    REAL*4 rainWater(720,1440,28)
    REAL*4 cloudWater(720,1440,28)
    REAL*4 mixedWater(720,1440,28)
    REAL*4 iceWater(720,1440,28)
    REAL*4 latentHeat(720,1440,28)
    INTEGER*4 npixTotal(720,1440)
    INTEGER*4 npixPrecipitation(720,1440)
    INTEGER*4 surfaceTypeIndex(720,1440)
    REAL*4 fractionQuality0(720,1440)
    REAL*4 fractionQuality1(720,1440)
    REAL*4 fractionQuality2(720,1440)
```

```
END STRUCTURE
```

5.33 3DPR - DPR Full Product

3DPR, "DPR Full Product", computes statistics of the DPR measurements at both a low horizontal resolution (G1, 5° x 5° latitude/longitude) and a high horizontal resolution (G2, 0.25^o x 0.25^o latitude/longitude). The product can be monthly or daily.

```
Histograms have the following category thresholds, where
histbin(i) =  cat(i) less than x less than or equal to cat(i+1)
cat rain = [ 0.01,    ! mm/h  (logarithmic steps)
        0.10,   0.13,   0.17,   0.23,   0.30,   0.40,
        0.52,   0.69,   0.91,   1.20,   1.58,   2.08,
        2.75,   3.62,   4.77,   6.29,   8.29,  10.92,
       14.40,  18.97,  25.00,  32.95,  43.43,  57.24,
       75.44,  99.43, 131.04, 172.71, 227.63, 300.00 ],

cat Z = [ 0.01,       ! dBZ
       6.0,    8.0,   10.0,   12.0,   14.0,   16.0,
       18.0,   20.0,   22.0,   24.0,   26.0,   28.0,
       30.0,   32.0,   34.0,   36.0,   38.0,   40.0,
       42.0,   44.0,   46.0,   48.0,   50.0,   52.0,
       54.0,   56.0,   58.0,   60.0,   62.0,   64.0 ],

cat integratedWater = [ 0.0,      ! kg/m^2
     200.0,  400.0,  600.0,  800.0, 1000.0, 1200.0,
     1400.0, 1600.0, 1800.0, 2000.0, 2200.0, 2400.0,
     2600.0, 2800.0, 3000.0, 3200.0, 3400.0, 3600.0,
     3800.0, 4000.0, 4200.0, 4400.0, 4600.0, 4800.0,
     5000.0, 5200.0, 5400.0, 5600.0, 5800.0, 6000.0 ],

cat bbhgt = [ 10.0,    ! meters
     250.0,  500.0,  750.0, 1000.0, 1250.0, 1500.0,
     1750.0, 2000.0, 2250.0, 2500.0, 2750.0, 3000.0,
     3250.0, 3500.0, 3750.0, 4000.0, 4250.0, 4500.0,
     4750.0, 5000.0, 5250.0, 5500.0, 5750.0, 6000.0,
     6250.0, 6500.0, 6750.0, 7000.0, 7500.0,20000.0 ],

cat bbwdth = [ 0.0,    ! meters
      125.0,  250.0,  375.0,  500.0,  625.0,  750.0,
      875.0, 1000.0, 1125.0, 1250.0, 1375.0, 1500.0,
```

```
     1625.0, 1750.0, 1875.0, 2000.0, 2125.0, 2250.0,
     2375.0, 2500.0, 2625.0, 2750.0, 2875.0, 3000.0,
     3125.0, 3250.0, 3375.0, 3500.0, 3625.0, 3750.0 ],

cat stormh = 1000.0*[ 0.01,   ! km  (convert m > km)
        0.5,    1.0,    1.5,    2.0,    2.5,    3.0,
        3.5,    4.0,    4.5,    5.0,    5.5,    6.0,
        6.5,    7.0,    7.5,    8.0,    8.5,    9.0,
        9.5,   10.0,   10.5,   11.0,   11.5,   12.0,
       12.5,   13.0,   14.0,   15.0,   16.0,   20.0 ],

cat epsilon = [ 0.0,
        0.1,    0.2,    0.3,    0.4,    0.5,    0.6,
        0.7,    0.8,    0.9,    1.0,    1.1,    1.2,
        1.3,    1.4,    1.5,    1.6,    1.7,    1.8,
        1.9,    2.0,    2.1,    2.2,    2.3,    2.4,
        2.5,    2.6,    2.7,    2.8,    2.9,    3.0 ],

cat nubf = [ 1.0,
        1.05,   1.1,    1.15,   1.2,    1.25,   1.3,
        1.35,   1.4,    1.45,   1.5,    1.55,   1.6,
        1.65,   1.7,    1.75,   1.8,    1.85,   1.9,
        1.95,   2.0,    2.1,    2.2,    2.3,    2.4,
        2.5,    2.6,    2.7,    2.8,    2.9,    3.0 ],

cat pia = [ 0.01,
        0.1,    0.2,    0.3,    0.4,    0.5,    0.6,
        0.8,    1.0,    1.2,    1.4,    1.6,    1.8,
        2.0,    2.5,    3.0,    3.5,    4.0,    4.5,
        5.0,    5.5,    6.0,    7.0,    8.0,    9.0,
       10.0,   15.0,   20.0,   25.0,   30.0,  100.0 ],

cat dBNw = [ 0.1,
       1.0,    2.0,    4.0,    6.0,    8.0,   10.0,
       12.0,   14.0,   16.0,   18.0,   20.0,   22.0,
       24.0,   26.0,   28.0,   30.0,   32.0,   34.0,
       36.0,   38.0,   40.0,   42.0,   44.0,   46.0,
       48.0,   50.0,   52.0,   54.0,   56.0,   60.0 ],

cat Dm = [ 0.1,        ! mm
        0.2,    0.3,    0.4,    0.5,    0.6,    0.7,
        0.8,    0.9,    1.0,    1.1,    1.2,    1.3,
        1.4,    1.5,    1.6,    1.7,    1.8,    1.9,
```

```
2.0,    2.1,    2.2,    2.3,    2.4,    2.5,
2.6,    2.7,    2.8,    2.9,    3.0,    4.0 ]
```

Dimension definitions:

ltL	28	Number of low resolution 5° grid intervals of latitude from 70^oS to 70^oN.
lnL	72	Number of low resolution 5° grid intervals of longitude from 180^oW to 180^oE.
ltH	536	Number of high resolution 0.25^o grid intervals of latitude from 67^oS to 67^oN.
lnH	1440	Number of high resolution 0.25^o grid intervals of longitude from 180^oW to 180^oE.
chn	5	Number of channels: Ku, Ka, KaHS, DPR, KuMS.
inst	4	Number of instruments: Ku, Ka, KaHS, KuMS.
hgt	5	Number of heights above the earth ellipsoid: 2, 4, 6, 10, and 15 km.
tim	24	Number of hours (local time).
ang	7	Number of angles. The meaning of ang is different for each channel. For Ku channel all indeces are used with the meaning 0, 1, 2,...,6 = angle bins 24, (20,28), (16,32), (12,36), (8,40), (3,44), and (0,48). For Ka channel 4 indeces are used with the meaning 0, 1, 2, 3 = angle bins 12, (8,16), (4,20), and (0,24). For KaHS channel 4 indeces are used with the meaning 0, 1, 2, 3 = angle bins (11,2), (7,16), (3,20), and (0,23).
rt	3	Number of rain types: stratiform, convective, all.
st	3	Number of surface types: ocean, land, all.
bin	30	Number of bins in histogram. The thresholds are different for different variables. See the introduction to this algorithm.

Figure 414 through Figure 487 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

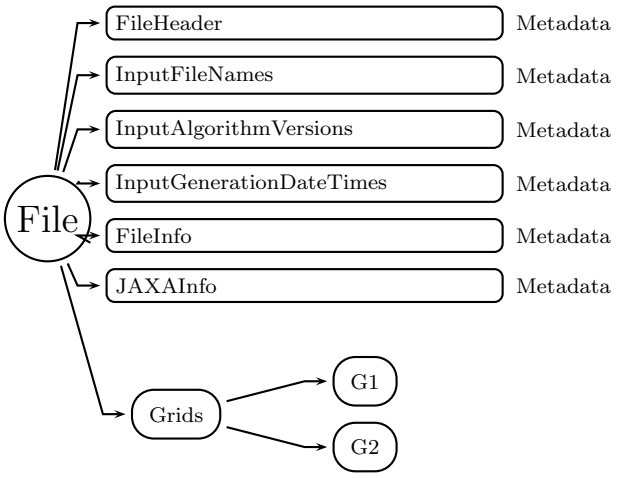
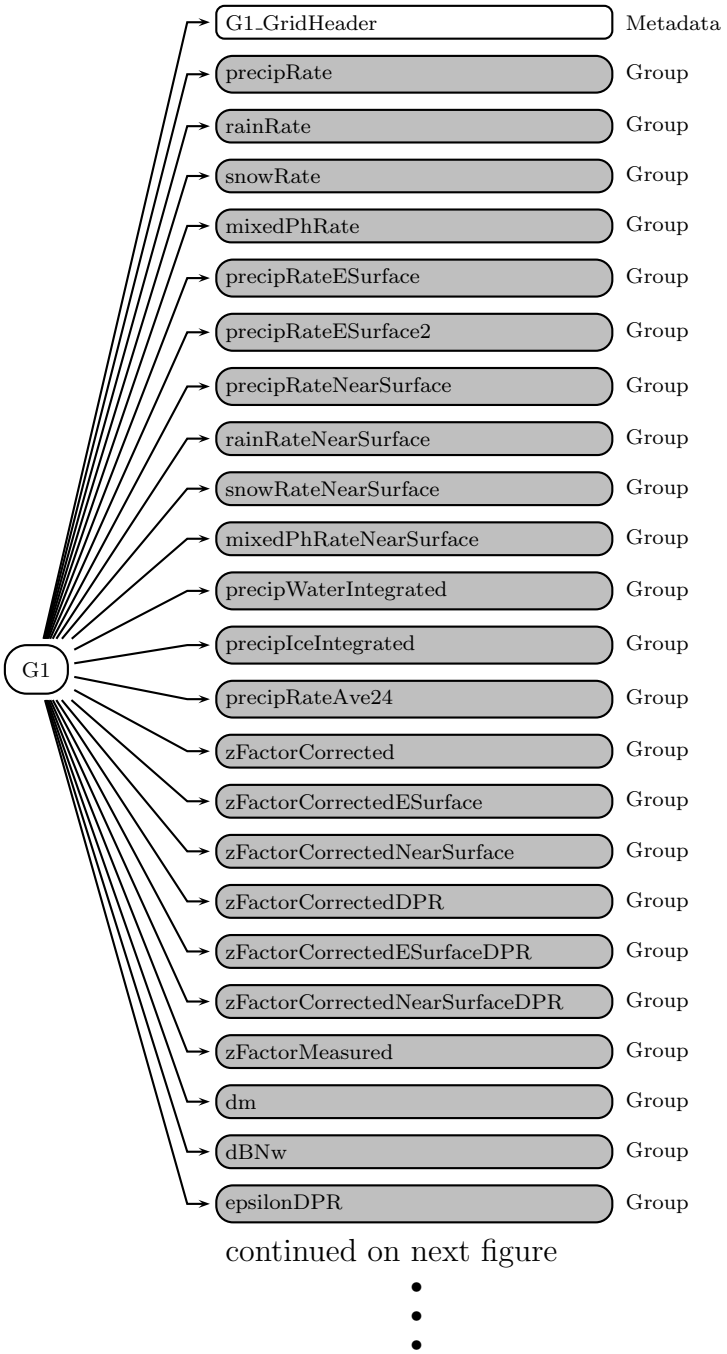


Figure 414: Data Format Structure for 3DPR, DPR Full Product



continued on next figure

Figure 415: Data Format Structure for 3DPR, G1, G1

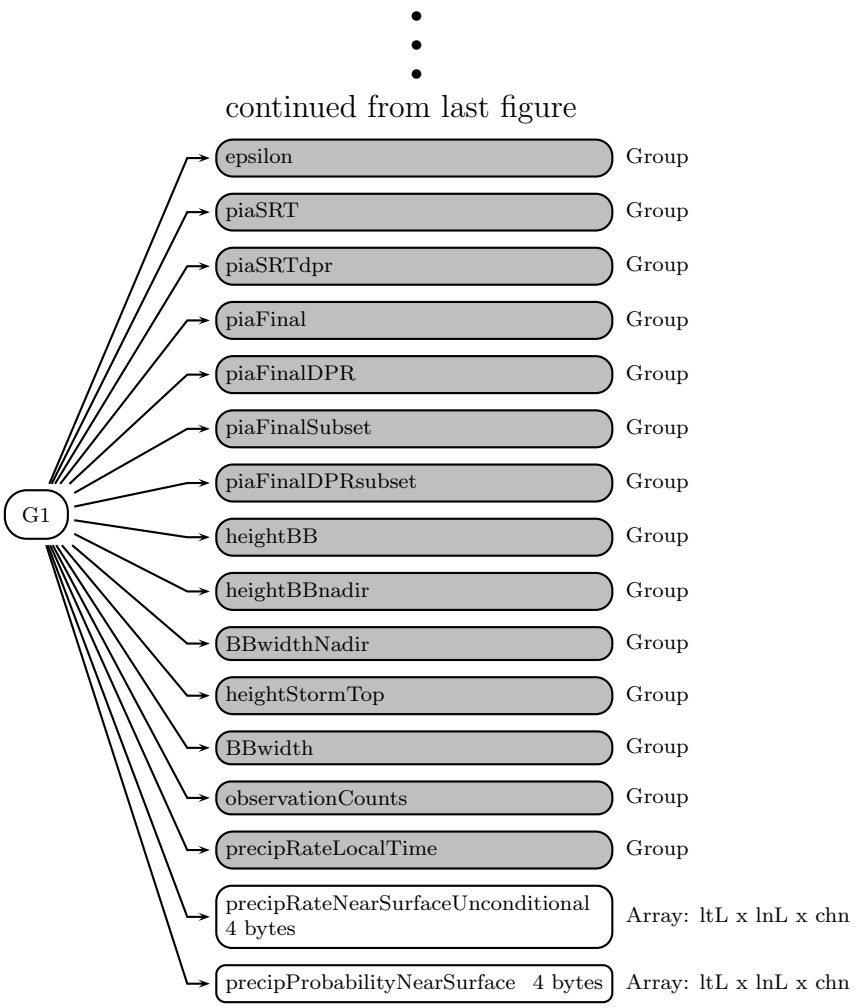
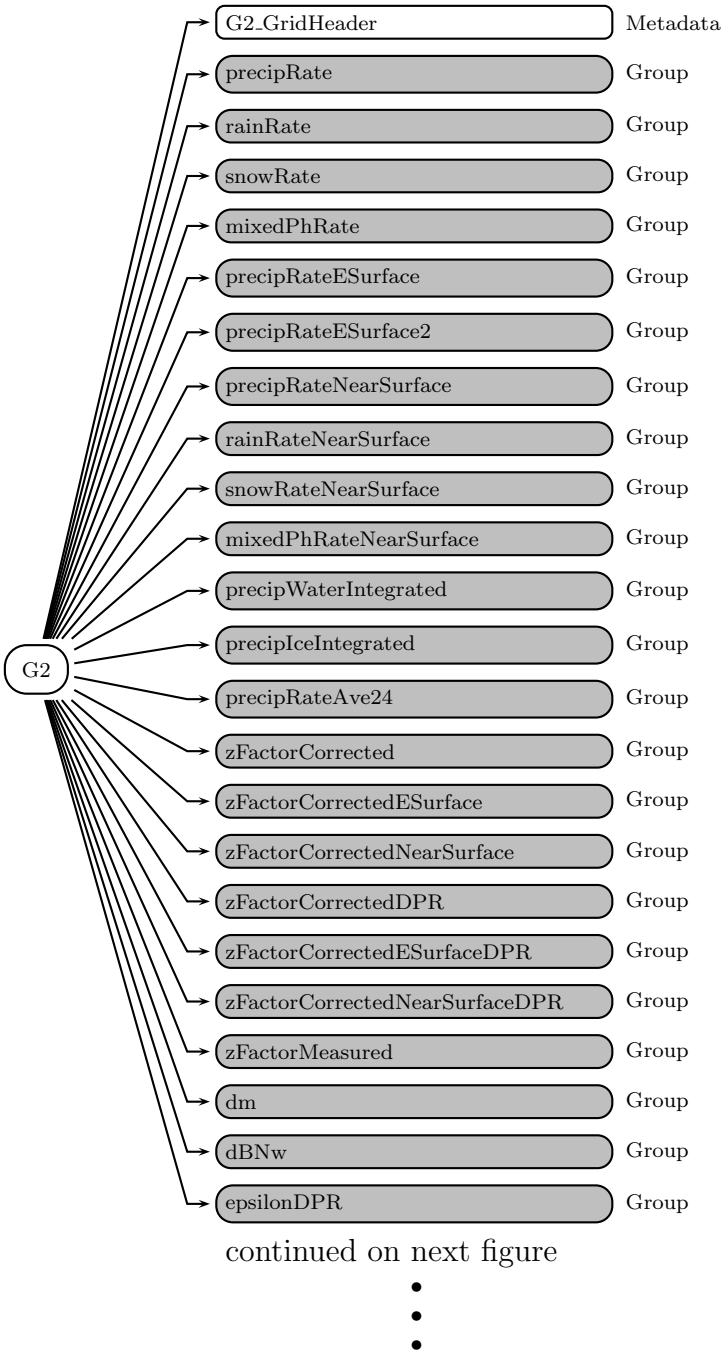


Figure 416: Data Format Structure for 3DPR, G1



continued on next figure

Figure 417: Data Format Structure for 3DPR, G2, G2

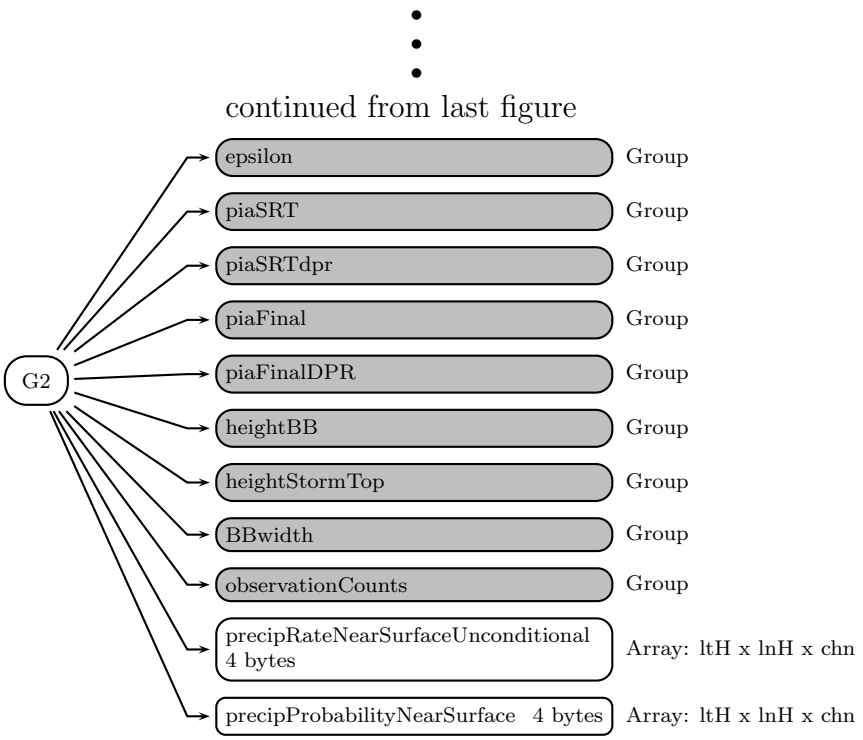


Figure 418: Data Format Structure for 3DPR, G2

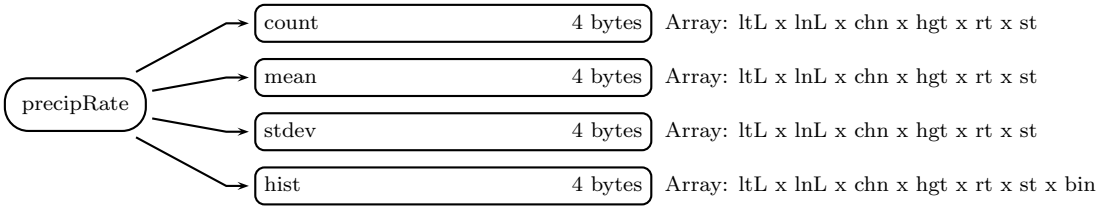


Figure 419: Data Format Structure for 3DPR, G1, precipRate

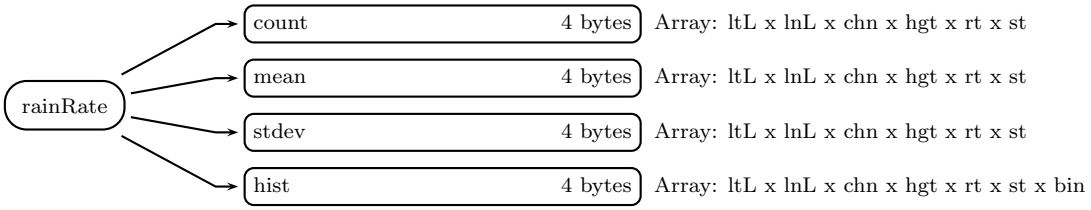


Figure 420: Data Format Structure for 3DPR, G1, rainRate

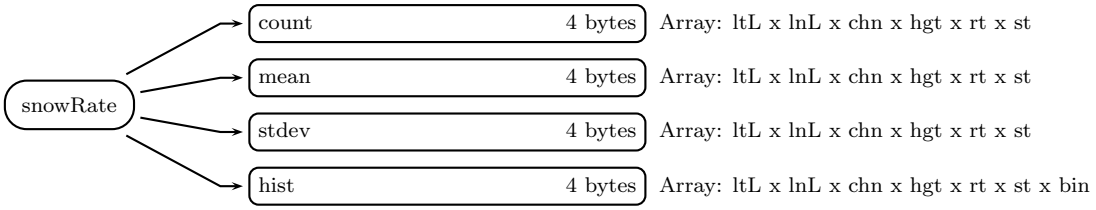


Figure 421: Data Format Structure for 3DPR, G1, snowRate

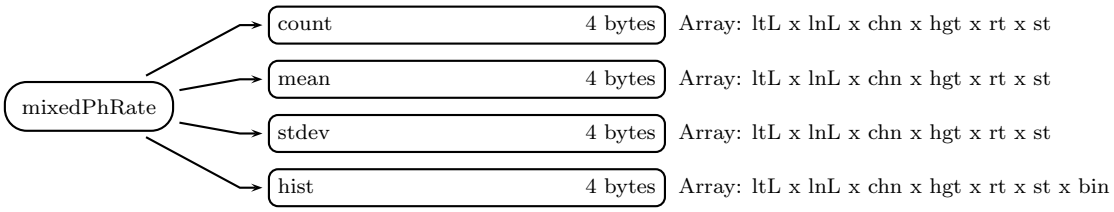


Figure 422: Data Format Structure for 3DPR, G1, mixedPhRate

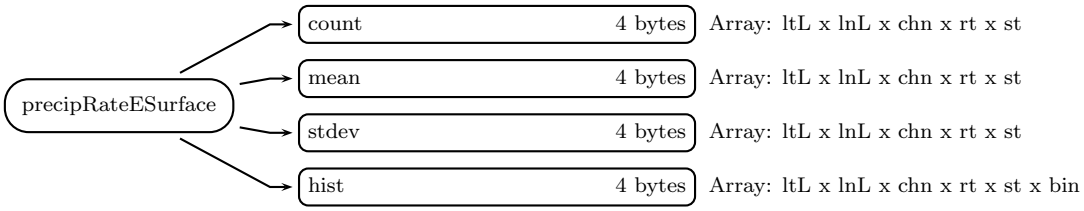


Figure 423: Data Format Structure for 3DPR, G1, precipRateESurface

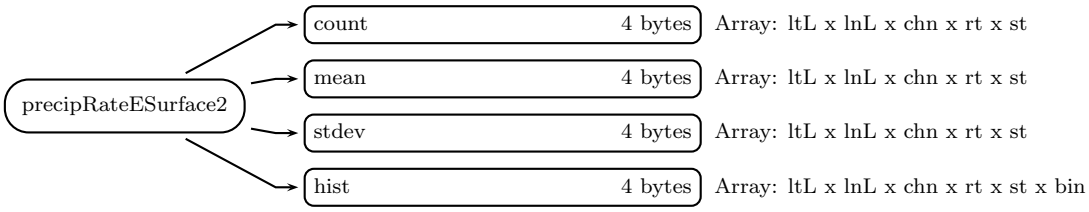


Figure 424: Data Format Structure for 3DPR, G1, precipRateESurface2

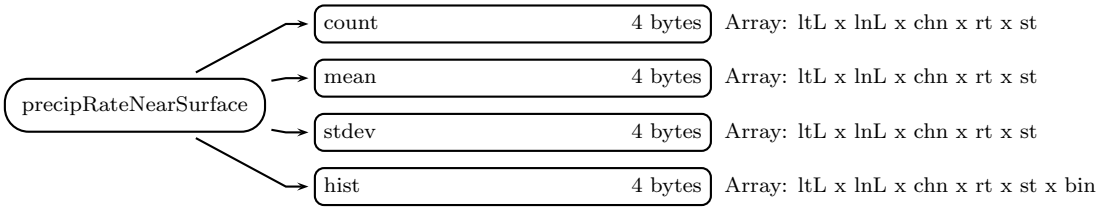


Figure 425: Data Format Structure for 3DPR, G1, precipRateNearSurface

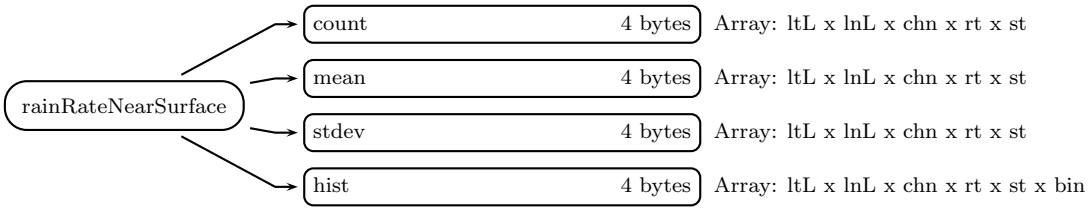


Figure 426: Data Format Structure for 3DPR, G1, rainRateNearSurface

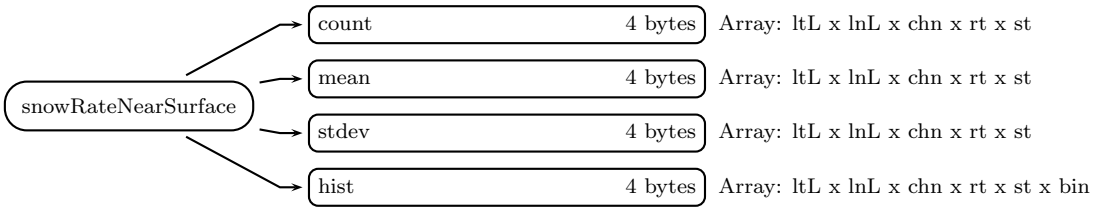


Figure 427: Data Format Structure for 3DPR, G1, snowRateNearSurface

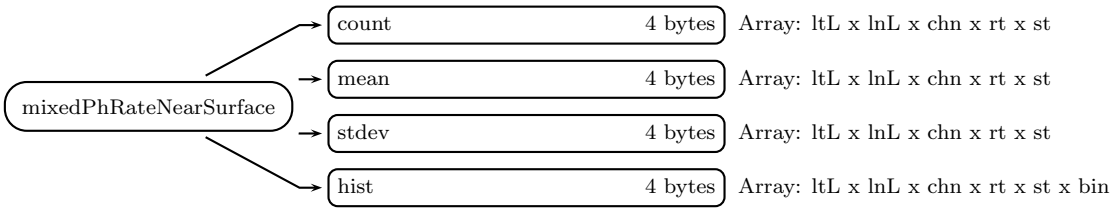


Figure 428: Data Format Structure for 3DPR, G1, mixedPhRateNearSurface

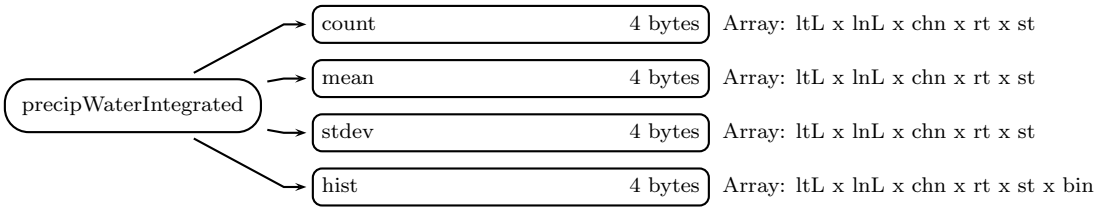


Figure 429: Data Format Structure for 3DPR, G1, precipWaterIntegrated

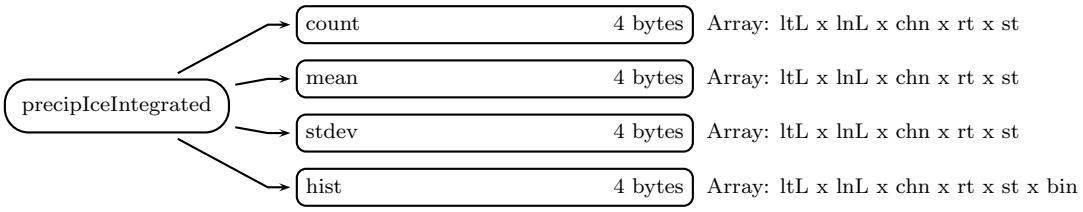


Figure 430: Data Format Structure for 3DPR, G1, precipIceIntegrated

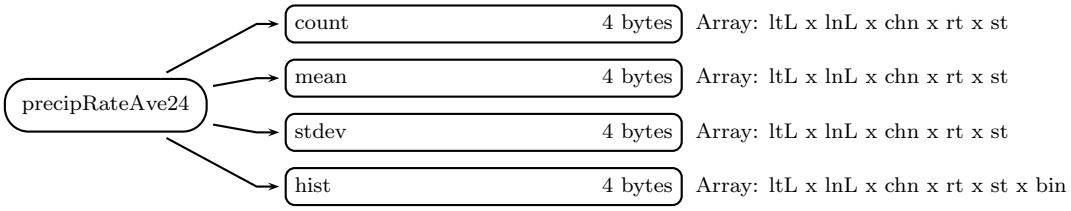


Figure 431: Data Format Structure for 3DPR, G1, precipRateAve24

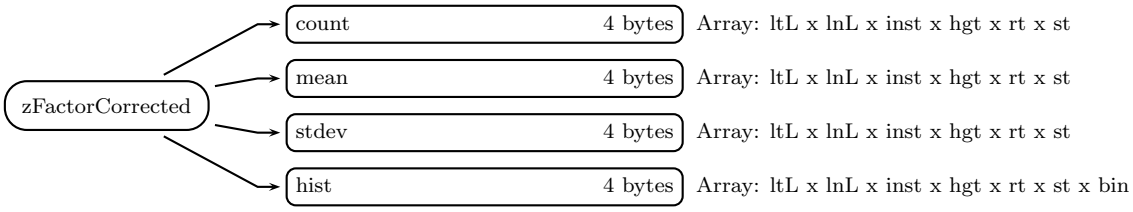


Figure 432: Data Format Structure for 3DPR, G1, zFactorCorrected

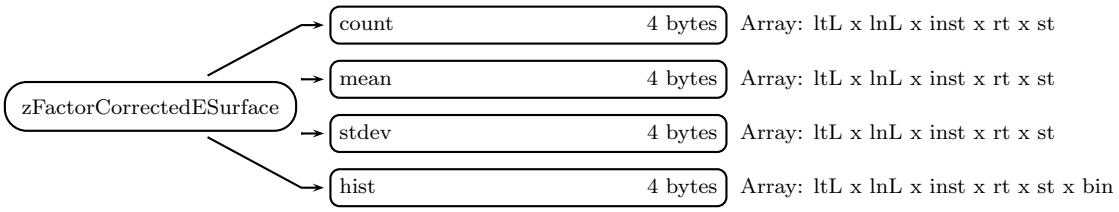


Figure 433: Data Format Structure for 3DPR, G1, zFactorCorrectedESurface

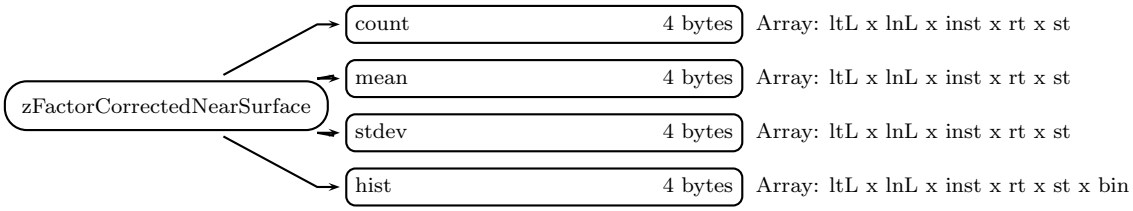


Figure 434: Data Format Structure for 3DPR, G1, zFactorCorrectedNearSurface

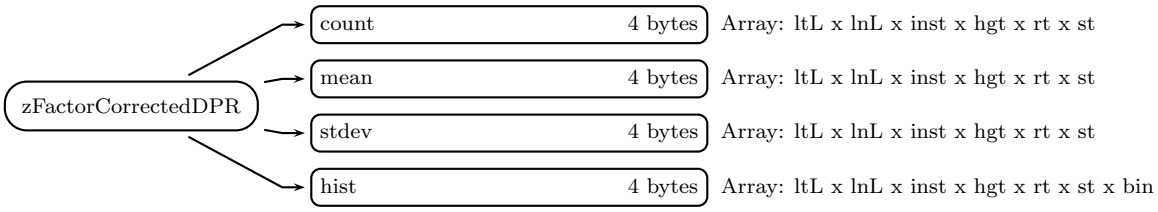


Figure 435: Data Format Structure for 3DPR, G1, zFactorCorrectedDPR

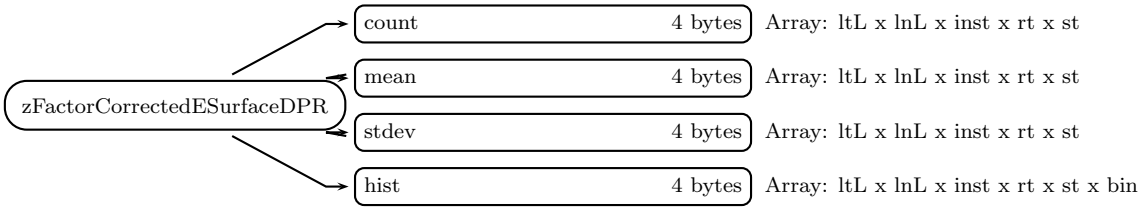


Figure 436: Data Format Structure for 3DPR, G1, zFactorCorrectedESurfaceDPR

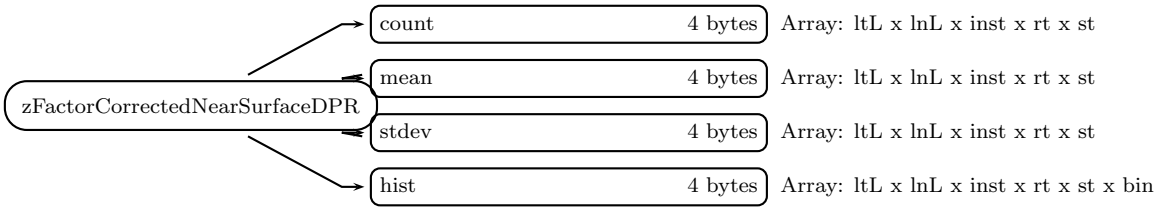


Figure 437: Data Format Structure for 3DPR, G1, zFactorCorrectedNearSurfaceDPR

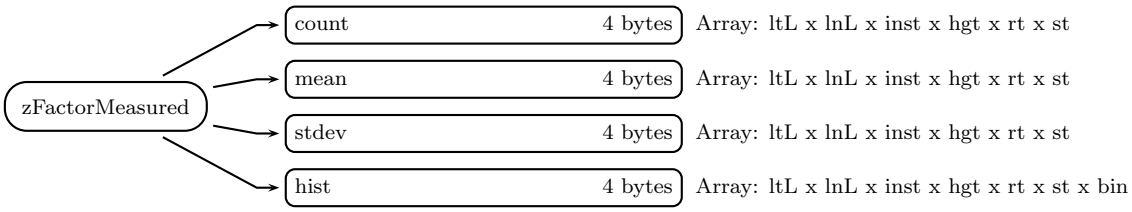


Figure 438: Data Format Structure for 3DPR, G1, zFactorMeasured

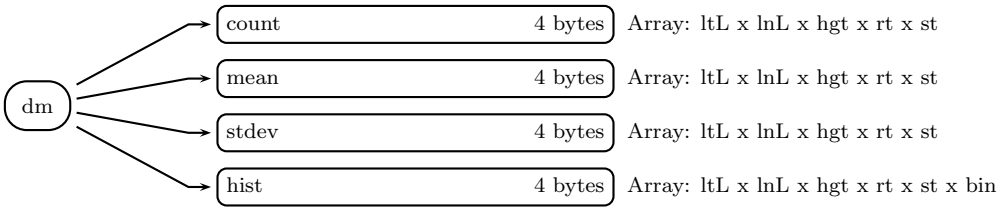


Figure 439: Data Format Structure for 3DPR, G1, dm

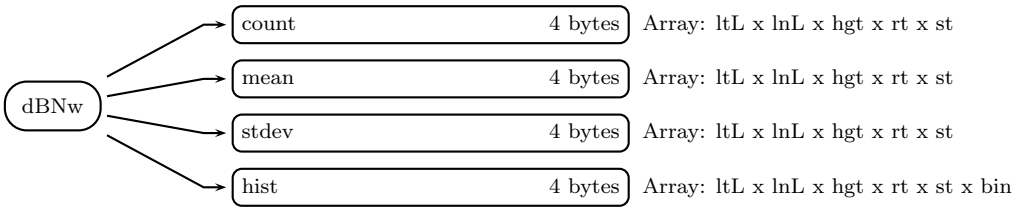


Figure 440: Data Format Structure for 3DPR, G1, dBNw

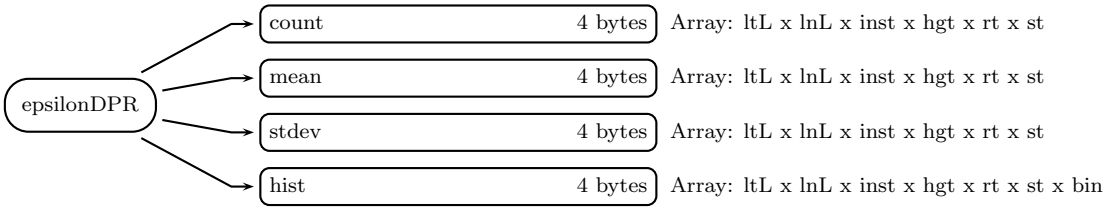


Figure 441: Data Format Structure for 3DPR, G1, epsilonDPR

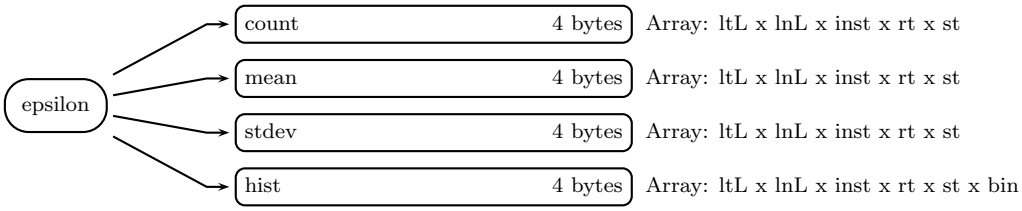


Figure 442: Data Format Structure for 3DPR, G1, epsilon

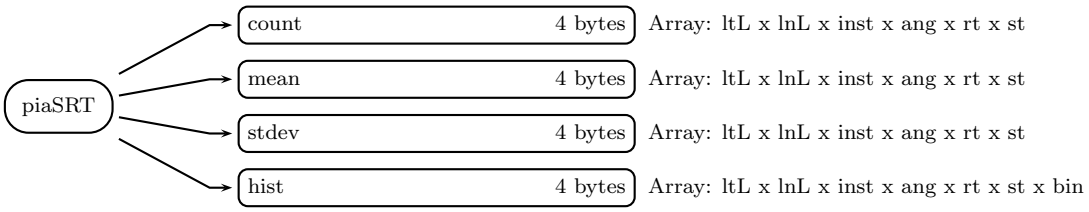


Figure 443: Data Format Structure for 3DPR, G1, piaSRT

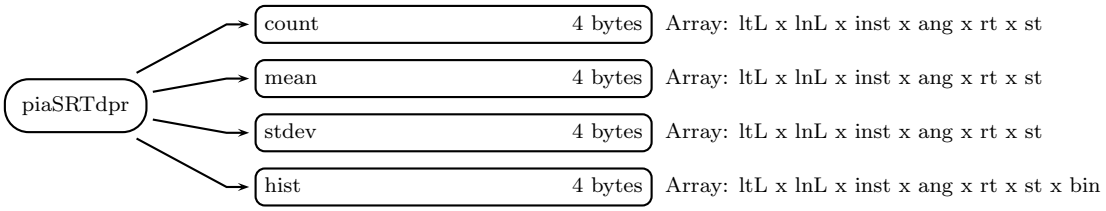


Figure 444: Data Format Structure for 3DPR, G1, piaSRTdpr

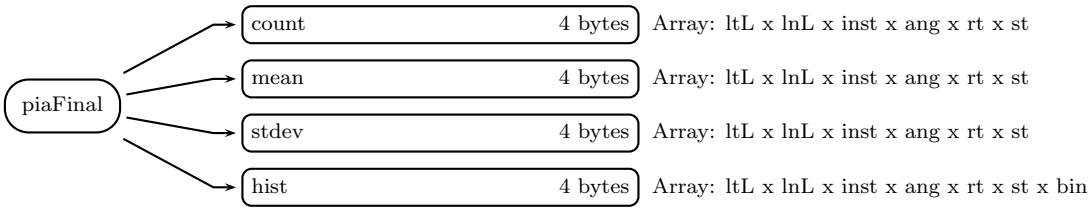


Figure 445: Data Format Structure for 3DPR, G1, piaFinal

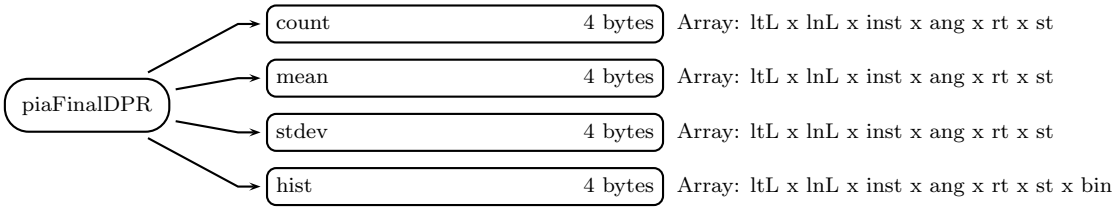


Figure 446: Data Format Structure for 3DPR, G1, piaFinalDPR

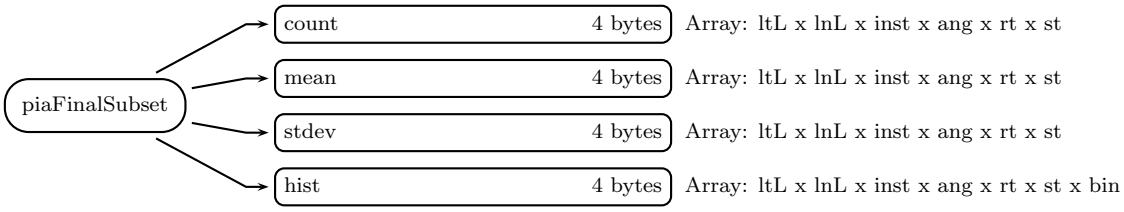


Figure 447: Data Format Structure for 3DPR, G1, piaFinalSubset

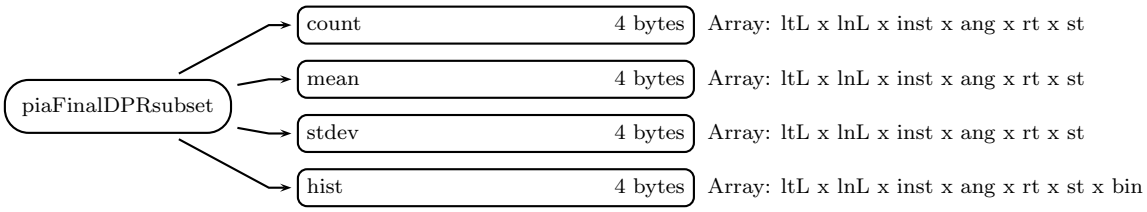


Figure 448: Data Format Structure for 3DPR, G1, piaFinalDPRsubset

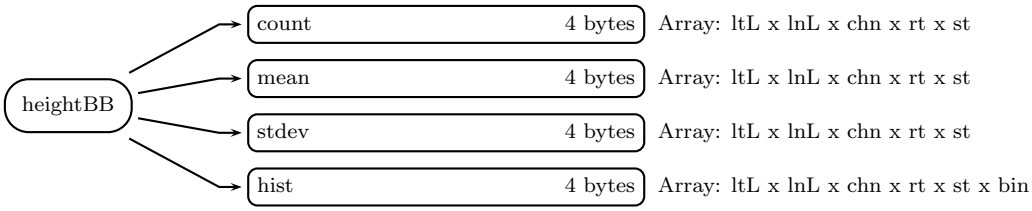


Figure 449: Data Format Structure for 3DPR, G1, heightBB

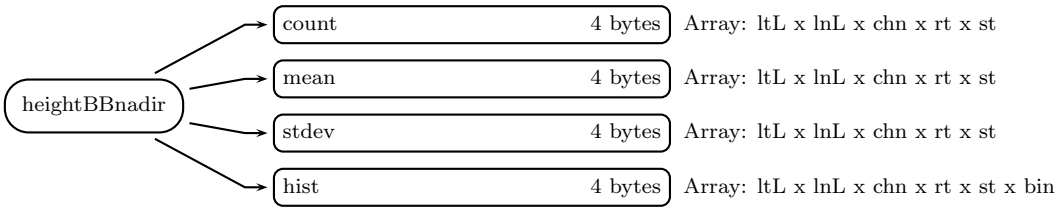


Figure 450: Data Format Structure for 3DPR, G1, heightBBnadir

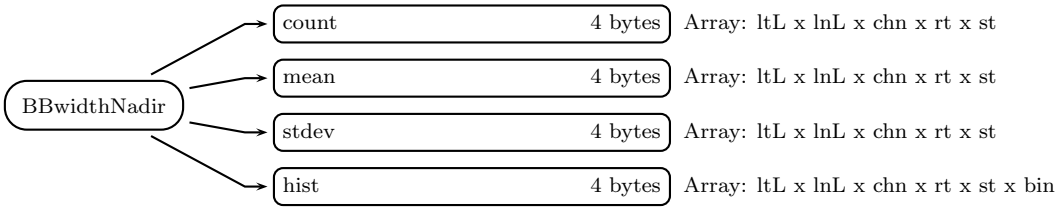


Figure 451: Data Format Structure for 3DPR, G1, BBwidthNadir

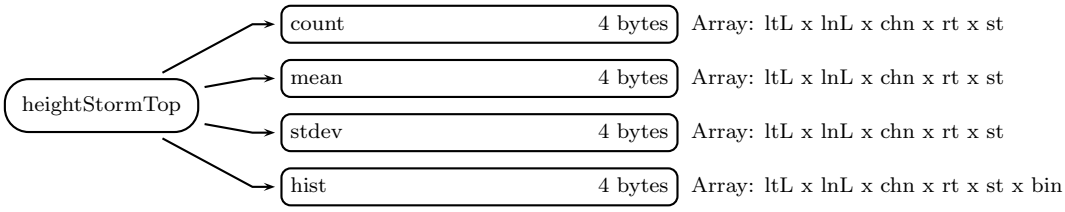


Figure 452: Data Format Structure for 3DPR, G1, heightStormTop

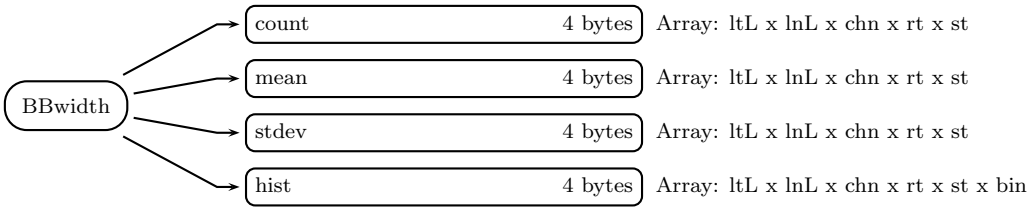


Figure 453: Data Format Structure for 3DPR, G1, BBwidth

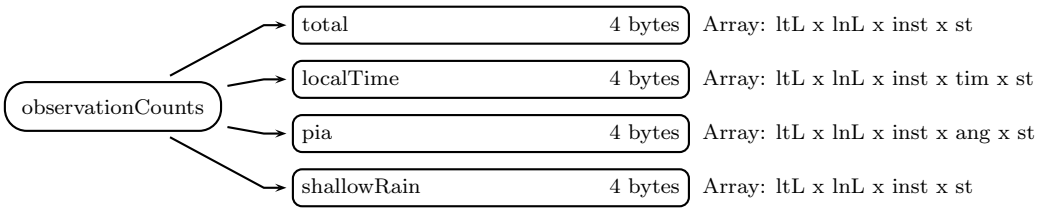


Figure 454: Data Format Structure for 3DPR, G1, observationCounts

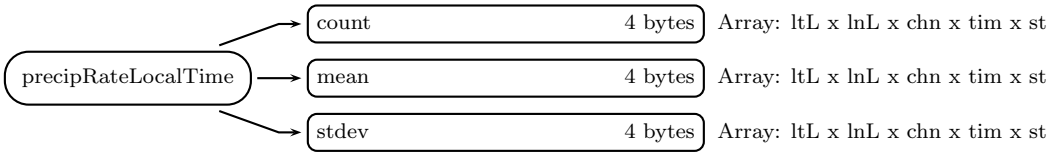


Figure 455: Data Format Structure for 3DPR, G1, precipRateLocalTime

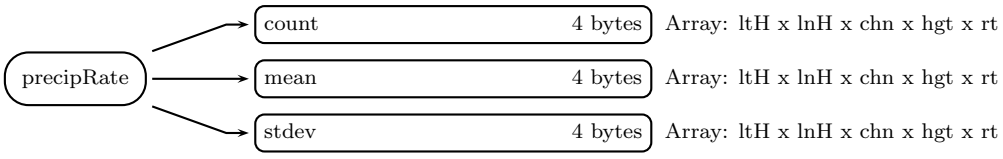


Figure 456: Data Format Structure for 3DPR, G2, precipRate

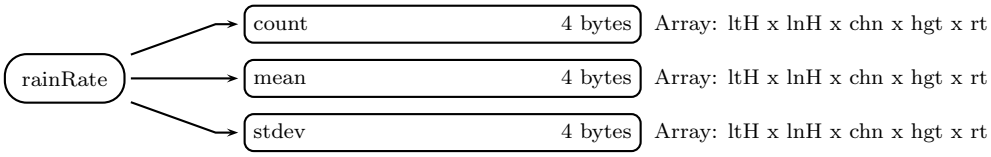


Figure 457: Data Format Structure for 3DPR, G2, rainRate

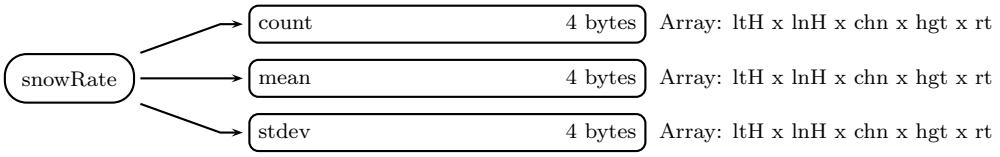


Figure 458: Data Format Structure for 3DPR, G2, snowRate

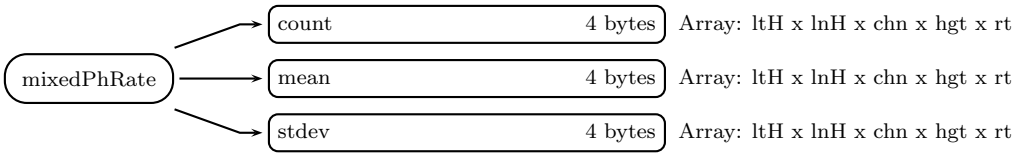


Figure 459: Data Format Structure for 3DPR, G2, mixedPhRate

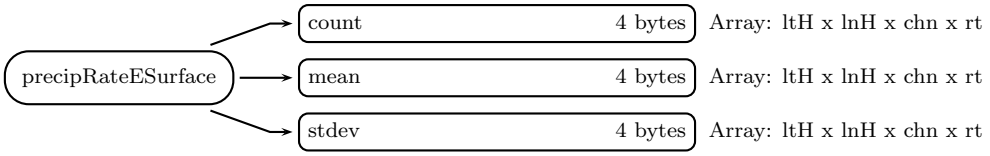


Figure 460: Data Format Structure for 3DPR, G2, precipRateESurface

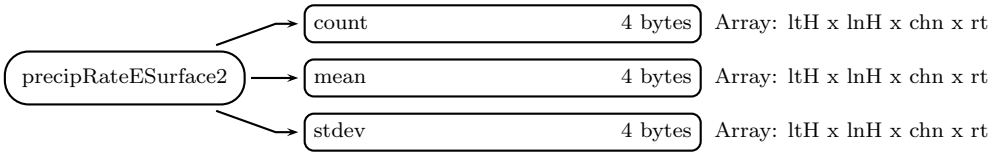


Figure 461: Data Format Structure for 3DPR, G2, precipRateESurface2

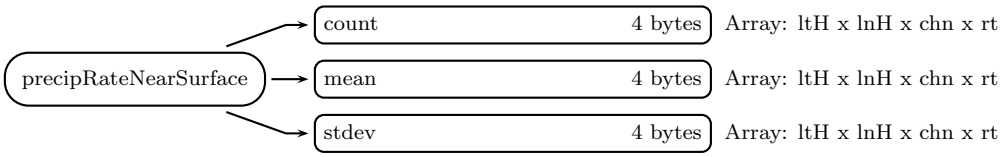


Figure 462: Data Format Structure for 3DPR, G2, precipRateNearSurface

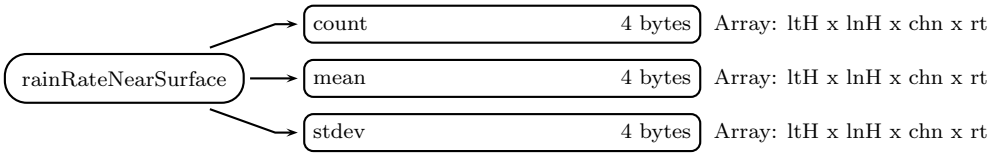


Figure 463: Data Format Structure for 3DPR, G2, rainRateNearSurface

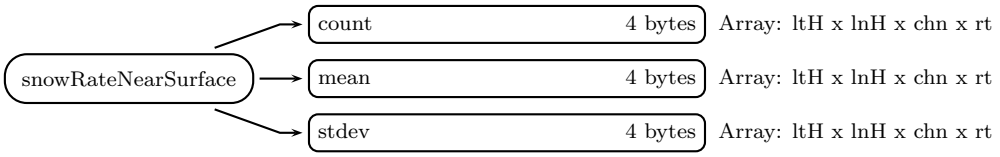


Figure 464: Data Format Structure for 3DPR, G2, snowRateNearSurface

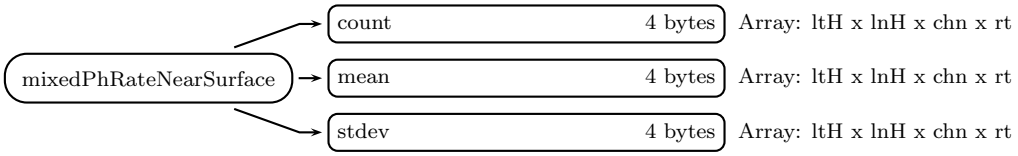


Figure 465: Data Format Structure for 3DPR, G2, mixedPhRateNearSurface

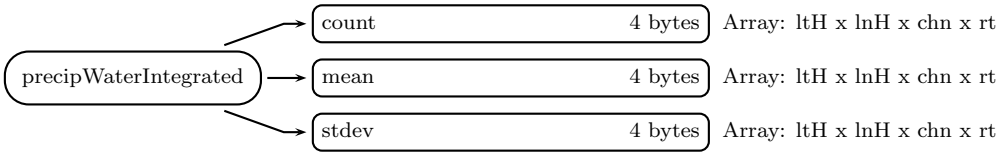


Figure 466: Data Format Structure for 3DPR, G2, precipWaterIntegrated

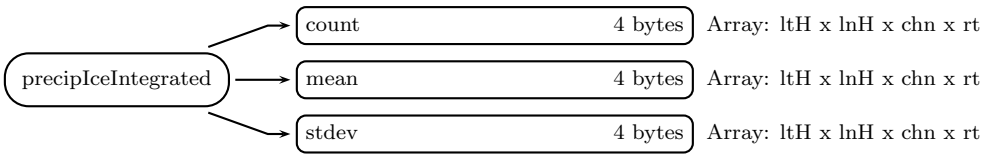


Figure 467: Data Format Structure for 3DPR, G2, precipIceIntegrated

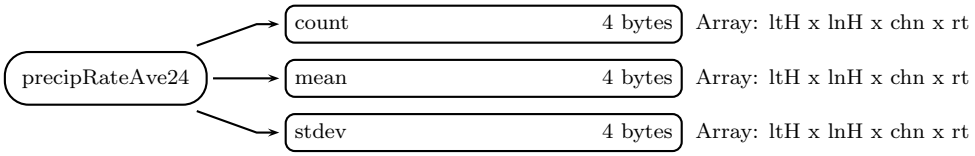


Figure 468: Data Format Structure for 3DPR, G2, precipRateAve24

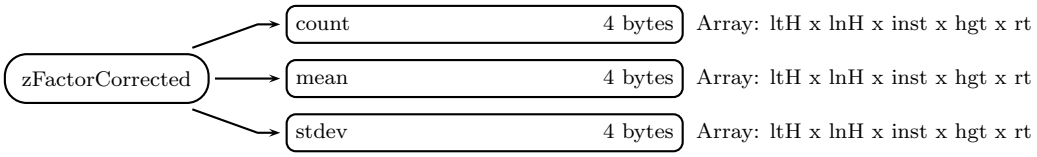


Figure 469: Data Format Structure for 3DPR, G2, zFactorCorrected

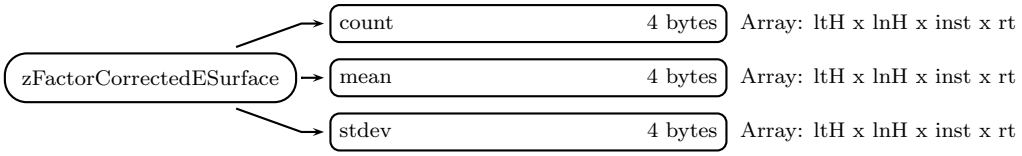


Figure 470: Data Format Structure for 3DPR, G2, zFactorCorrectedESurface

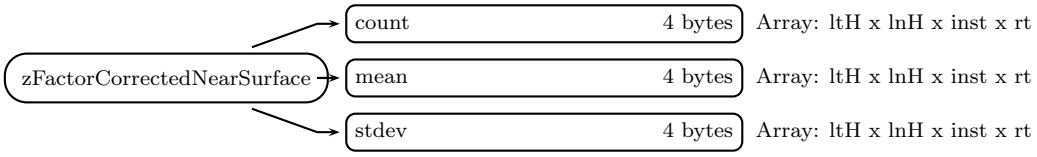


Figure 471: Data Format Structure for 3DPR, G2, zFactorCorrectedNearSurface

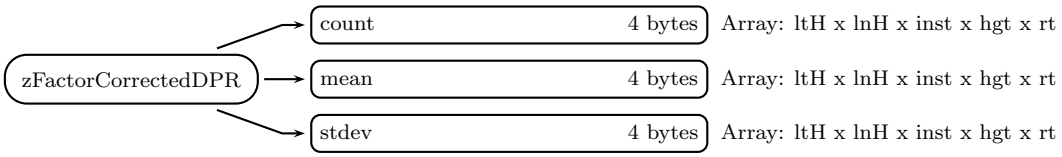


Figure 472: Data Format Structure for 3DPR, G2, zFactorCorrectedDPR

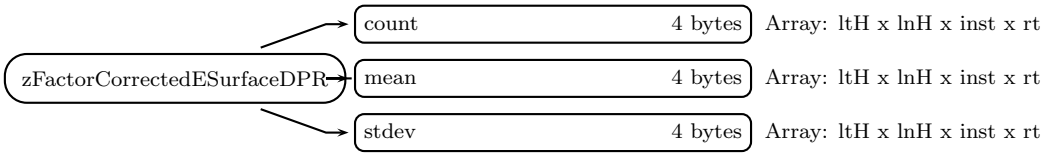


Figure 473: Data Format Structure for 3DPR, G2, zFactorCorrectedESurfaceDPR

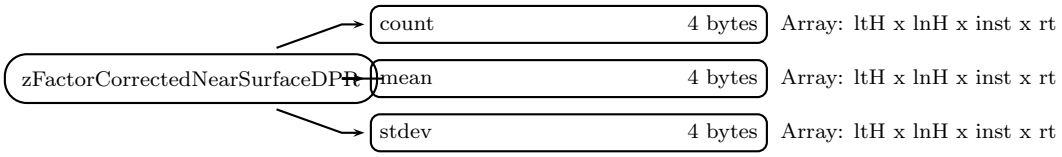


Figure 474: Data Format Structure for 3DPR, G2, zFactorCorrectedNearSurfaceDPR

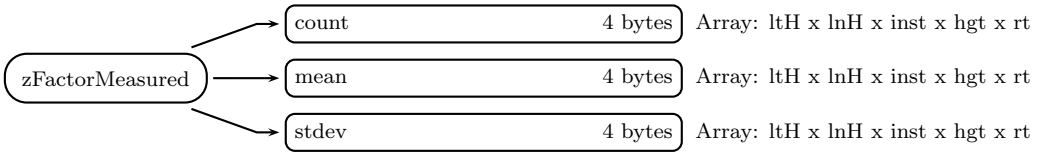


Figure 475: Data Format Structure for 3DPR, G2, zFactorMeasured

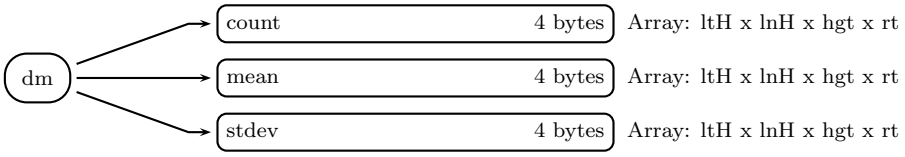


Figure 476: Data Format Structure for 3DPR, G2, dm

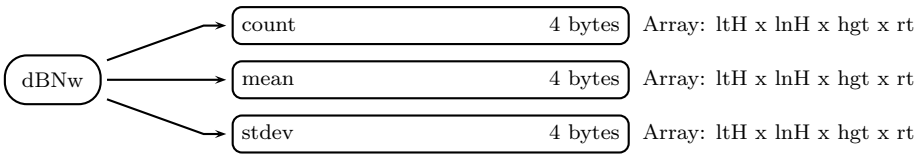


Figure 477: Data Format Structure for 3DPR, G2, dBNw

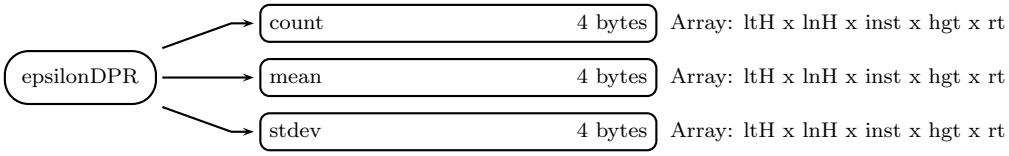


Figure 478: Data Format Structure for 3DPR, G2, epsilonDPR

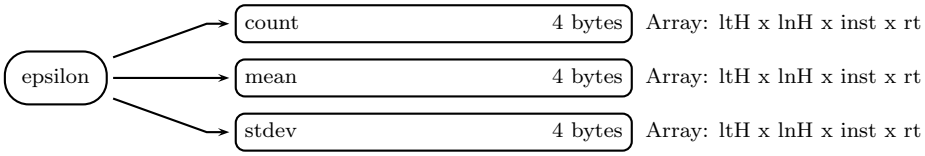


Figure 479: Data Format Structure for 3DPR, G2, epsilon

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputFileNames (Metadata):
InputFileNames contains a list of input file names for this granule. See Metadata for GPM Products for details.

InputAlgorithmVersions (Metadata):
InputAlgorithmVersions contains a list of input algorithm versions for this granule. See Metadata for GPM Products for details.

InputGenerationDateTimes (Metadata):
InputGenerationDateTimes contains a list of input generation datetimes. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

Grids (Group)

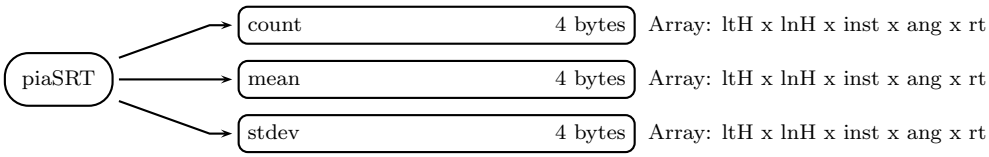


Figure 480: Data Format Structure for 3DPR, G2, piaSRT

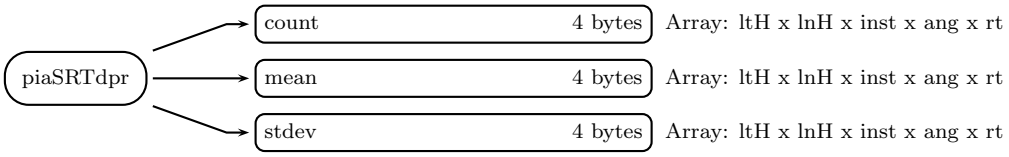


Figure 481: Data Format Structure for 3DPR, G2, piaSRTdpr

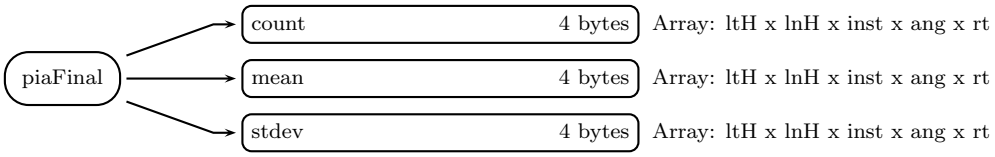


Figure 482: Data Format Structure for 3DPR, G2, piaFinal

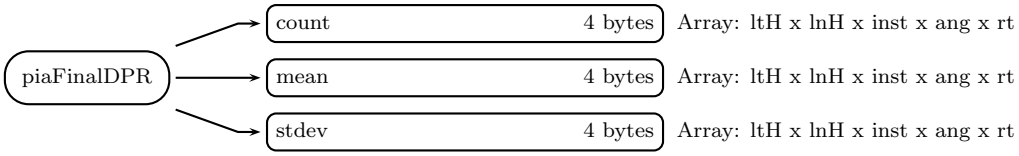


Figure 483: Data Format Structure for 3DPR, G2, piaFinalDPR

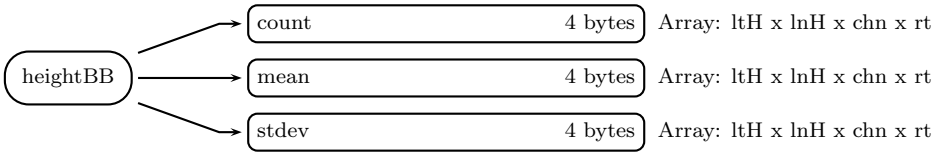


Figure 484: Data Format Structure for 3DPR, G2, heightBB

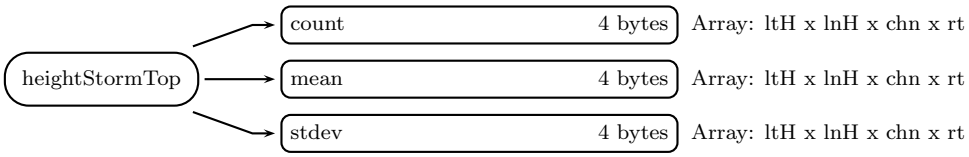


Figure 485: Data Format Structure for 3DPR, G2, heightStormTop

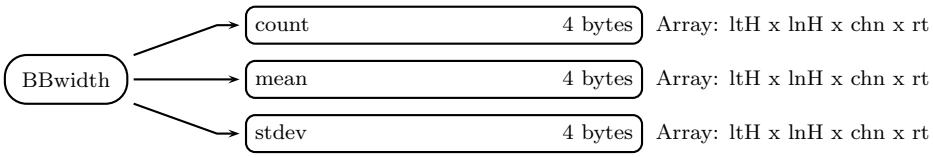


Figure 486: Data Format Structure for 3DPR, G2, BBwidth

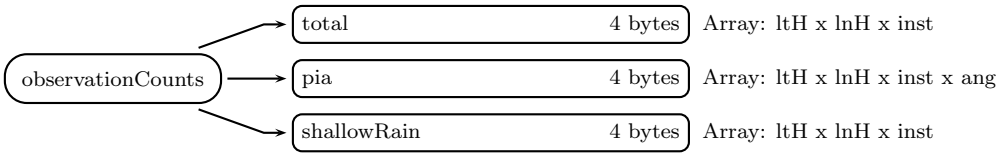


Figure 487: Data Format Structure for 3DPR, G2, observationCounts

G1 (Grid)

G1_GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

precipRate (Group in G1)

Conditional Precipitation Rate.

count (4-byte integer, array size: ltL x lnL x chn x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

rainRate (Group in G1)

Conditional liquid water Rain Rate.

count (4-byte integer, array size: ltL x lnL x chn x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

snowRate (Group in G1)

Conditional Snowfall Rate.

count (4-byte integer, array size: ltL x lnL x chn x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

mixedPhRate (Group in G1)

Conditional Mixed Phase Precipitation Rate.

count (4-byte integer, array size: ltL x lnL x chn x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipRateESurface (Group in G1)

Conditional Estimated Surface Precipitation Rate.

count (4-byte integer, array size: ltL x lnL x chn x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipRateESurface2 (Group in G1)

Alternate Conditional Estimated Surface Precipitation Rate.

count (4-byte integer, array size: ltL x lnL x chn x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipRateNearSurface (Group in G1)

Conditional Precipitation Rate at Near Surface Level.

count (4-byte integer, array size: ltL x lnL x chn x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

rainRateNearSurface (Group in G1)

Unconditional liquid Rain Rate at Near Surface Level.

count (4-byte integer, array size: ltL x lnL x chn x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

snowRateNearSurface (Group in G1)

Conditional Snow Rate at Near Surface Level.

count (4-byte integer, array size: ltL x lnL x chn x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

mixedPhRateNearSurface (Group in G1)

Conditional Mixed Phase Precipitation Rate at Near Surface Level.

count (4-byte integer, array size: ltL x lnL x chn x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipWaterIntegrated (Group in G1)

Integrated Precipitable Water (g/m^2).

count (4-byte integer, array size: ltL x lnL x chn x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipIceIntegrated (Group in G1)

Integrated Precipitable Ice

count (4-byte integer, array size: ltL x lnL x chn x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipRateAve24 (Group in G1)

Average Precipitation Rate in 24hrs.

count (4-byte integer, array size: ltL x lnL x chn x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorCorrected (Group in G1)

Corrected Reflectivity

count (4-byte integer, array size: ltL x lnL x inst x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x inst x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x inst x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x inst x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorCorrectedESurface (Group in G1)

Corrected Reflectivity at the Estimated Surface

count (4-byte integer, array size: ltL x lnL x inst x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x inst x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x inst x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x inst x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorCorrectedNearSurface (Group in G1)

Corrected Reflectivity at the Near Surface Level.

count (4-byte integer, array size: ltL x lnL x inst x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x inst x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x inst x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x inst x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorCorrectedDPR (Group in G1)

Corrected Reflectivity from DPR

count (4-byte integer, array size: ltL x lnL x inst x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x inst x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x inst x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x inst x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorCorrectedESurfaceDPR (Group in G1)

Corrected Reflectivity from DPR at Estimated Surface.

count (4-byte integer, array size: ltL x lnL x inst x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x inst x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x inst x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x inst x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorCorrectedNearSurfaceDPR (Group in G1)

Corrected Reflectivity from DPR at the Near Surface Level.

count (4-byte integer, array size: ltL x lnL x inst x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x inst x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x inst x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x inst x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorMeasured (Group in G1)

Measured Reflectivity

count (4-byte integer, array size: ltL x lnL x inst x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x inst x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x inst x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x inst x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

dm (Group in G1)

count (4-byte integer, array size: ltL x lnL x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

dBNw (Group in G1)

count (4-byte integer, array size: ltL x lnL x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

epsilonDPR (Group in G1)

count (4-byte integer, array size: ltL x lnL x inst x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x inst x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x inst x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x inst x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

epsilon (Group in G1)

count (4-byte integer, array size: ltL x lnL x inst x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x inst x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x inst x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x inst x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaSRT (Group in G1)

Path Integrated Attenuation from SRT.

count (4-byte integer, array size: ltL x lnL x inst x ang x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x inst x ang x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x inst x ang x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x inst x ang x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaSRTdpr (Group in G1)

Path Integrated Attenuation from SRT DPR

count (4-byte integer, array size: ltL x lnL x inst x ang x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x inst x ang x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x inst x ang x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x inst x ang x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaFinal (Group in G1)
Final Path Integrated Attenuation

count (4-byte integer, array size: ltL x lnL x inst x ang x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x inst x ang x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x inst x ang x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x inst x ang x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaFinalDPR (Group in G1)
Final Path Integrated Attenuation from DPR

count (4-byte integer, array size: ltL x lnL x inst x ang x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x inst x ang x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x inst x ang x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x inst x ang x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaFinalSubset (Group in G1)
Final Path Integrated Attenuation Subset

count (4-byte integer, array size: ltL x lnL x inst x ang x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x inst x ang x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x inst x ang x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x inst x ang x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaFinalDPRsubset (Group in G1)

Final Path Integrated Attenuation from DPR Subset

count (4-byte integer, array size: ltL x lnL x inst x ang x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x inst x ang x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x inst x ang x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x inst x ang x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

heightBB (Group in G1)

Height of Bright Band.

count (4-byte integer, array size: ltL x lnL x chn x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

heightBBnadir (Group in G1)

Height of Bright Band from Nadir.

count (4-byte integer, array size: ltL x lnL x chn x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

BBwidthNadir (Group in G1)

Width of Bright Band at Nadir

count (4-byte integer, array size: ltL x lnL x chn x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

heightStormTop (Group in G1)

Storm Top Height

count (4-byte integer, array size: ltL x lnL x chn x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

BBwidth (Group in G1)

Bright Band Width

count (4-byte integer, array size: ltL x lnL x chn x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

observationCounts (Group in G1)

Observation Counts

total (4-byte integer, array size: ltL x lnL x inst x st):
Total obs. Special values are defined as:
-9999 Missing value

localTime (4-byte integer, array size: ltL x lnL x inst x tim x st):
obs time. Special values are defined as:
-9999 Missing value

pia (4-byte integer, array size: ltL x lnL x inst x ang x st):
obs PIA. Special values are defined as:
-9999 Missing value

shallowRain (4-byte integer, array size: ltL x lnL x inst x st):
obs time. Special values are defined as:
-9999 Missing value

precipRateLocalTime (Group in G1)

Precipitation Rate by Local Time

count (4-byte integer, array size: ltL x lnL x chn x tim x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn x tim x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn x tim x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateNearSurfaceUnconditional (4-byte float, array size: ltL x lnL x chn):
Rain, not conditioned on rain. Special values are defined as:
-9999.9 Missing value

precipProbabilityNearSurface (4-byte float, array size: ltL x lnL x chn):
Probability of rain. Special values are defined as:
-9999.9 Missing value

G2 (Grid)

G2_GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

precipRate (Group in G2)

Conditional Precipitation Rate

count (4-byte integer, array size: ltH x lnH x chn x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

rainRate (Group in G2)

Conditional Liquid Rain Rate

count (4-byte integer, array size: ltH x lnH x chn x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

snowRate (Group in G2)

Conditional Snow Rate

count (4-byte integer, array size: ltH x lnH x chn x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

mixedPhRate (Group in G2)

Conditional Preciptiation Rate of Mixed Phase

count (4-byte integer, array size: ltH x lnH x chn x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateESurface (Group in G2)

Conditional Estimated Precipitation Rate at the Surface

count (4-byte integer, array size: ltH x lnH x chn x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateESurface2 (Group in G2)

Alternate Conditional Estimated Precipitation Rate at the Surface

count (4-byte integer, array size: ltH x lnH x chn x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateNearSurface (Group in G2)

Conditional Precipitation Rate at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x chn x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

rainRateNearSurface (Group in G2)

Conditional Liquid Rain Rate at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x chn x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

snowRateNearSurface (Group in G2)

Conditional Snow Rate at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x chn x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

mixedPhRateNearSurface (Group in G2)

Conditional Precipitation Rate of Mixed Phase at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x chn x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipWaterIntegrated (Group in G2)

Integrated Precipitable Water (g/m^2).

count (4-byte integer, array size: ltH x lnH x chn x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipIceIntegrated (Group in G2)

Integrated Precipitable Ice

count (4-byte integer, array size: ltH x lnH x chn x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateAve24 (Group in G2)

Conditional Precipitation Rate Averaged for 24hrs.

count (4-byte integer, array size: ltH x lnH x chn x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorCorrected (Group in G2)

Corrected Reflectivity.

count (4-byte integer, array size: ltH x lnH x inst x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x inst x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x inst x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorCorrectedESurface (Group in G2)

Corrected Reflectivity Estimate at the Surface

count (4-byte integer, array size: ltH x lnH x inst x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x inst x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x inst x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorCorrectedNearSurface (Group in G2)

Corrected Reflectivity at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x inst x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x inst x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x inst x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorCorrectedDPR (Group in G2)

Corrected Reflectivity from DPR

count (4-byte integer, array size: ltH x lnH x inst x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x inst x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x inst x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorCorrectedESurfaceDPR (Group in G2)

Estimated Corrected Reflectivity at the Surface

count (4-byte integer, array size: ltH x lnH x inst x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x inst x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x inst x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorCorrectedNearSurfaceDPR (Group in G2)

Corrected Reflectivity at the Near Surface Level for DPR

count (4-byte integer, array size: ltH x lnH x inst x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x inst x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x inst x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorMeasured (Group in G2)

Corrected Reflectivity

count (4-byte integer, array size: ltH x lnH x inst x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x inst x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x inst x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

dm (Group in G2)

Mean Mass-Weighted Drop Diameter

count (4-byte integer, array size: ltH x lnH x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

dBNw (Group in G2)

Normalized Drop Concentration Parameter

count (4-byte integer, array size: ltH x lnH x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

epsilonDPR (Group in G2)

count (4-byte integer, array size: ltH x lnH x inst x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x inst x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x inst x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

epsilon (Group in G2)

count (4-byte integer, array size: ltH x lnH x inst x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x inst x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x inst x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

piaSRT (Group in G2)

Path Integrated Attenuation from SRT.

count (4-byte integer, array size: ltH x lnH x inst x ang x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x inst x ang x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x inst x ang x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

piaSRTdpr (Group in G2)

Path Integrated Attenuation from SRT for DPR.

count (4-byte integer, array size: ltH x lnH x inst x ang x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x inst x ang x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x inst x ang x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

piaFinal (Group in G2)

Final Path Integrated Attenuation Estimate.

count (4-byte integer, array size: ltH x lnH x inst x ang x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x inst x ang x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x inst x ang x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

piaFinalDPR (Group in G2)

Final Path Integrated Attenuation Estimage for DPR.

count (4-byte integer, array size: ltH x lnH x inst x ang x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x inst x ang x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x inst x ang x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

heightBB (Group in G2)

Height Of the Bright Band.

count (4-byte integer, array size: ltH x lnH x chn x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

heightStormTop (Group in G2)

Height of the Storm Top.

count (4-byte integer, array size: ltH x lnH x chn x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

BBwidth (Group in G2)

Bright Band Width

count (4-byte integer, array size: ltH x lnH x chn x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

observationCounts (Group in G2)

Observation Counts.

total (4-byte integer, array size: ltH x lnH x inst):
Total obs. Special values are defined as:
-9999 Missing value

pia (4-byte integer, array size: ltH x lnH x inst x ang):
obs PIA. Special values are defined as:
-9999 Missing value

shallowRain (4-byte integer, array size: ltH x lnH x inst):
obs time. Special values are defined as:
-9999 Missing value

precipRateNearSurfaceUnconditional (4-byte float, array size: ltH x lnH x chn):
Rain, not conditioned on rain. Special values are defined as:
-9999.9 Missing value

precipProbabilityNearSurface (4-byte float, array size: ltH x lnH x chn):
Probability of rain. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_3DPR_H_
#define _TK_3DPR_H_

#ifndef _L3DPR_G2_OBSERVATIONCOUNTS_
#define _L3DPR_G2_OBSERVATIONCOUNTS_

typedef struct {
    int total[4][1440][536];
    int pia[7][4][1440][536];
    int shallowRain[4][1440][536];
} L3DPR_G2_OBSERVATIONCOUNTS;

#endif
```

```
#ifndef _L3DPR_G2_BBWIDTH_
#define _L3DPR_G2_BBWIDTH_

typedef struct {
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3DPR_G2_BBWIDTH;

#endif

#ifndef _L3DPR_G2_HEIGHTSTORMTOP_
#define _L3DPR_G2_HEIGHTSTORMTOP_

typedef struct {
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3DPR_G2_HEIGHTSTORMTOP;

#endif

#ifndef _L3DPR_G2_HEIGHTBB_
#define _L3DPR_G2_HEIGHTBB_

typedef struct {
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3DPR_G2_HEIGHTBB;

#endif

#ifndef _L3DPR_G2_PIAFINALDPR_
#define _L3DPR_G2_PIAFINALDPR_

typedef struct {
    int count[3][7][4][1440][536];
    float mean[3][7][4][1440][536];
    float stdev[3][7][4][1440][536];
} L3DPR_G2_PIAFINALDPR;
```

```
#endif

#ifndef _L3DPR_G2_PIAFINAL_
#define _L3DPR_G2_PIAFINAL_

typedef struct {
    int count[3][7][4][1440][536];
    float mean[3][7][4][1440][536];
    float stdev[3][7][4][1440][536];
} L3DPR_G2_PIAFINAL;

#endif

#ifndef _L3DPR_G2_PIASRTDPR_
#define _L3DPR_G2_PIASRTDPR_

typedef struct {
    int count[3][7][4][1440][536];
    float mean[3][7][4][1440][536];
    float stdev[3][7][4][1440][536];
} L3DPR_G2_PIASRTDPR;

#endif

#ifndef _L3DPR_G2_PIASRT_
#define _L3DPR_G2_PIASRT_

typedef struct {
    int count[3][7][4][1440][536];
    float mean[3][7][4][1440][536];
    float stdev[3][7][4][1440][536];
} L3DPR_G2_PIASRT;

#endif

#ifndef _L3DPR_G2_EPSILON_
#define _L3DPR_G2_EPSILON_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3DPR_G2_EPSILON;
```

```
#endif

#ifndef _L3DPR_G2_EPSILONDPR_
#define _L3DPR_G2_EPSILONDPR_

typedef struct {
    int count[3][5][4][1440][536];
    float mean[3][5][4][1440][536];
    float stdev[3][5][4][1440][536];
} L3DPR_G2_EPSILONDPR;

#endif

#ifndef _L3DPR_G2_DBNW_
#define _L3DPR_G2_DBNW_

typedef struct {
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3DPR_G2_DBNW;

#endif

#ifndef _L3DPR_G2_DM_
#define _L3DPR_G2_DM_

typedef struct {
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3DPR_G2_DM;

#endif

#ifndef _L3DPR_G2_ZFACTORMEASURED_
#define _L3DPR_G2_ZFACTORMEASURED_

typedef struct {
    int count[3][5][4][1440][536];
    float mean[3][5][4][1440][536];
    float stdev[3][5][4][1440][536];
```

```
} L3DPR_G2_ZFACTORMEASURED;

#endif

#ifndef _L3DPR_G2_ZFACTORCORRECTEDNEARSURFACEDPR_
#define _L3DPR_G2_ZFACTORCORRECTEDNEARSURFACEDPR_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3DPR_G2_ZFACTORCORRECTEDNEARSURFACEDPR;

#endif

#ifndef _L3DPR_G2_ZFACTORCORRECTEDESURFACEDPR_
#define _L3DPR_G2_ZFACTORCORRECTEDESURFACEDPR_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3DPR_G2_ZFACTORCORRECTEDESURFACEDPR;

#endif

#ifndef _L3DPR_G2_ZFACTORCORRECTEDDPR_
#define _L3DPR_G2_ZFACTORCORRECTEDDPR_

typedef struct {
    int count[3][5][4][1440][536];
    float mean[3][5][4][1440][536];
    float stdev[3][5][4][1440][536];
} L3DPR_G2_ZFACTORCORRECTEDDPR;

#endif

#ifndef _L3DPR_G2_ZFACTORCORRECTEDNEARSURFACE_
#define _L3DPR_G2_ZFACTORCORRECTEDNEARSURFACE_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
```

```
    float stdev[3][4][1440][536];
} L3DPR_G2_ZFACTORCORRECTEDNEARSURFACE;

#endif

#ifndef _L3DPR_G2_ZFACTORCORRECTEDESURFACE_
#define _L3DPR_G2_ZFACTORCORRECTEDESURFACE_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3DPR_G2_ZFACTORCORRECTEDESURFACE;

#endif

#ifndef _L3DPR_G2_ZFACTORCORRECTED_
#define _L3DPR_G2_ZFACTORCORRECTED_

typedef struct {
    int count[3][5][4][1440][536];
    float mean[3][5][4][1440][536];
    float stdev[3][5][4][1440][536];
} L3DPR_G2_ZFACTORCORRECTED;

#endif

#ifndef _L3DPR_G2_PRECIPRATEAVE24_
#define _L3DPR_G2_PRECIPRATEAVE24_

typedef struct {
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3DPR_G2_PRECIPRATEAVE24;

#endif

#ifndef _L3DPR_G2_PRECIPICEINTEGRATED_
#define _L3DPR_G2_PRECIPICEINTEGRATED_

typedef struct {
    int count[3][5][1440][536];
```

```
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3DPR_G2_PRECIPICEINTEGRATED;

#endif

#ifndef _L3DPR_G2_PRECIPWATERINTEGRATED_
#define _L3DPR_G2_PRECIPWATERINTEGRATED_

typedef struct {
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3DPR_G2_PRECIPWATERINTEGRATED;

#endif

#ifndef _L3DPR_G2_MIXEDPHRATENEARSURFACE_
#define _L3DPR_G2_MIXEDPHRATENEARSURFACE_

typedef struct {
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3DPR_G2_MIXEDPHRATENEARSURFACE;

#endif

#ifndef _L3DPR_G2_SNOWRATENEARSURFACE_
#define _L3DPR_G2_SNOWRATENEARSURFACE_

typedef struct {
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3DPR_G2_SNOWRATENEARSURFACE;

#endif

#ifndef _L3DPR_G2_RAINRATENEARSURFACE_
#define _L3DPR_G2_RAINRATENEARSURFACE_

typedef struct {
```

```
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3DPR_G2_RAINRATENEARSURFACE;

#endif

#ifndef _L3DPR_G2_PRECIPRATENEARSURFACE_
#define _L3DPR_G2_PRECIPRATENEARSURFACE_

typedef struct {
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3DPR_G2_PRECIPRATENEARSURFACE;

#endif

#ifndef _L3DPR_G2_PRECIPRATEESURFACE2_
#define _L3DPR_G2_PRECIPRATEESURFACE2_

typedef struct {
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3DPR_G2_PRECIPRATEESURFACE2;

#endif

#ifndef _L3DPR_G2_PRECIPRATEESURFACE_
#define _L3DPR_G2_PRECIPRATEESURFACE_

typedef struct {
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3DPR_G2_PRECIPRATEESURFACE;

#endif

#ifndef _L3DPR_G2_MIXEDPHRATE_
#define _L3DPR_G2_MIXEDPHRATE_
```

```
typedef struct {
    int count[3][5][5][1440][536];
    float mean[3][5][5][1440][536];
    float stdev[3][5][5][1440][536];
} L3DPR_G2_MIXEDPHRATE;

#endif

#ifndef _L3DPR_G2_SNOWRATE_
#define _L3DPR_G2_SNOWRATE_

typedef struct {
    int count[3][5][5][1440][536];
    float mean[3][5][5][1440][536];
    float stdev[3][5][5][1440][536];
} L3DPR_G2_SNOWRATE;

#endif

#ifndef _L3DPR_G2_RAINRATE_
#define _L3DPR_G2_RAINRATE_

typedef struct {
    int count[3][5][5][1440][536];
    float mean[3][5][5][1440][536];
    float stdev[3][5][5][1440][536];
} L3DPR_G2_RAINRATE;

#endif

#ifndef _L3DPR_G2_PRECIPRATE_
#define _L3DPR_G2_PRECIPRATE_

typedef struct {
    int count[3][5][5][1440][536];
    float mean[3][5][5][1440][536];
    float stdev[3][5][5][1440][536];
} L3DPR_G2_PRECIPRATE;

#endif

#ifndef _L3DPR_G2_
#define _L3DPR_G2_
```

```
typedef struct {
    L3DPR_G2_PRECIPRATE precipRate;
    L3DPR_G2_RAINRATE rainRate;
    L3DPR_G2_SNOWRATE snowRate;
    L3DPR_G2_MIXEDPHRATE mixedPhRate;
    L3DPR_G2_PRECIPRATEESURFACE precipRateESurface;
    L3DPR_G2_PRECIPRATEESURFACE2 precipRateESurface2;
    L3DPR_G2_PRECIPRATENEARSURFACE precipRateNearSurface;
    L3DPR_G2_RAINRATENEARSURFACE rainRateNearSurface;
    L3DPR_G2_SNOWRATENEARSURFACE snowRateNearSurface;
    L3DPR_G2_MIXEDPHRATENEARSURFACE mixedPhRateNearSurface;
    L3DPR_G2_PRECIPWATERINTEGRATED precipWaterIntegrated;
    L3DPR_G2_PRECIPICEINTEGRATED precipIceIntegrated;
    L3DPR_G2_PRECIPRATEAVE24 precipRateAve24;
    L3DPR_G2_ZFACTORCORRECTED zFactorCorrected;
    L3DPR_G2_ZFACTORCORRECTEDESURFACE zFactorCorrectedESurface;
    L3DPR_G2_ZFACTORCORRECTEDNEARSURFACE zFactorCorrectedNearSurface;
    L3DPR_G2_ZFACTORCORRECTEDDPR zFactorCorrectedDPR;
    L3DPR_G2_ZFACTORCORRECTEDESURFACEDPR zFactorCorrectedESurfaceDPR;
    L3DPR_G2_ZFACTORCORRECTEDNEARSURFACEDPR zFactorCorrectedNearSurfaceDPR;
    L3DPR_G2_ZFACTORMEASURED zFactorMeasured;
    L3DPR_G2_DM dm;
    L3DPR_G2_DBNW dBNw;
    L3DPR_G2_EPSILONDPR epsilonDPR;
    L3DPR_G2_EPSILON epsilon;
    L3DPR_G2_PIASRT piaSRT;
    L3DPR_G2_PIASRTDPR piaSRTdpr;
    L3DPR_G2_PIAFINAL piaFinal;
    L3DPR_G2_PIAFINALDPR piaFinalDPR;
    L3DPR_G2_HEIGHTBB heightBB;
    L3DPR_G2_HEIGHTSTORMTOP heightStormTop;
    L3DPR_G2_BBWIDTH BBwidth;
    L3DPR_G2_OBSERVATIONCOUNTS observationCounts;
    float precipRateNearSurfaceUnconditional[5][1440][536];
    float precipProbabilityNearSurface[5][1440][536];
} L3DPR_G2;

#endif

#ifndef _L3DPR_G1_PRECIPRATELOCALTIME_
#define _L3DPR_G1_PRECIPRATELOCALTIME_
```

```
typedef struct {
    int count[3][24][5][72][28];
    float mean[3][24][5][72][28];
    float stdev[3][24][5][72][28];
} L3DPR_G1_PRECIPRATELOCALTIME;

#endif

#ifndef _L3DPR_G1_OBSERVATIONCOUNTS_
#define _L3DPR_G1_OBSERVATIONCOUNTS_

typedef struct {
    int total[3][4][72][28];
    int localTime[3][24][4][72][28];
    int pia[3][7][4][72][28];
    int shallowRain[3][4][72][28];
} L3DPR_G1_OBSERVATIONCOUNTS;

#endif

#ifndef _L3DPR_G1_BBWIDTH_
#define _L3DPR_G1_BBWIDTH_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3DPR_G1_BBWIDTH;

#endif

#ifndef _L3DPR_G1_HEIGHTSTORMTOP_
#define _L3DPR_G1_HEIGHTSTORMTOP_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3DPR_G1_HEIGHTSTORMTOP;

#endif
```

```
#ifndef _L3DPR_G1_BBWIDTHNADIR_
#define _L3DPR_G1_BBWIDTHNADIR_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3DPR_G1_BBWIDTHNADIR;

#endif

#ifndef _L3DPR_G1_HEIGHTBBNADIR_
#define _L3DPR_G1_HEIGHTBBNADIR_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3DPR_G1_HEIGHTBBNADIR;

#endif

#ifndef _L3DPR_G1_HEIGHTBB_
#define _L3DPR_G1_HEIGHTBB_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3DPR_G1_HEIGHTBB;

#endif

#ifndef _L3DPR_G1_PIAFINALDPRSUBSET_
#define _L3DPR_G1_PIAFINALDPRSUBSET_

typedef struct {
    int count[3][3][7][4][72][28];
    float mean[3][3][7][4][72][28];
```

```
    float stdev[3][3][7][4][72][28];
    int hist[30][3][3][7][4][72][28];
} L3DPR_G1_PIAFINALDPRSUBSET;

#endif

#ifndef _L3DPR_G1_PIAFINALSUBSET_
#define _L3DPR_G1_PIAFINALSUBSET_

typedef struct {
    int count[3][3][7][4][72][28];
    float mean[3][3][7][4][72][28];
    float stdev[3][3][7][4][72][28];
    int hist[30][3][3][7][4][72][28];
} L3DPR_G1_PIAFINALSUBSET;

#endif

#ifndef _L3DPR_G1_PIAFINALDPR_
#define _L3DPR_G1_PIAFINALDPR_

typedef struct {
    int count[3][3][7][4][72][28];
    float mean[3][3][7][4][72][28];
    float stdev[3][3][7][4][72][28];
    int hist[30][3][3][7][4][72][28];
} L3DPR_G1_PIAFINALDPR;

#endif

#ifndef _L3DPR_G1_PIAFINAL_
#define _L3DPR_G1_PIAFINAL_

typedef struct {
    int count[3][3][7][4][72][28];
    float mean[3][3][7][4][72][28];
    float stdev[3][3][7][4][72][28];
    int hist[30][3][3][7][4][72][28];
} L3DPR_G1_PIAFINAL;

#endif

#ifndef _L3DPR_G1_PIASRTDPR_
```

```
#define _L3DPR_G1_PIASRTDPR_

typedef struct {
    int count[3][3][7][4][72][28];
    float mean[3][3][7][4][72][28];
    float stdev[3][3][7][4][72][28];
    int hist[30][3][3][7][4][72][28];
} L3DPR_G1_PIASRTDPR;

#endif

#ifndef _L3DPR_G1_PIASRT_
#define _L3DPR_G1_PIASRT_

typedef struct {
    int count[3][3][7][4][72][28];
    float mean[3][3][7][4][72][28];
    float stdev[3][3][7][4][72][28];
    int hist[30][3][3][7][4][72][28];
} L3DPR_G1_PIASRT;

#endif

#ifndef _L3DPR_G1_EPSILON_
#define _L3DPR_G1_EPSILON_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3DPR_G1_EPSILON;

#endif

#ifndef _L3DPR_G1_EPSILONDPR_
#define _L3DPR_G1_EPSILONDPR_

typedef struct {
    int count[3][3][5][4][72][28];
    float mean[3][3][5][4][72][28];
    float stdev[3][3][5][4][72][28];
    int hist[30][3][3][5][4][72][28];
```

```
} L3DPR_G1_EPSILONDPR;

#endif

#ifndef _L3DPR_G1_DBNW_
#define _L3DPR_G1_DBNW_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3DPR_G1_DBNW;

#endif

#ifndef _L3DPR_G1_DM_
#define _L3DPR_G1_DM_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3DPR_G1_DM;

#endif

#ifndef _L3DPR_G1_ZFACTORMEASURED_
#define _L3DPR_G1_ZFACTORMEASURED_

typedef struct {
    int count[3][3][5][4][72][28];
    float mean[3][3][5][4][72][28];
    float stdev[3][3][5][4][72][28];
    int hist[30][3][3][5][4][72][28];
} L3DPR_G1_ZFACTORMEASURED;

#endif

#ifndef _L3DPR_G1_ZFACTORCORRECTEDNEARSURFACEDPR_
#define _L3DPR_G1_ZFACTORCORRECTEDNEARSURFACEDPR_
```

```
typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3DPR_G1_ZFACTORCORRECTEDNEARSURFACEDPR;

#endif

#ifndef _L3DPR_G1_ZFACTORCORRECTEDESURFACEDPR_
#define _L3DPR_G1_ZFACTORCORRECTEDESURFACEDPR_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3DPR_G1_ZFACTORCORRECTEDESURFACEDPR;

#endif

#ifndef _L3DPR_G1_ZFACTORCORRECTEDDPR_
#define _L3DPR_G1_ZFACTORCORRECTEDDPR_

typedef struct {
    int count[3][3][5][4][72][28];
    float mean[3][3][5][4][72][28];
    float stdev[3][3][5][4][72][28];
    int hist[30][3][3][5][4][72][28];
} L3DPR_G1_ZFACTORCORRECTEDDPR;

#endif

#ifndef _L3DPR_G1_ZFACTORCORRECTEDNEARSURFACE_
#define _L3DPR_G1_ZFACTORCORRECTEDNEARSURFACE_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3DPR_G1_ZFACTORCORRECTEDNEARSURFACE;
```

```
#endif

#ifndef _L3DPR_G1_ZFACTORCORRECTEDESURFACE_
#define _L3DPR_G1_ZFACTORCORRECTEDESURFACE_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3DPR_G1_ZFACTORCORRECTEDESURFACE;

#endif

#ifndef _L3DPR_G1_ZFACTORCORRECTED_
#define _L3DPR_G1_ZFACTORCORRECTED_

typedef struct {
    int count[3][3][5][4][72][28];
    float mean[3][3][5][4][72][28];
    float stdev[3][3][5][4][72][28];
    int hist[30][3][3][5][4][72][28];
} L3DPR_G1_ZFACTORCORRECTED;

#endif

#ifndef _L3DPR_G1_PRECIPRATEAVE24_
#define _L3DPR_G1_PRECIPRATEAVE24_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3DPR_G1_PRECIPRATEAVE24;

#endif

#ifndef _L3DPR_G1_PRECIPICEINTEGRATED_
#define _L3DPR_G1_PRECIPICEINTEGRATED_

typedef struct {
    int count[3][3][5][72][28];
```

```
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3DPR_G1_PRECIPICEINTEGRATED;

#endif

#ifndef _L3DPR_G1_PRECIPWATERINTEGRATED_
#define _L3DPR_G1_PRECIPWATERINTEGRATED_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3DPR_G1_PRECIPWATERINTEGRATED;

#endif

#ifndef _L3DPR_G1_MIXEDPHRATENEARSURFACE_
#define _L3DPR_G1_MIXEDPHRATENEARSURFACE_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3DPR_G1_MIXEDPHRATENEARSURFACE;

#endif

#ifndef _L3DPR_G1_SNOWRATENEARSURFACE_
#define _L3DPR_G1_SNOWRATENEARSURFACE_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3DPR_G1_SNOWRATENEARSURFACE;

#endif
```

```
#ifndef _L3DPR_G1_RAINRATENEARSURFACE_
#define _L3DPR_G1_RAINRATENEARSURFACE_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3DPR_G1_RAINRATENEARSURFACE;

#endif

#ifndef _L3DPR_G1_PRECIPRATENEARSURFACE_
#define _L3DPR_G1_PRECIPRATENEARSURFACE_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3DPR_G1_PRECIPRATENEARSURFACE;

#endif

#ifndef _L3DPR_G1_PRECIPRATEESURFACE2_
#define _L3DPR_G1_PRECIPRATEESURFACE2_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3DPR_G1_PRECIPRATEESURFACE2;

#endif

#ifndef _L3DPR_G1_PRECIPRATEESURFACE_
#define _L3DPR_G1_PRECIPRATEESURFACE_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
```

```
    int hist[30][3][3][5][72][28];
} L3DPR_G1_PRECIPRATEESURFACE;

#endif

#ifndef _L3DPR_G1_MIXEDPHRATE_
#define _L3DPR_G1_MIXEDPHRATE_

typedef struct {
    int count[3][3][5][5][72][28];
    float mean[3][3][5][5][72][28];
    float stdev[3][3][5][5][72][28];
    int hist[30][3][3][5][5][72][28];
} L3DPR_G1_MIXEDPHRATE;

#endif

#ifndef _L3DPR_G1_SNOWRATE_
#define _L3DPR_G1_SNOWRATE_

typedef struct {
    int count[3][3][5][5][72][28];
    float mean[3][3][5][5][72][28];
    float stdev[3][3][5][5][72][28];
    int hist[30][3][3][5][5][72][28];
} L3DPR_G1_SNOWRATE;

#endif

#ifndef _L3DPR_G1_RAINRATE_
#define _L3DPR_G1_RAINRATE_

typedef struct {
    int count[3][3][5][5][72][28];
    float mean[3][3][5][5][72][28];
    float stdev[3][3][5][5][72][28];
    int hist[30][3][3][5][5][72][28];
} L3DPR_G1_RAINRATE;

#endif

#ifndef _L3DPR_G1_PRECIPRATE_
#define _L3DPR_G1_PRECIPRATE_
```

```
typedef struct {
    int count[3][3][5][5][72][28];
    float mean[3][3][5][5][72][28];
    float stdev[3][3][5][5][72][28];
    int hist[30][3][3][5][5][72][28];
} L3DPR_G1_PRECIPRATE;

#endif

#ifndef _L3DPR_G1_
#define _L3DPR_G1_

typedef struct {
    L3DPR_G1_PRECIPRATE precipRate;
    L3DPR_G1_RAINRATE rainRate;
    L3DPR_G1_SNOWRATE snowRate;
    L3DPR_G1_MIXEDPHRATE mixedPhRate;
    L3DPR_G1_PRECIPRATEESURFACE precipRateESurface;
    L3DPR_G1_PRECIPRATEESURFACE2 precipRateESurface2;
    L3DPR_G1_PRECIPRATENEARSURFACE precipRateNearSurface;
    L3DPR_G1_RAINRATENEARSURFACE rainRateNearSurface;
    L3DPR_G1_SNOWRATENEARSURFACE snowRateNearSurface;
    L3DPR_G1_MIXEDPHRATENEARSURFACE mixedPhRateNearSurface;
    L3DPR_G1_PRECIPWATERINTEGRATED precipWaterIntegrated;
    L3DPR_G1_PRECIPICEINTEGRATED precipIceIntegrated;
    L3DPR_G1_PRECIPRATEAVE24 precipRateAve24;
    L3DPR_G1_ZFACTORCORRECTED zFactorCorrected;
    L3DPR_G1_ZFACTORCORRECTEDESURFACE zFactorCorrectedESurface;
    L3DPR_G1_ZFACTORCORRECTEDNEARSURFACE zFactorCorrectedNearSurface;
    L3DPR_G1_ZFACTORCORRECTEDDPR zFactorCorrectedDPR;
    L3DPR_G1_ZFACTORCORRECTEDESURFACEDPR zFactorCorrectedESurfaceDPR;
    L3DPR_G1_ZFACTORCORRECTEDNEARSURFACEDPR zFactorCorrectedNearSurfaceDPR;
    L3DPR_G1_ZFACTORMEASURED zFactorMeasured;
    L3DPR_G1_DM dm;
    L3DPR_G1_DBNW dBNw;
    L3DPR_G1_EPSILONDPR epsilonDPR;
    L3DPR_G1_EPSILON epsilon;
    L3DPR_G1_PIASRT piaSRT;
    L3DPR_G1_PIASRTDPR piaSRTdpr;
    L3DPR_G1_PIAFINAL piaFinal;
    L3DPR_G1_PIAFINALDPR piaFinalDPR;
    L3DPR_G1_PIAFINALSUBSET piaFinalSubset;
```

```
    L3DPR_G1_PIAFINALDPRSUBSET piaFinalDPRsubset;
    L3DPR_G1_HEIGHTBB heightBB;
    L3DPR_G1_HEIGHTBBNADIR heightBBnadir;
    L3DPR_G1_BBWIDTHNADIR BBwidthNadir;
    L3DPR_G1_HEIGHTSTORMTOP heightStormTop;
    L3DPR_G1_BBWIDTH BBwidth;
    L3DPR_G1_OBSERVATIONCOUNTS observationCounts;
    L3DPR_G1_PRECIPRATELOCALTIME precipRateLocalTime;
    float precipRateNearSurfaceUnconditional[5][72][28];
    float precipProbabilityNearSurface[5][72][28];
} L3DPR_G1;

#endif

#ifndef _L3DPR_GRIDS_
#define _L3DPR_GRIDS_

typedef struct {
    L3DPR_G1 G1;
    L3DPR_G2 G2;
} L3DPR_GRIDS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3DPR_G2_OBSERVATIONCOUNTS/
    INTEGER*4 total(536,1440,4)
    INTEGER*4 pia(536,1440,4,7)
    INTEGER*4 shallowRain(536,1440,4)
END STRUCTURE

STRUCTURE /L3DPR_G2_BBWIDTH/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_HEIGHTSTORMTOP/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
```

```
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_HEIGHTBB/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_PIAFINALDPR/
    INTEGER*4 count(536,1440,4,7,3)
    REAL*4 mean(536,1440,4,7,3)
    REAL*4 stdev(536,1440,4,7,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_PIAFINAL/
    INTEGER*4 count(536,1440,4,7,3)
    REAL*4 mean(536,1440,4,7,3)
    REAL*4 stdev(536,1440,4,7,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_PIASRTDPR/
    INTEGER*4 count(536,1440,4,7,3)
    REAL*4 mean(536,1440,4,7,3)
    REAL*4 stdev(536,1440,4,7,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_PIASRT/
    INTEGER*4 count(536,1440,4,7,3)
    REAL*4 mean(536,1440,4,7,3)
    REAL*4 stdev(536,1440,4,7,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_EPSILON/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_EPSILONDPR/
    INTEGER*4 count(536,1440,4,5,3)
    REAL*4 mean(536,1440,4,5,3)
    REAL*4 stdev(536,1440,4,5,3)
```

```
END STRUCTURE

STRUCTURE /L3DPR_G2_DBNW/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_DM/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_ZFACTORMEASURED/
    INTEGER*4 count(536,1440,4,5,3)
    REAL*4 mean(536,1440,4,5,3)
    REAL*4 stdev(536,1440,4,5,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_ZFACTORCORRECTEDNEARSURFACEDPR/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_ZFACTORCORRECTEDESURFACEDPR/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_ZFACTORCORRECTEDDPR/
    INTEGER*4 count(536,1440,4,5,3)
    REAL*4 mean(536,1440,4,5,3)
    REAL*4 stdev(536,1440,4,5,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_ZFACTORCORRECTEDNEARSURFACE/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE
```

```
STRUCTURE /L3DPR_G2_ZFACTORCORRECTEDESURFACE/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_ZFACTORCORRECTED/
    INTEGER*4 count(536,1440,4,5,3)
    REAL*4 mean(536,1440,4,5,3)
    REAL*4 stdev(536,1440,4,5,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_PRECIPRATEAVE24/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_PRECIPICEINTEGRATED/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_PRECIPWATERINTEGRATED/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_MIXEDPHRATENEARSURFACE/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_SNOWRATENEARSURFACE/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE
```

```
STRUCTURE /L3DPR_G2_RAINRATENEARSURFACE/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_PRECIPRATENEARSURFACE/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_PRECIPRATEESURFACE2/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_PRECIPRATEESURFACE/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_MIXEDPHRATE/
    INTEGER*4 count(536,1440,5,5,3)
    REAL*4 mean(536,1440,5,5,3)
    REAL*4 stdev(536,1440,5,5,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_SNOWRATE/
    INTEGER*4 count(536,1440,5,5,3)
    REAL*4 mean(536,1440,5,5,3)
    REAL*4 stdev(536,1440,5,5,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_RAINRATE/
    INTEGER*4 count(536,1440,5,5,3)
    REAL*4 mean(536,1440,5,5,3)
    REAL*4 stdev(536,1440,5,5,3)
END STRUCTURE

STRUCTURE /L3DPR_G2_PRECIPRATE/
```

```
    INTEGER*4 count(536,1440,5,5,3)
    REAL*4 mean(536,1440,5,5,3)
    REAL*4 stdev(536,1440,5,5,3)
END STRUCTURE

STRUCTURE /L3DPR_G2/
    RECORD /L3DPR_G2_PRECIPRATE/ precipRate
    RECORD /L3DPR_G2_RAINRATE/ rainRate
    RECORD /L3DPR_G2_SNOWRATE/ snowRate
    RECORD /L3DPR_G2_MIXEDPHRATE/ mixedPhRate
    RECORD /L3DPR_G2_PRECIPRATEESURFACE/ precipRateESurface
    RECORD /L3DPR_G2_PRECIPRATEESURFACE2/ precipRateESurface2
    RECORD /L3DPR_G2_PRECIPRATENEARSURFACE/ precipRateNearSurface
    RECORD /L3DPR_G2_RAINRATENEARSURFACE/ rainRateNearSurface
    RECORD /L3DPR_G2_SNOWRATENEARSURFACE/ snowRateNearSurface
    RECORD /L3DPR_G2_MIXEDPHRATENEARSURFACE/ mixedPhRateNearSurface
    RECORD /L3DPR_G2_PRECIPWATERINTEGRATED/ precipWaterIntegrated
    RECORD /L3DPR_G2_PRECIPICEINTEGRATED/ precipIceIntegrated
    RECORD /L3DPR_G2_PRECIPRATEAVE24/ precipRateAve24
    RECORD /L3DPR_G2_ZFACTORCORRECTED/ zFactorCorrected
    RECORD /L3DPR_G2_ZFACTORCORRECTEDESURFACE/ zFactorCorrectedESurface
    RECORD /L3DPR_G2_ZFACTORCORRECTEDNEARSURFACE/ zFactorCorrectedNearSurface
    RECORD /L3DPR_G2_ZFACTORCORRECTEDDPR/ zFactorCorrectedDPR
    RECORD /L3DPR_G2_ZFACTORCORRECTEDESURFACEDPR/ zFactorCorrectedESurfaceDPR
    RECORD /L3DPR_G2_ZFACTORCORRECTEDNEARSURFACEDPR/ zFactorCorrectedNearSurfaceDPR
    RECORD /L3DPR_G2_ZFACTORMEASURED/ zFactorMeasured
    RECORD /L3DPR_G2_DM/ dm
    RECORD /L3DPR_G2_DBNW/ dBNw
    RECORD /L3DPR_G2_EPSILONDPR/ epsilonDPR
    RECORD /L3DPR_G2_EPSILON/ epsilon
    RECORD /L3DPR_G2_PIASRT/ piaSRT
    RECORD /L3DPR_G2_PIASRTDPR/ piaSRTdpr
    RECORD /L3DPR_G2_PIAFINAL/ piaFinal
    RECORD /L3DPR_G2_PIAFINALDPR/ piaFinalDPR
    RECORD /L3DPR_G2_HEIGHTBB/ heightBB
    RECORD /L3DPR_G2_HEIGHTSTORMTOP/ heightStormTop
    RECORD /L3DPR_G2_BBWIDTH/ BBwidth
    RECORD /L3DPR_G2_OBSERVATIONCOUNTS/ observationCounts
    REAL*4 precipRateNearSurfaceUnconditional(536,1440,5)
    REAL*4 precipProbabilityNearSurface(536,1440,5)
END STRUCTURE

STRUCTURE /L3DPR_G1_PRECIPRATELOCALTIME/
```

```
    INTEGER*4 count(28,72,5,24,3)
    REAL*4 mean(28,72,5,24,3)
    REAL*4 stdev(28,72,5,24,3)
END STRUCTURE

STRUCTURE /L3DPR_G1_OBSERVATIONCOUNTS/
    INTEGER*4 total(28,72,4,3)
    INTEGER*4 localTime(28,72,4,24,3)
    INTEGER*4 pia(28,72,4,7,3)
    INTEGER*4 shallowRain(28,72,4,3)
END STRUCTURE

STRUCTURE /L3DPR_G1_BBWIDTH/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_HEIGHTSTORMTOP/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_BBWIDTHNADIR/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_HEIGHTBBNADIR/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_HEIGHTBB/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
```

```
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_PIAFINALDPRSUBSET/
    INTEGER*4 count(28,72,4,7,3,3)
    REAL*4 mean(28,72,4,7,3,3)
    REAL*4 stdev(28,72,4,7,3,3)
    INTEGER*4 hist(28,72,4,7,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_PIAFINALSUBSET/
    INTEGER*4 count(28,72,4,7,3,3)
    REAL*4 mean(28,72,4,7,3,3)
    REAL*4 stdev(28,72,4,7,3,3)
    INTEGER*4 hist(28,72,4,7,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_PIAFINALDPR/
    INTEGER*4 count(28,72,4,7,3,3)
    REAL*4 mean(28,72,4,7,3,3)
    REAL*4 stdev(28,72,4,7,3,3)
    INTEGER*4 hist(28,72,4,7,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_PIAFINAL/
    INTEGER*4 count(28,72,4,7,3,3)
    REAL*4 mean(28,72,4,7,3,3)
    REAL*4 stdev(28,72,4,7,3,3)
    INTEGER*4 hist(28,72,4,7,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_PIASRTDPR/
    INTEGER*4 count(28,72,4,7,3,3)
    REAL*4 mean(28,72,4,7,3,3)
    REAL*4 stdev(28,72,4,7,3,3)
    INTEGER*4 hist(28,72,4,7,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_PIASRT/
    INTEGER*4 count(28,72,4,7,3,3)
    REAL*4 mean(28,72,4,7,3,3)
    REAL*4 stdev(28,72,4,7,3,3)
```

```
    INTEGER*4 hist(28,72,4,7,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_EPSILON/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_EPSILONDPR/
    INTEGER*4 count(28,72,4,5,3,3)
    REAL*4 mean(28,72,4,5,3,3)
    REAL*4 stdev(28,72,4,5,3,3)
    INTEGER*4 hist(28,72,4,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_DBNW/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_DM/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_ZFACTORMEASURED/
    INTEGER*4 count(28,72,4,5,3,3)
    REAL*4 mean(28,72,4,5,3,3)
    REAL*4 stdev(28,72,4,5,3,3)
    INTEGER*4 hist(28,72,4,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_ZFACTORCORRECTEDNEARSURFACEDPR/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
```

```
END STRUCTURE

STRUCTURE /L3DPR_G1_ZFACTORCORRECTEDESURFACEDPR/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_ZFACTORCORRECTEDDPR/
    INTEGER*4 count(28,72,4,5,3,3)
    REAL*4 mean(28,72,4,5,3,3)
    REAL*4 stdev(28,72,4,5,3,3)
    INTEGER*4 hist(28,72,4,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_ZFACTORCORRECTEDNEARSURFACE/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_ZFACTORCORRECTEDESURFACE/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_ZFACTORCORRECTED/
    INTEGER*4 count(28,72,4,5,3,3)
    REAL*4 mean(28,72,4,5,3,3)
    REAL*4 stdev(28,72,4,5,3,3)
    INTEGER*4 hist(28,72,4,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_PRECIPRATEAVE24/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE
```

```
STRUCTURE /L3DPR_G1_PRECIPICEINTEGRATED/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_PRECIPWATERINTEGRATED/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_MIXEDPHRATENEARSURFACE/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_SNOWRATENEARSURFACE/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_RAINRATENEARSURFACE/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_PRECIPRATENEARSURFACE/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE
```

```
STRUCTURE /L3DPR_G1_PRECIPRATEESURFACE2/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_PRECIPRATEESURFACE/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_MIXEDPHRATE/
    INTEGER*4 count(28,72,5,5,3,3)
    REAL*4 mean(28,72,5,5,3,3)
    REAL*4 stdev(28,72,5,5,3,3)
    INTEGER*4 hist(28,72,5,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_SNOWRATE/
    INTEGER*4 count(28,72,5,5,3,3)
    REAL*4 mean(28,72,5,5,3,3)
    REAL*4 stdev(28,72,5,5,3,3)
    INTEGER*4 hist(28,72,5,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_RAINRATE/
    INTEGER*4 count(28,72,5,5,3,3)
    REAL*4 mean(28,72,5,5,3,3)
    REAL*4 stdev(28,72,5,5,3,3)
    INTEGER*4 hist(28,72,5,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1_PRECIPRATE/
    INTEGER*4 count(28,72,5,5,3,3)
    REAL*4 mean(28,72,5,5,3,3)
    REAL*4 stdev(28,72,5,5,3,3)
    INTEGER*4 hist(28,72,5,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_G1/
```

```
    RECORD /L3DPR_G1_PRECIPRATE/ precipRate
    RECORD /L3DPR_G1_RAINRATE/ rainRate
    RECORD /L3DPR_G1_SNOWRATE/ snowRate
    RECORD /L3DPR_G1_MIXEDPHRATE/ mixedPhRate
    RECORD /L3DPR_G1_PRECIPRATEESURFACE/ precipRateESurface
    RECORD /L3DPR_G1_PRECIPRATEESURFACE2/ precipRateESurface2
    RECORD /L3DPR_G1_PRECIPRATENEARSURFACE/ precipRateNearSurface
    RECORD /L3DPR_G1_RAINRATENEARSURFACE/ rainRateNearSurface
    RECORD /L3DPR_G1_SNOWRATENEARSURFACE/ snowRateNearSurface
    RECORD /L3DPR_G1_MIXEDPHRATENEARSURFACE/ mixedPhRateNearSurface
    RECORD /L3DPR_G1_PRECIPWATERINTEGRATED/ precipWaterIntegrated
    RECORD /L3DPR_G1_PRECIPICEINTEGRATED/ precipIceIntegrated
    RECORD /L3DPR_G1_PRECIPRATEAVE24/ precipRateAve24
    RECORD /L3DPR_G1_ZFACTORCORRECTED/ zFactorCorrected
    RECORD /L3DPR_G1_ZFACTORCORRECTEDESURFACE/ zFactorCorrectedESurface
    RECORD /L3DPR_G1_ZFACTORCORRECTEDNEARSURFACE/ zFactorCorrectedNearSurface
    RECORD /L3DPR_G1_ZFACTORCORRECTEDDPR/ zFactorCorrectedDPR
    RECORD /L3DPR_G1_ZFACTORCORRECTEDESURFACEDPR/ zFactorCorrectedESurfaceDPR
    RECORD /L3DPR_G1_ZFACTORCORRECTEDNEARSURFACEDPR/ zFactorCorrectedNearSurfaceDPR
    RECORD /L3DPR_G1_ZFACTORMEASURED/ zFactorMeasured
    RECORD /L3DPR_G1_DM/ dm
    RECORD /L3DPR_G1_DBNW/ dBNw
    RECORD /L3DPR_G1_EPSILONDPR/ epsilonDPR
    RECORD /L3DPR_G1_EPSILON/ epsilon
    RECORD /L3DPR_G1_PIASRT/ piaSRT
    RECORD /L3DPR_G1_PIASRTDPR/ piaSRTdpr
    RECORD /L3DPR_G1_PIAFINAL/ piaFinal
    RECORD /L3DPR_G1_PIAFINALDPR/ piaFinalDPR
    RECORD /L3DPR_G1_PIAFINALSUBSET/ piaFinalSubset
    RECORD /L3DPR_G1_PIAFINALDPRSUBSET/ piaFinalDPRsubset
    RECORD /L3DPR_G1_HEIGHTBB/ heightBB
    RECORD /L3DPR_G1_HEIGHTBBNADIR/ heightBBnadir
    RECORD /L3DPR_G1_BBWIDTHNADIR/ BBwidthNadir
    RECORD /L3DPR_G1_HEIGHTSTORMTOP/ heightStormTop
    RECORD /L3DPR_G1_BBWIDTH/ BBwidth
    RECORD /L3DPR_G1_OBSERVATIONCOUNTS/ observationCounts
    RECORD /L3DPR_G1_PRECIPRATELOCALTIME/ precipRateLocalTime
    REAL*4 precipRateNearSurfaceUnconditional(28,72,5)
    REAL*4 precipProbabilityNearSurface(28,72,5)
END STRUCTURE

STRUCTURE /L3DPR_GRIDS/
    RECORD /L3DPR_G1/ G1
```

```
    RECORD /L3DPR_G2/ G2
END STRUCTURE
```

5.34 3DPRD - DPR Daily Product

3DPRD, "DPR Daily Product", computes daily statistics of the DPR measurements at a high horizontal resolution (0.25^o x 0.25^o latitude/longitude).

Ranges and descriptions not included in this version.

Dimension definitions:

nlat	536	Number of high resolution 0.25^o grid intervals of latitude from 67^oS to 67^oN.
nlon	1440	Number of high resolution 0.25^o grid intervals of longitude from 180^oW to 180^oE.
nalt	5	Number of heights above the earth ellipsoid: 2km, 4km, 6km, 10km, and 15km.
nvar	3	Number of phase bins. Bins are counts of phase less than 100, counts of phase greater than or equal to 100 and less than 200, counts of phase greater than or equal to 200.
AD	2	Ascending or descending half of the orbit.

Figure 488 through Figure 491 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

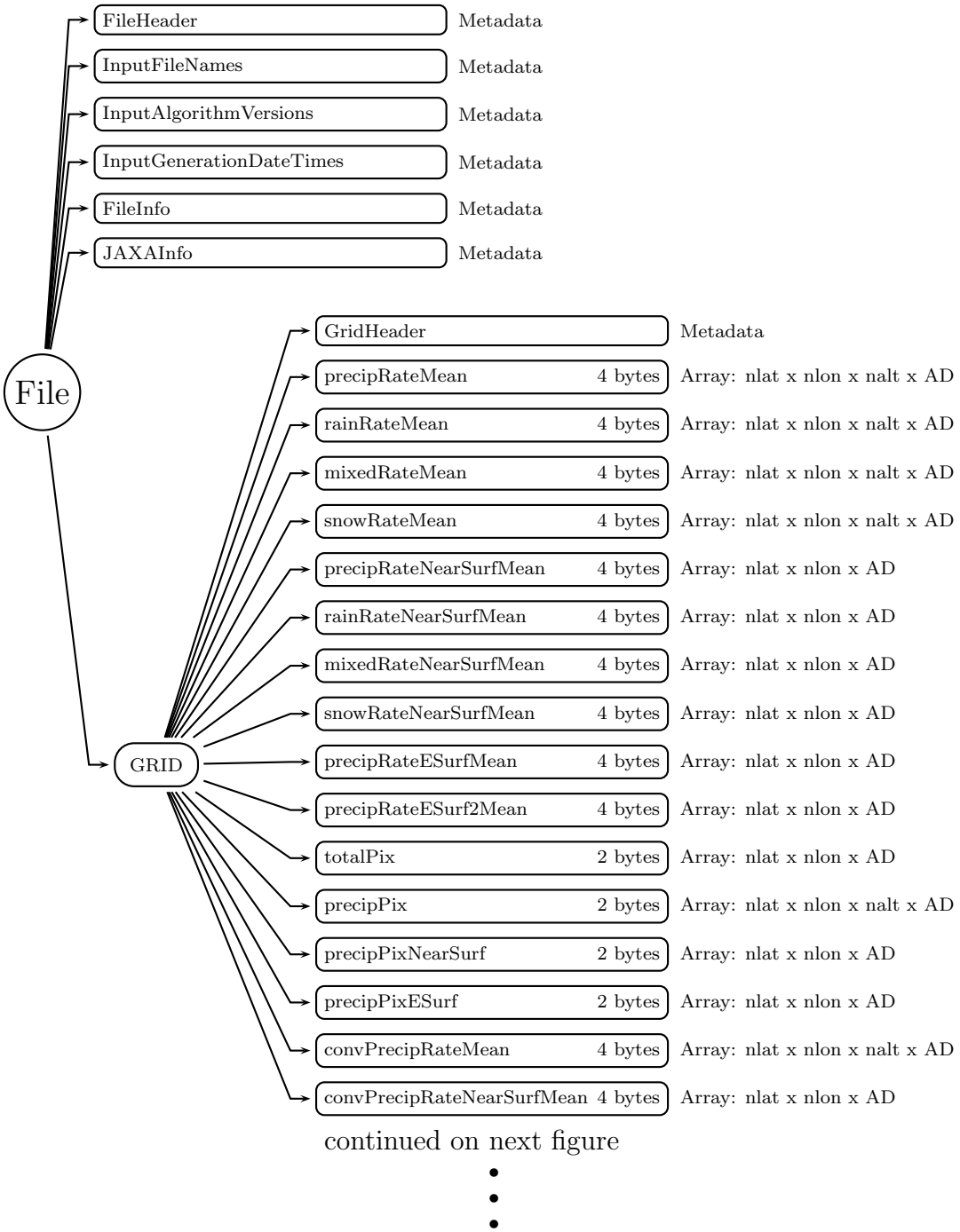
FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputFileNames (Metadata):
InputFileNames contains a list of input file names for this granule. See Metadata for GPM Products for details.

InputAlgorithmVersions (Metadata):
InputAlgorithmVersions contains a list of input algorithm versions for this granule. See Metadata for GPM Products for details.

InputGenerationDateTimes (Metadata):
InputGenerationDateTimes contains a list of input generation datetimes. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.



continued on next figure

Figure 488: Data Format Structure for 3DPRD, DPR Daily Product

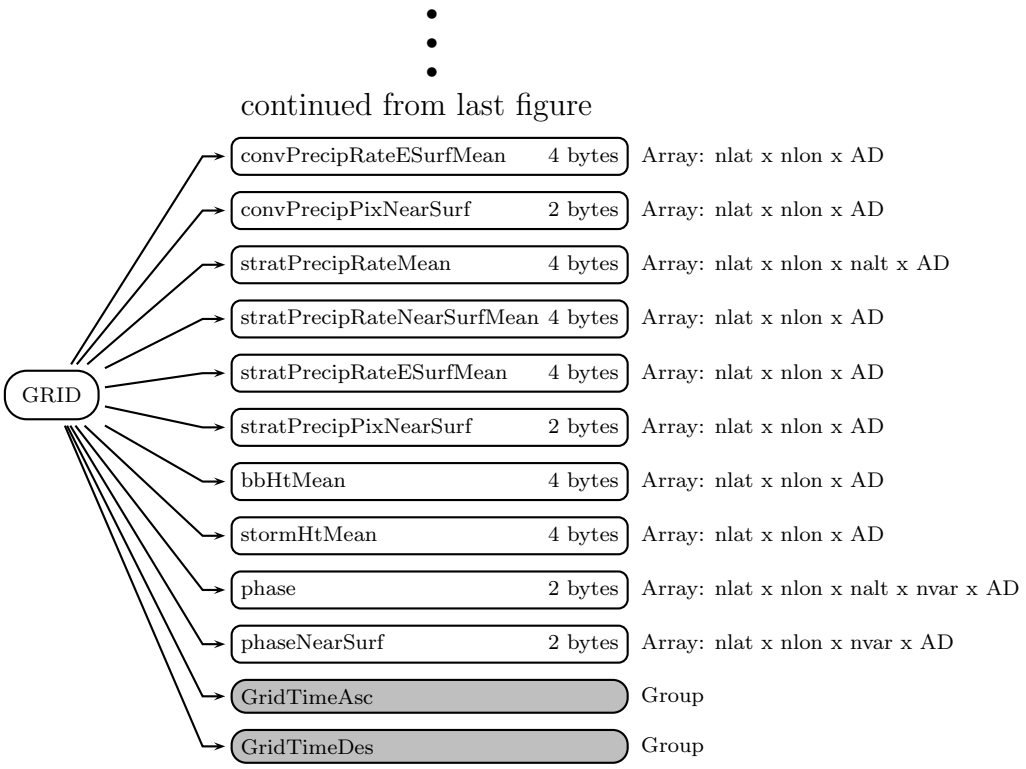


Figure 489: Data Format Structure for 3DPRD, DPR Daily Product

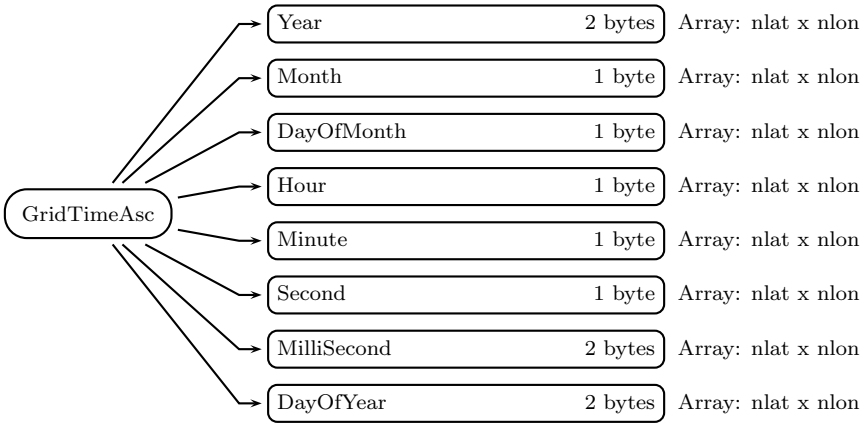


Figure 490: Data Format Structure for 3DPRD, GridTimeAsc

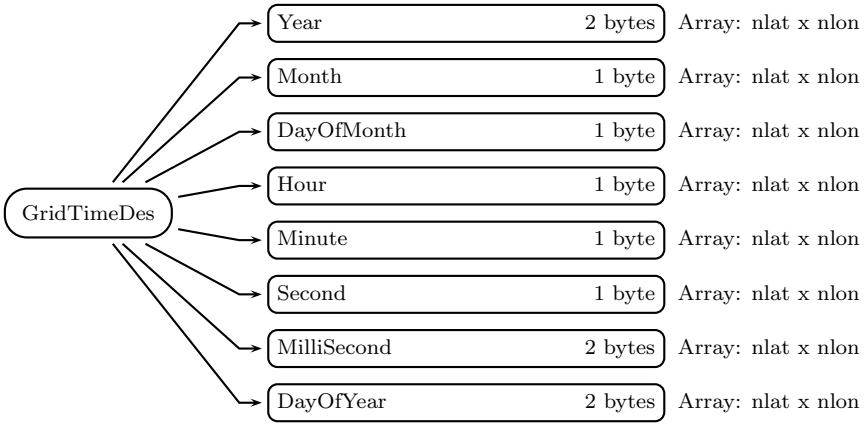


Figure 491: Data Format Structure for 3DPRD, GridTimeDes

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

GRID (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

precipRateMean (4-byte float, array size: nlat x nlon x nalt x AD):
Mean Precipitation rate, includes both liquid and solid phases at various height levels. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

rainRateMean (4-byte float, array size: nlat x nlon x nalt x AD):
Mean rainfall rate, excludes solid precipitation at various height levels. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

mixedRateMean (4-byte float, array size: nlat x nlon x nalt x AD):
Mean rainfall rate of the mixed phase precipitation at various height levels. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

snowRateMean (4-byte float, array size: nlat x nlon x nalt x AD):
Mean rainfall rate of solid precipitation at various height levels. First index is Ascending

node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateNearSurfMean (4-byte float, array size: nlat x nlon x AD):
Mean precipitation rate in a grid box using only the Near Surface location along the slant path for each radar ray. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

rainRateNearSurfMean (4-byte float, array size: nlat x nlon x AD):
Mean rainfall rate of liquid precipitation in a grid box using only the Near Surface location along the slant path for each radar ray. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

mixedRateNearSurfMean (4-byte float, array size: nlat x nlon x AD):
Mean rainfall rate of mixed phase precipitation in a grid box using only the Near Surface location along the slant path for each radar ray. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

snowRateNearSurfMean (4-byte float, array size: nlat x nlon x AD):
Mean rainfall rate of solid precipitation in a grid box using only the Near Surface location along the slant path for each radar ray. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurfMean (4-byte float, array size: nlat x nlon x AD):
Mean precipitation rate in a grid box using only the Estimated Surface location along the slant path for each radar ray. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurf2Mean (4-byte float, array size: nlat x nlon x AD):
Mean precipitation rate in a grid box using only the Estimated Surface 2 location along the slant path for each radar ray. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

totalPix (2-byte integer, array size: nlat x nlon x AD):
The total number of measurements in each grid box. First index is Ascending node, second index is Descending. Special values are defined as:
-9999 Missing value

precipPix (2-byte integer, array size: nlat x nlon x nalt x AD):
The number of measurements in each grid box that included detectable precipitation at various height levels. First index is Ascending node, second index is Descending. Special values are defined as:
-9999 Missing value

precipPixNearSurf (2-byte integer, array size: nlat x nlon x AD):
The number of measurements in a grid box that included detectable precipitation at the Near Surface level. First index is Ascending node, second index is Descending. Special values are defined as:
-9999 Missing value

precipPixESurf (2-byte integer, array size: nlat x nlon x AD):
The number of measurements in a grid box that included detectable precipitation at the Estimated Surface level. First index is Ascending node, second index is Descending. Special values are defined as:
-9999 Missing value

convPrecipRateMean (4-byte float, array size: nlat x nlon x nalt x AD):
The mean precipitation rate of convective type at various height levels. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

convPrecipRateNearSurfMean (4-byte float, array size: nlat x nlon x AD):
The mean precipitation rate of convective type at the Near Surface level along the radar ray. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

convPrecipRateESurfMean (4-byte float, array size: nlat x nlon x AD):
The mean precipitation rate of convective type at the Estimated Surface level along the radar ray. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

convPrecipPixNearSurf (2-byte integer, array size: nlat x nlon x AD):
The number of convective precipitation measurements in a grid box at the Near Surface level. First index is Ascending node, second index is Descending. Special values are defined as:
-9999 Missing value

stratPrecipRateMean (4-byte float, array size: nlat x nlon x nalt x AD):
The mean precipitation rate of stratiform type at various height levels. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

stratPrecipRateNearSurfMean (4-byte float, array size: nlat x nlon x AD):
The mean precipitation rate of stratiform type at the Near Surface level along the radar ray. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

stratPrecipRateESurfMean (4-byte float, array size: nlat x nlon x AD):
The mean precipitation rate of stratiform type at the Estimated Surface level along the radar ray. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

stratPrecipPixNearSurf (2-byte integer, array size: nlat x nlon x AD):
The number of stratiform precipitation measurements in a grid box at the Near Surface level. First index is Ascending node, second index is Descending. Special values are defined as:
-9999 Missing value

bbHtMean (4-byte float, array size: nlat x nlon x AD):
The mean bright band height in a grid box. First index is Ascending node, second index is Descending. Values are in m. Special values are defined as:
-9999.9 Missing value

stormHtMean (4-byte float, array size: nlat x nlon x AD):
The mean storm height in a grid box. First index is Ascending node, second index is Descending. Values are in m. Special values are defined as:
-9999.9 Missing value

phase (2-byte integer, array size: nlat x nlon x nalt x nvar x AD):
The precipitation phase type in a grid box a various heights. First index is Ascending node, second index is Descending. Special values are defined as:
-9999 Missing value

phaseNearSurf (2-byte integer, array size: nlat x nlon x nvar x AD):
The precipitation phase type in a grid box. First index is Ascending node, second index is Descending. Special values are defined as:
-9999 Missing value

GridTimeAsc (Group)

A UTC time associated with the grid box.

Year (2-byte integer, array size: nlat x nlon):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nlat x nlon):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nlat x nlon):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nlat x nlon):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nlat x nlon):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nlat x nlon):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nlat x nlon):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nlat x nlon):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

GridTimeDes (Group)

A UTC time associated with the grid box.

Year (2-byte integer, array size: nlat x nlon):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nlat x nlon):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nlat x nlon):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nlat x nlon):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nlat x nlon):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nlat x nlon):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nlat x nlon):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nlat x nlon):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

C Structure Header file:

```
#ifndef _TK_3DPRD_H_
#define _TK_3DPRD_H_

#ifndef _L3DPRD_GRIDTIMEDES_
#define _L3DPRD_GRIDTIMEDES_

typedef struct {
    short Year[1440][536];
    signed char Month[1440][536];
    signed char DayOfMonth[1440][536];
    signed char Hour[1440][536];
    signed char Minute[1440][536];
    signed char Second[1440][536];
    short MilliSecond[1440][536];
    short DayOfYear[1440][536];
} L3DPRD_GRIDTIMEDES;

#endif

#ifndef _L3DPRD_GRIDTIMEASC_
#define _L3DPRD_GRIDTIMEASC_

typedef struct {
    short Year[1440][536];
    signed char Month[1440][536];
    signed char DayOfMonth[1440][536];
    signed char Hour[1440][536];
    signed char Minute[1440][536];
    signed char Second[1440][536];
    short MilliSecond[1440][536];
    short DayOfYear[1440][536];
} L3DPRD_GRIDTIMEASC;

#endif
```

```
#ifndef _L3DPRD_GRID_
#define _L3DPRD_GRID_

typedef struct {
    float precipRateMean[2][5][1440][536];
    float rainRateMean[2][5][1440][536];
    float mixedRateMean[2][5][1440][536];
    float snowRateMean[2][5][1440][536];
    float precipRateNearSurfMean[2][1440][536];
    float rainRateNearSurfMean[2][1440][536];
    float mixedRateNearSurfMean[2][1440][536];
    float snowRateNearSurfMean[2][1440][536];
    float precipRateESurfMean[2][1440][536];
    float precipRateESurf2Mean[2][1440][536];
    short totalPix[2][1440][536];
    short precipPix[2][5][1440][536];
    short precipPixNearSurf[2][1440][536];
    short precipPixESurf[2][1440][536];
    float convPrecipRateMean[2][5][1440][536];
    float convPrecipRateNearSurfMean[2][1440][536];
    float convPrecipRateESurfMean[2][1440][536];
    short convPrecipPixNearSurf[2][1440][536];
    float stratPrecipRateMean[2][5][1440][536];
    float stratPrecipRateNearSurfMean[2][1440][536];
    float stratPrecipRateESurfMean[2][1440][536];
    short stratPrecipPixNearSurf[2][1440][536];
    float bbHtMean[2][1440][536];
    float stormHtMean[2][1440][536];
    short phase[2][3][5][1440][536];
    short phaseNearSurf[2][3][1440][536];
    L3DPRD_GRIDTIMEASC GridTimeAsc;
    L3DPRD_GRIDTIMEDES GridTimeDes;
} L3DPRD_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3DPRD_GRIDTIMEDES/
    INTEGER*2 Year(536,1440)
```

```
    BYTE Month(536,1440)
    BYTE DayOfMonth(536,1440)
    BYTE Hour(536,1440)
    BYTE Minute(536,1440)
    BYTE Second(536,1440)
    INTEGER*2 MilliSecond(536,1440)
    INTEGER*2 DayOfYear(536,1440)
END STRUCTURE

STRUCTURE /L3DPRD_GRIDTIMEASC/
    INTEGER*2 Year(536,1440)
    BYTE Month(536,1440)
    BYTE DayOfMonth(536,1440)
    BYTE Hour(536,1440)
    BYTE Minute(536,1440)
    BYTE Second(536,1440)
    INTEGER*2 MilliSecond(536,1440)
    INTEGER*2 DayOfYear(536,1440)
END STRUCTURE

STRUCTURE /L3DPRD_GRID/
    REAL*4 precipRateMean(536,1440,5,2)
    REAL*4 rainRateMean(536,1440,5,2)
    REAL*4 mixedRateMean(536,1440,5,2)
    REAL*4 snowRateMean(536,1440,5,2)
    REAL*4 precipRateNearSurfMean(536,1440,2)
    REAL*4 rainRateNearSurfMean(536,1440,2)
    REAL*4 mixedRateNearSurfMean(536,1440,2)
    REAL*4 snowRateNearSurfMean(536,1440,2)
    REAL*4 precipRateESurfMean(536,1440,2)
    REAL*4 precipRateESurf2Mean(536,1440,2)
    INTEGER*2 totalPix(536,1440,2)
    INTEGER*2 precipPix(536,1440,5,2)
    INTEGER*2 precipPixNearSurf(536,1440,2)
    INTEGER*2 precipPixESurf(536,1440,2)
    REAL*4 convPrecipRateMean(536,1440,5,2)
    REAL*4 convPrecipRateNearSurfMean(536,1440,2)
    REAL*4 convPrecipRateESurfMean(536,1440,2)
    INTEGER*2 convPrecipPixNearSurf(536,1440,2)
    REAL*4 stratPrecipRateMean(536,1440,5,2)
    REAL*4 stratPrecipRateNearSurfMean(536,1440,2)
    REAL*4 stratPrecipRateESurfMean(536,1440,2)
    INTEGER*2 stratPrecipPixNearSurf(536,1440,2)
```

```
    REAL*4 bbHtMean(536,1440,2)
    REAL*4 stormHtMean(536,1440,2)
    INTEGER*2 phase(536,1440,5,3,2)
    INTEGER*2 phaseNearSurf(536,1440,3,2)
    RECORD /L3DPRD_GRIDTIMEASC/ GridTimeAsc
    RECORD /L3DPRD_GRIDTIMEDES/ GridTimeDes
END STRUCTURE
```

5.35 3CMB - Combined precipitation

3CMB, "Combined precipitation", computes statistics of the Combined measurements at both a low horizontal resolution (G1, 5° x 5° latitude/longitude) and a high horizontal resolution (G2, 0.25^o x 0.25^o latitude/longitude). There will be both a monthly product and a daily product.

Units and ranges not included in this version. When units and ranges are provided and no more changes are coming then they could be added. Use specific reference for each variable.

Dimension definitions:

ltL	28	Number of low resolution 5° grid intervals of latitude from 70^oS to 70^oN.
lnL	72	Number of low resolution 5° grid intervals of longitude from 180^oW to 180^oE.
ltH	536	Number of high resolution 0.25^o grid intervals of latitude from 67^oS to 67^oN.
lnH	1440	Number of high resolution 0.25^o grid intervals of longitude from 180^oW to 180^oE.
ns	2	Number of swaths:, MS (Ku+Ka+microwave), NS (Ku+microwave).
hgt	16	Number of level heights 0-15: 0: near surface, 1-10: height = 1.0km * index, 11-15: height = 10.0km + 2.0km * (index-10),
tim	24	Number of hourly local time bins.
rt	3	Number of rain types: stratiform, convective, all.
st	3	Number of surface types: ocean, land, all.
bin	30	Number of bins in histogram.

Figure 492 through Figure 508 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

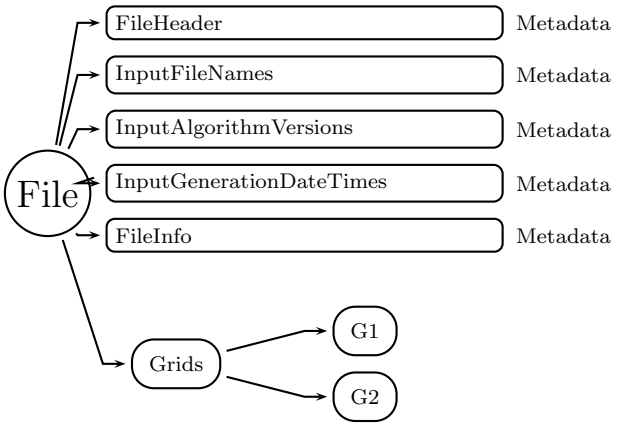


Figure 492: Data Format Structure for 3CMB, Combined precipitation

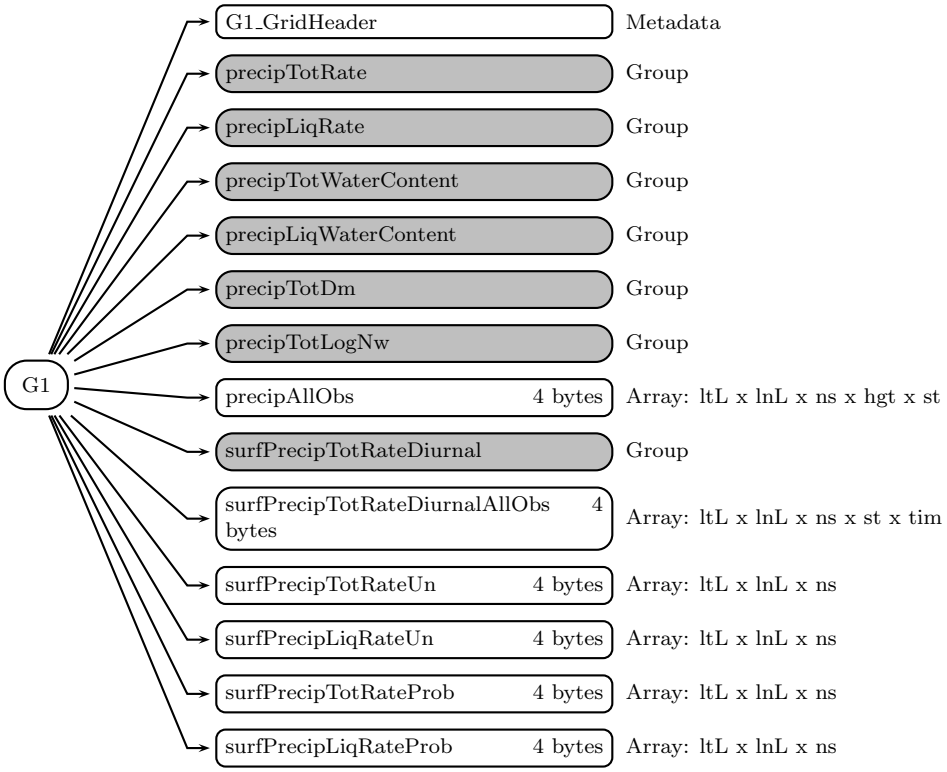


Figure 493: Data Format Structure for 3CMB, G1

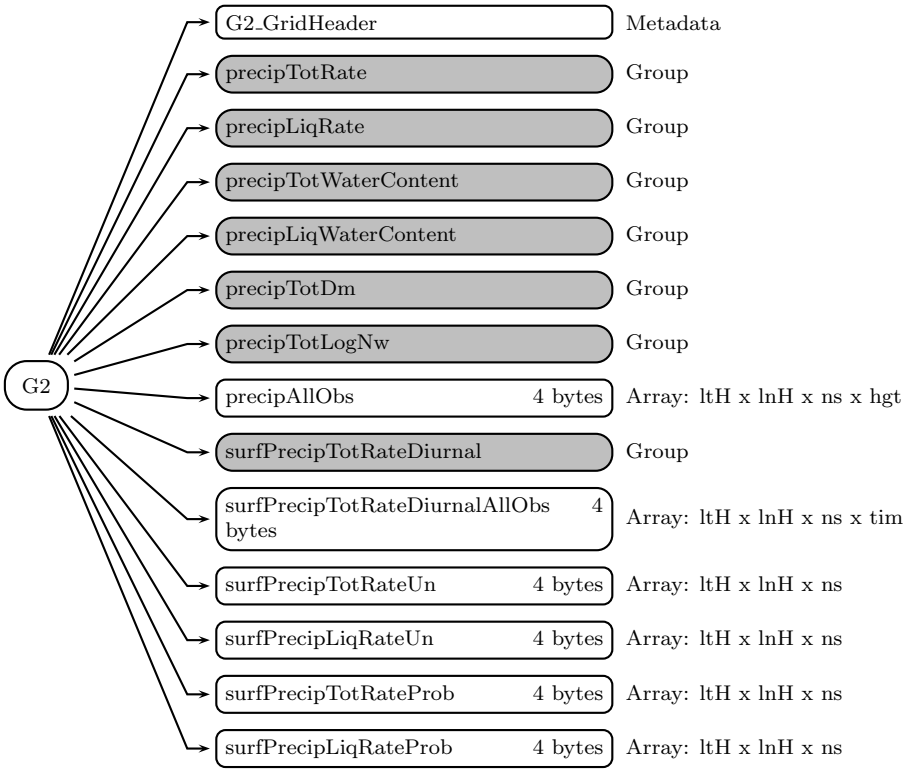


Figure 494: Data Format Structure for 3CMB, G2

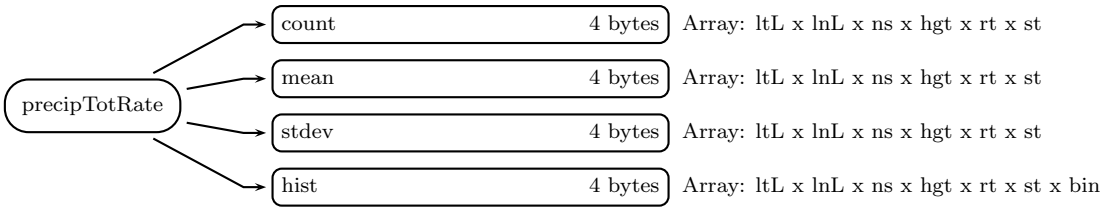


Figure 495: Data Format Structure for 3CMB, G1, precipTotRate

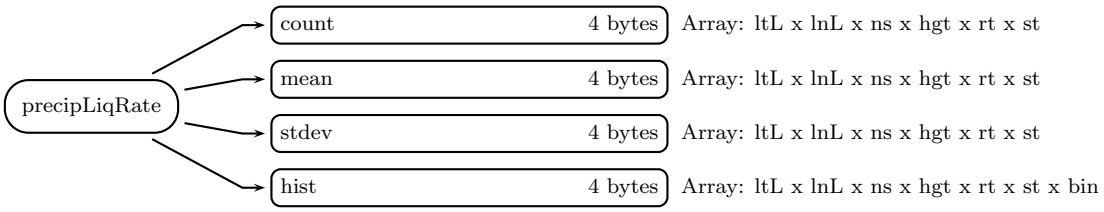


Figure 496: Data Format Structure for 3CMB, G1, precipLiqRate

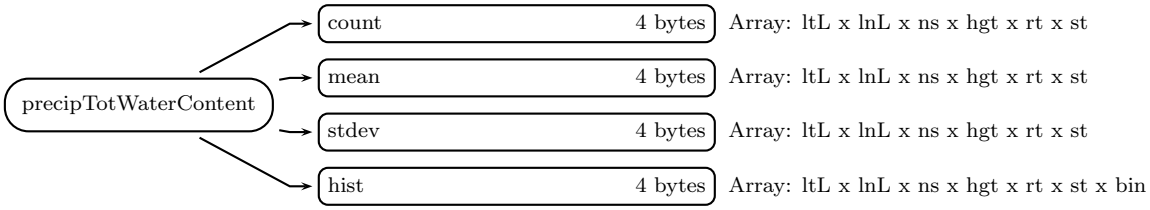


Figure 497: Data Format Structure for 3CMB, G1, precipTotWaterContent

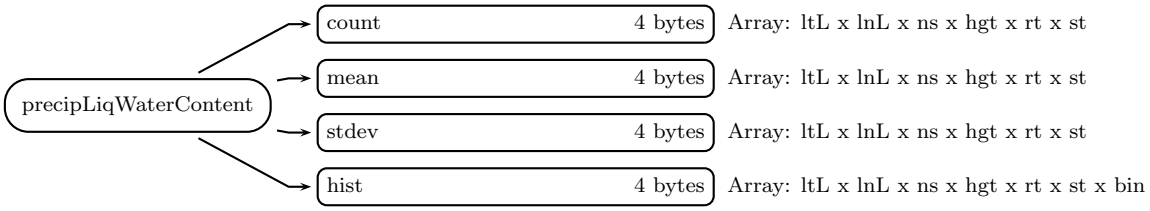


Figure 498: Data Format Structure for 3CMB, G1, precipLiqWaterContent

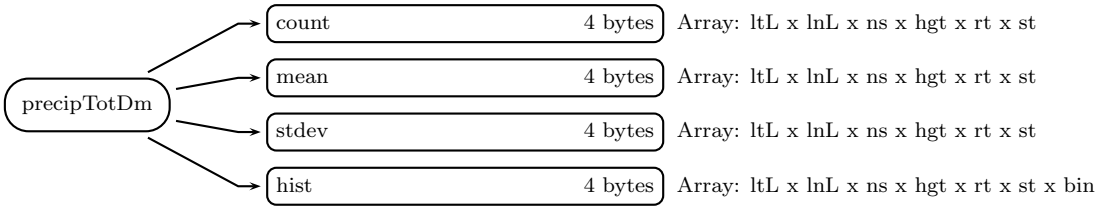


Figure 499: Data Format Structure for 3CMB, G1, precipTotDm

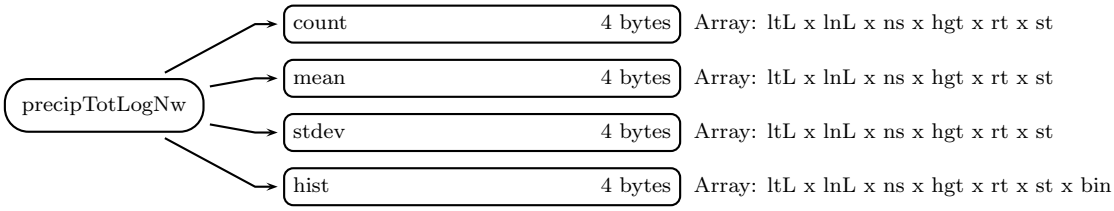


Figure 500: Data Format Structure for 3CMB, G1, precipTotLogNw

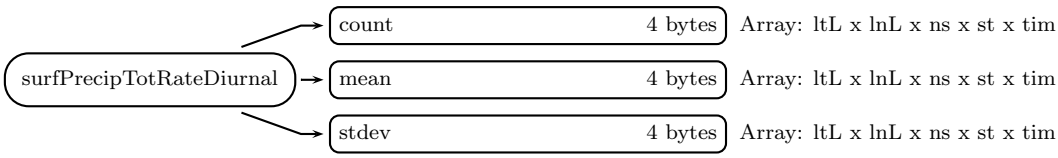


Figure 501: Data Format Structure for 3CMB, G1, surfPrecipTotRateDiurnal

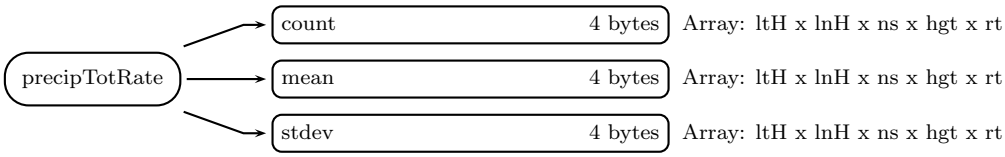


Figure 502: Data Format Structure for 3CMB, G2, precipTotRate

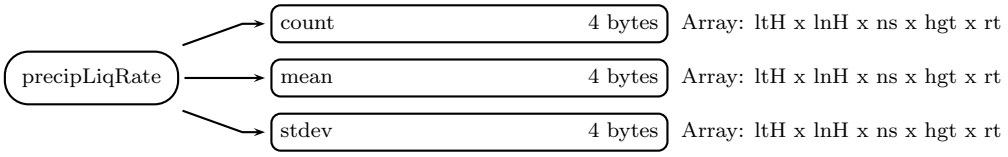


Figure 503: Data Format Structure for 3CMB, G2, precipLiqRate

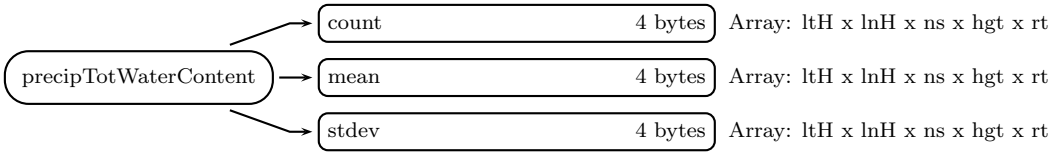


Figure 504: Data Format Structure for 3CMB, G2, precipTotWaterContent

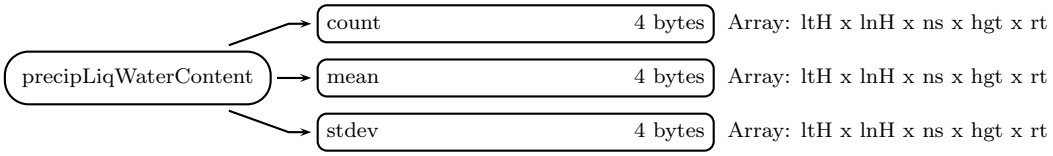


Figure 505: Data Format Structure for 3CMB, G2, precipLiqWaterContent

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputFileNames (Metadata):
InputFileNames contains a list of input file names for this granule. See Metadata for GPM Products for details.

InputAlgorithmVersions (Metadata):
InputAlgorithmVersions contains a list of input algorithm versions for this granule. See Metadata for GPM Products for details.

InputGenerationDateTimes (Metadata):
InputGenerationDateTimes contains a list of input generation datetimes. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

Grids (Group)

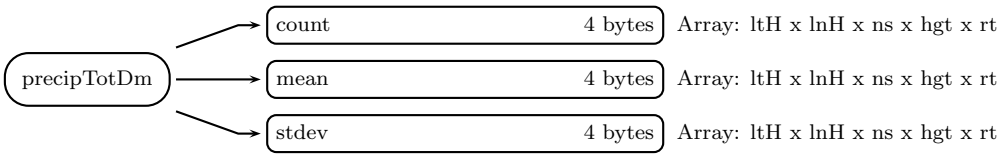


Figure 506: Data Format Structure for 3CMB, G2, precipTotDm

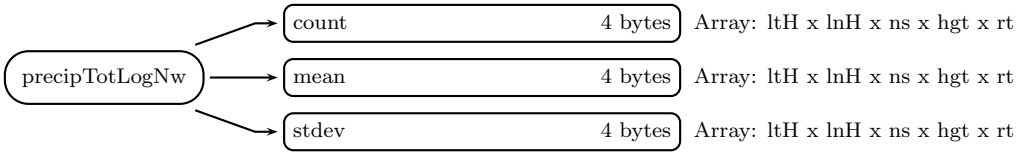


Figure 507: Data Format Structure for 3CMB, G2, precipTotLogNw

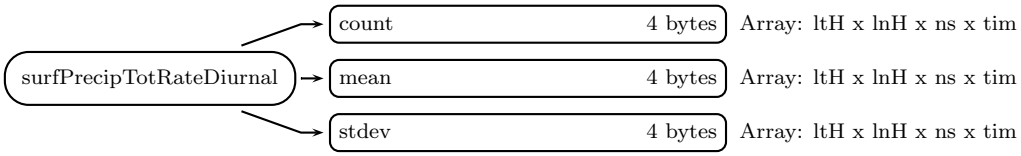


Figure 508: Data Format Structure for 3CMB, G2, surfPrecipTotRateDiurnal

G1 (Grid)

G1_GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

precipTotRate (Group in G1)

Equivalent precipitation rate of both liquid-phase and ice-phase precipitation water (mm/hr). (Note: liquid can be in the form of rain or liquid water in mixed-phase particles; ice can be in the form of ice particles or ice in mixed-phase particles.)

count (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipLiqRate (Group in G1)

Equivalent precipitation rate of liquid-phase precipitating water (mm/hr). (Note: liquid

can be in the form of rain or liquid water in mixed-phase particles.)

count (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipTotWaterContent (Group in G1)

Equivalent water content of both liquid-phase and ice-phase precipitating water (g/m^3). (Note: liquid can be in the form of rain or melt water in mixed-phase particles; ice can be in the form of ice particles or ice in mixed-phase particles.)

count (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipLiqWaterContent (Group in G1)

Equivalent water content of liquid-phase precipitating water (g/m^3). (Note: liquid can be in the form of rain or liquid water in mixed-phase particles.)

count (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipTotDm (Group in G1)

Volume-weighted mean of the liquid-equivalent precipitation particle diameter (mm).

count (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipTotLogNw (Group in G1)

Common logarithm of the intercept of the normalized gamma distribution representing the liquid-equivalent precipitation particle size distribution (log10(m^-4)).

count (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipAllObs (4-byte integer, array size: ltL x lnL x ns x hgt x st):
Number of total observations, whether precipitating or not. Special values are defined as:
-9999 Missing value

surfPrecipTotRateDiurnal (Group in G1)

Equivalent precipitation rate of both liquid-phase and ice-phase precipitating water in the lowest uncontaminated range-bin (mm/hr), indexed by the local time. (Note: liquid can be in the form of rain or liquid water in mixed-phase particles; ice can be in the form of ice particles or ice in mixed-phase particles.)

count (4-byte integer, array size: ltL x lnL x ns x st x tim):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x st x tim):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ns x st x tim):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

surfPrecipTotRateDiurnalAllObs (4-byte integer, array size: ltL x lnL x ns x st x tim):
Number of total diurnal observations, whether precipitating or not. Special values are defined as:
-9999 Missing value

surfPrecipTotRateUn (4-byte float, array size: ltL x lnL x ns):
Surface total precipitation rate unconditioned. To obtain rate conditioned on precipitation, divide by the probability. Special values are defined as:
-9999.9 Missing value

surfPrecipLiqRateUn (4-byte float, array size: ltL x lnL x ns):
Surface liquid precipitation rate unconditioned. To obtain rate conditioned on precipitation, divide by the probability. Special values are defined as:
-9999.9 Missing value

surfPrecipTotRateProb (4-byte float, array size: ltL x lnL x ns):
Probability of total surface precipitation. Special values are defined as:
-9999.9 Missing value

surfPrecipLiqRateProb (4-byte float, array size: ltL x lnL x ns):
Probability of liquid surface precipitation. Special values are defined as:
-9999.9 Missing value

G2 (Grid)

G2_GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

precipTotRate (Group in G2)

Equivalent precipitation rate of both liquid-phase and ice-phase precipitation water (mm/hr). (Note: liquid can be in the form of rain or liquid water in mixed-phase particles; ice can be in the form of ice particles or ice in mixed-phase particles.)

count (4-byte integer, array size: ltH x lnH x ns x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ns x hgt x rt):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

precipLiqRate (Group in G2)

Equivalent precipitation rate of liquid-phase precipitating water (mm/hr). (Note: liquid can be in the form of rain or liquid water in mixed-phase particles.)

count (4-byte integer, array size: ltH x lnH x ns x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ns x hgt x rt):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

precipTotWaterContent (Group in G2)

Equivalent water content of both liquid-phase and ice-phase precipitating water (g/m^3). (Note: liquid can be in the form of rain or melt water in mixed-phase particles; ice can be in the form of ice particles or ice in mixed-phase particles.)

count (4-byte integer, array size: ltH x lnH x ns x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ns x hgt x rt):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

precipLiqWaterContent (Group in G2)

Equivalent water content of liquid-phase precipitating water (g/m^3). (Note: liquid can be in the form of rain or liquid water in mixed-phase particles.)

count (4-byte integer, array size: ltH x lnH x ns x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ns x hgt x rt):
Standard deviation for the monthly product. Mean of squares for the daily product.

Special values are defined as:
-9999.9 Missing value

precipTotDm (Group in G2)

Volume-weighted mean of the liquid-equivalent precipitation particle diameter (mm).

count (4-byte integer, array size: ltH x lnH x ns x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ns x hgt x rt):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

precipTotLogNw (Group in G2)

Common logarithm of the intercept of the normalized gamma distribution representing the liquid-equivalent precipitation particle size distribution (log10(m^-4)).

count (4-byte integer, array size: ltH x lnH x ns x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ns x hgt x rt):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

precipAllObs (4-byte integer, array size: ltH x lnH x ns x hgt):
Number of total observations, whether precipitating or not. Special values are defined as:
-9999 Missing value

surfPrecipTotRateDiurnal (Group in G2)

Equivalent precipitation rate of both liquid-phase and ice-phase precipitating water in the lowest uncontaminated range-bin (mm/hr), indexed by the local time. (Note: liquid can

be in the form of rain or liquid water in mixed-phase particles; ice can be in the form of ice particles or ice in mixed-phase particles.)

count (4-byte integer, array size: ltH x lnH x ns x tim):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x tim):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ns x tim):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

surfPrecipTotRateDiurnalAllObs (4-byte integer, array size: ltH x lnH x ns x tim):
Number of total diurnal observations, whether precipitating or not. Special values are defined as:
-9999 Missing value

surfPrecipTotRateUn (4-byte float, array size: ltH x lnH x ns):
Surface total precipitation rate unconditioned. To obtain rate conditioned on precipitation, divide by the probability. Special values are defined as:
-9999.9 Missing value

surfPrecipLiqRateUn (4-byte float, array size: ltH x lnH x ns):
Surface liguid precipitation rate unconditioned. To obtain rate conditioned on precipitation, divide by the probability. Special values are defined as:
-9999.9 Missing value

surfPrecipTotRateProb (4-byte float, array size: ltH x lnH x ns):
Probability of total surface precipitation. Special values are defined as:
-9999.9 Missing value

surfPrecipLiqRateProb (4-byte float, array size: ltH x lnH x ns):
Probability of liquid surface precipitation. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_3CMB_H_
#define _TK_3CMB_H_

#ifndef _L3CMB_G2_SURFPRECIPTOTRATEDIURNAL_
#define _L3CMB_G2_SURFPRECIPTOTRATEDIURNAL_

typedef struct {
    int count[24][2][1440][536];
```

```
    float mean[24][2][1440][536];
    float stdev[24][2][1440][536];
} L3CMB_G2_SURFPRECIPTOTRATEDIURNAL;

#endif

#ifndef _L3CMB_G2_PRECIPTOTLOGNW_
#define _L3CMB_G2_PRECIPTOTLOGNW_

typedef struct {
    int count[3][16][2][1440][536];
    float mean[3][16][2][1440][536];
    float stdev[3][16][2][1440][536];
} L3CMB_G2_PRECIPTOTLOGNW;

#endif

#ifndef _L3CMB_G2_PRECIPTOTDM_
#define _L3CMB_G2_PRECIPTOTDM_

typedef struct {
    int count[3][16][2][1440][536];
    float mean[3][16][2][1440][536];
    float stdev[3][16][2][1440][536];
} L3CMB_G2_PRECIPTOTDM;

#endif

#ifndef _L3CMB_G2_PRECIPLIQWATERCONTENT_
#define _L3CMB_G2_PRECIPLIQWATERCONTENT_

typedef struct {
    int count[3][16][2][1440][536];
    float mean[3][16][2][1440][536];
    float stdev[3][16][2][1440][536];
} L3CMB_G2_PRECIPLIQWATERCONTENT;

#endif

#ifndef _L3CMB_G2_PRECIPTOTWATERCONTENT_
#define _L3CMB_G2_PRECIPTOTWATERCONTENT_

typedef struct {
```

```
    int count[3][16][2][1440][536];
    float mean[3][16][2][1440][536];
    float stdev[3][16][2][1440][536];
} L3CMB_G2_PRECIPTOTWATERCONTENT;

#endif

#ifndef _L3CMB_G2_PRECIPLIQRATE_
#define _L3CMB_G2_PRECIPLIQRATE_

typedef struct {
    int count[3][16][2][1440][536];
    float mean[3][16][2][1440][536];
    float stdev[3][16][2][1440][536];
} L3CMB_G2_PRECIPLIQRATE;

#endif

#ifndef _L3CMB_G2_PRECIPTOTRATE_
#define _L3CMB_G2_PRECIPTOTRATE_

typedef struct {
    int count[3][16][2][1440][536];
    float mean[3][16][2][1440][536];
    float stdev[3][16][2][1440][536];
} L3CMB_G2_PRECIPTOTRATE;

#endif

#ifndef _L3CMB_G2_
#define _L3CMB_G2_

typedef struct {
    L3CMB_G2_PRECIPTOTRATE precipTotRate;
    L3CMB_G2_PRECIPLIQRATE precipLiqRate;
    L3CMB_G2_PRECIPTOTWATERCONTENT precipTotWaterContent;
    L3CMB_G2_PRECIPLIQWATERCONTENT precipLiqWaterContent;
    L3CMB_G2_PRECIPTOTDM precipTotDm;
    L3CMB_G2_PRECIPTOTLOGNW precipTotLogNw;
    int precipAllObs[16][2][1440][536];
    L3CMB_G2_SURFPRECIPTOTRATEDIURNAL surfPrecipTotRateDiurnal;
    int surfPrecipTotRateDiurnalAllObs[24][2][1440][536];
    float surfPrecipTotRateUn[2][1440][536];
```

```
    float surfPrecipLiqRateUn[2][1440][536];
    float surfPrecipTotRateProb[2][1440][536];
    float surfPrecipLiqRateProb[2][1440][536];
} L3CMB_G2;

#endif

#ifndef _L3CMB_G1_SURFPRECIPTOTRATEDIURNAL_
#define _L3CMB_G1_SURFPRECIPTOTRATEDIURNAL_

typedef struct {
    int count[24][3][2][72][28];
    float mean[24][3][2][72][28];
    float stdev[24][3][2][72][28];
} L3CMB_G1_SURFPRECIPTOTRATEDIURNAL;

#endif

#ifndef _L3CMB_G1_PRECIPTOTLOGNW_
#define _L3CMB_G1_PRECIPTOTLOGNW_

typedef struct {
    int count[3][3][16][2][72][28];
    float mean[3][3][16][2][72][28];
    float stdev[3][3][16][2][72][28];
    int hist[30][3][3][16][2][72][28];
} L3CMB_G1_PRECIPTOTLOGNW;

#endif

#ifndef _L3CMB_G1_PRECIPTOTDM_
#define _L3CMB_G1_PRECIPTOTDM_

typedef struct {
    int count[3][3][16][2][72][28];
    float mean[3][3][16][2][72][28];
    float stdev[3][3][16][2][72][28];
    int hist[30][3][3][16][2][72][28];
} L3CMB_G1_PRECIPTOTDM;

#endif

#ifndef _L3CMB_G1_PRECIPLIQWATERCONTENT_
```

```
#define _L3CMB_G1_PRECIPLIQWATERCONTENT_

typedef struct {
    int count[3][3][16][2][72][28];
    float mean[3][3][16][2][72][28];
    float stdev[3][3][16][2][72][28];
    int hist[30][3][3][16][2][72][28];
} L3CMB_G1_PRECIPLIQWATERCONTENT;

#endif

#ifndef _L3CMB_G1_PRECIPTOTWATERCONTENT_
#define _L3CMB_G1_PRECIPTOTWATERCONTENT_

typedef struct {
    int count[3][3][16][2][72][28];
    float mean[3][3][16][2][72][28];
    float stdev[3][3][16][2][72][28];
    int hist[30][3][3][16][2][72][28];
} L3CMB_G1_PRECIPTOTWATERCONTENT;

#endif

#ifndef _L3CMB_G1_PRECIPLIQRATE_
#define _L3CMB_G1_PRECIPLIQRATE_

typedef struct {
    int count[3][3][16][2][72][28];
    float mean[3][3][16][2][72][28];
    float stdev[3][3][16][2][72][28];
    int hist[30][3][3][16][2][72][28];
} L3CMB_G1_PRECIPLIQRATE;

#endif

#ifndef _L3CMB_G1_PRECIPTOTRATE_
#define _L3CMB_G1_PRECIPTOTRATE_

typedef struct {
    int count[3][3][16][2][72][28];
    float mean[3][3][16][2][72][28];
    float stdev[3][3][16][2][72][28];
    int hist[30][3][3][16][2][72][28];
```

```
} L3CMB_G1_PRECIPTOTRATE;

#endif

#ifndef _L3CMB_G1_
#define _L3CMB_G1_

typedef struct {
    L3CMB_G1_PRECIPTOTRATE precipTotRate;
    L3CMB_G1_PRECIPLIQRATE precipLiqRate;
    L3CMB_G1_PRECIPTOTWATERCONTENT precipTotWaterContent;
    L3CMB_G1_PRECIPLIQWATERCONTENT precipLiqWaterContent;
    L3CMB_G1_PRECIPTOTDM precipTotDm;
    L3CMB_G1_PRECIPTOTLOGNW precipTotLogNw;
    int precipAllObs[3][16][2][72][28];
    L3CMB_G1_SURFPRECIPTOTRATEDIURNAL surfPrecipTotRateDiurnal;
    int surfPrecipTotRateDiurnalAllObs[24][3][2][72][28];
    float surfPrecipTotRateUn[2][72][28];
    float surfPrecipLiqRateUn[2][72][28];
    float surfPrecipTotRateProb[2][72][28];
    float surfPrecipLiqRateProb[2][72][28];
} L3CMB_G1;

#endif

#ifndef _L3CMB_GRIDS_
#define _L3CMB_GRIDS_

typedef struct {
    L3CMB_G1 G1;
    L3CMB_G2 G2;
} L3CMB_GRIDS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3CMB_G2_SURFPRECIPTOTRATEDIURNAL/
    INTEGER*4 count(536,1440,2,24)
    REAL*4 mean(536,1440,2,24)
    REAL*4 stdev(536,1440,2,24)
```

```
END STRUCTURE

STRUCTURE /L3CMB_G2_PRECIPTOTLOGNW/
    INTEGER*4 count(536,1440,2,16,3)
    REAL*4 mean(536,1440,2,16,3)
    REAL*4 stdev(536,1440,2,16,3)
END STRUCTURE

STRUCTURE /L3CMB_G2_PRECIPTOTDM/
    INTEGER*4 count(536,1440,2,16,3)
    REAL*4 mean(536,1440,2,16,3)
    REAL*4 stdev(536,1440,2,16,3)
END STRUCTURE

STRUCTURE /L3CMB_G2_PRECIPLIQWATERCONTENT/
    INTEGER*4 count(536,1440,2,16,3)
    REAL*4 mean(536,1440,2,16,3)
    REAL*4 stdev(536,1440,2,16,3)
END STRUCTURE

STRUCTURE /L3CMB_G2_PRECIPTOTWATERCONTENT/
    INTEGER*4 count(536,1440,2,16,3)
    REAL*4 mean(536,1440,2,16,3)
    REAL*4 stdev(536,1440,2,16,3)
END STRUCTURE

STRUCTURE /L3CMB_G2_PRECIPLIQRATE/
    INTEGER*4 count(536,1440,2,16,3)
    REAL*4 mean(536,1440,2,16,3)
    REAL*4 stdev(536,1440,2,16,3)
END STRUCTURE

STRUCTURE /L3CMB_G2_PRECIPTOTRATE/
    INTEGER*4 count(536,1440,2,16,3)
    REAL*4 mean(536,1440,2,16,3)
    REAL*4 stdev(536,1440,2,16,3)
END STRUCTURE

STRUCTURE /L3CMB_G2/
    RECORD /L3CMB_G2_PRECIPTOTRATE/ precipTotRate
    RECORD /L3CMB_G2_PRECIPLIQRATE/ precipLiqRate
    RECORD /L3CMB_G2_PRECIPTOTWATERCONTENT/ precipTotWaterContent
    RECORD /L3CMB_G2_PRECIPLIQWATERCONTENT/ precipLiqWaterContent
```

```
    RECORD /L3CMB_G2_PRECIPTOTDM/ precipTotDm
    RECORD /L3CMB_G2_PRECIPTOTLOGNW/ precipTotLogNw
    INTEGER*4 precipAllObs(536,1440,2,16)
    RECORD /L3CMB_G2_SURFPRECIPTOTRATEDIURNAL/ surfPrecipTotRateDiurnal
    INTEGER*4 surfPrecipTotRateDiurnalAllObs(536,1440,2,24)
    REAL*4 surfPrecipTotRateUn(536,1440,2)
    REAL*4 surfPrecipLiqRateUn(536,1440,2)
    REAL*4 surfPrecipTotRateProb(536,1440,2)
    REAL*4 surfPrecipLiqRateProb(536,1440,2)
END STRUCTURE

STRUCTURE /L3CMB_G1_SURFPRECIPTOTRATEDIURNAL/
    INTEGER*4 count(28,72,2,3,24)
    REAL*4 mean(28,72,2,3,24)
    REAL*4 stdev(28,72,2,3,24)
END STRUCTURE

STRUCTURE /L3CMB_G1_PRECIPTOTLOGNW/
    INTEGER*4 count(28,72,2,16,3,3)
    REAL*4 mean(28,72,2,16,3,3)
    REAL*4 stdev(28,72,2,16,3,3)
    INTEGER*4 hist(28,72,2,16,3,3,30)
END STRUCTURE

STRUCTURE /L3CMB_G1_PRECIPTOTDM/
    INTEGER*4 count(28,72,2,16,3,3)
    REAL*4 mean(28,72,2,16,3,3)
    REAL*4 stdev(28,72,2,16,3,3)
    INTEGER*4 hist(28,72,2,16,3,3,30)
END STRUCTURE

STRUCTURE /L3CMB_G1_PRECIPLIQWATERCONTENT/
    INTEGER*4 count(28,72,2,16,3,3)
    REAL*4 mean(28,72,2,16,3,3)
    REAL*4 stdev(28,72,2,16,3,3)
    INTEGER*4 hist(28,72,2,16,3,3,30)
END STRUCTURE

STRUCTURE /L3CMB_G1_PRECIPTOTWATERCONTENT/
    INTEGER*4 count(28,72,2,16,3,3)
    REAL*4 mean(28,72,2,16,3,3)
    REAL*4 stdev(28,72,2,16,3,3)
    INTEGER*4 hist(28,72,2,16,3,3,30)
```

```
END STRUCTURE

STRUCTURE /L3CMB_G1_PRECIPLIQRATE/
    INTEGER*4 count(28,72,2,16,3,3)
    REAL*4 mean(28,72,2,16,3,3)
    REAL*4 stdev(28,72,2,16,3,3)
    INTEGER*4 hist(28,72,2,16,3,3,30)
END STRUCTURE

STRUCTURE /L3CMB_G1_PRECIPTOTRATE/
    INTEGER*4 count(28,72,2,16,3,3)
    REAL*4 mean(28,72,2,16,3,3)
    REAL*4 stdev(28,72,2,16,3,3)
    INTEGER*4 hist(28,72,2,16,3,3,30)
END STRUCTURE

STRUCTURE /L3CMB_G1/
    RECORD /L3CMB_G1_PRECIPTOTRATE/ precipTotRate
    RECORD /L3CMB_G1_PRECIPLIQRATE/ precipLiqRate
    RECORD /L3CMB_G1_PRECIPTOTWATERCONTENT/ precipTotWaterContent
    RECORD /L3CMB_G1_PRECIPLIQWATERCONTENT/ precipLiqWaterContent
    RECORD /L3CMB_G1_PRECIPTOTDM/ precipTotDm
    RECORD /L3CMB_G1_PRECIPTOTLOGNW/ precipTotLogNw
    INTEGER*4 precipAllObs(28,72,2,16,3)
    RECORD /L3CMB_G1_SURFPRECIPTOTRATEDIURNAL/ surfPrecipTotRateDiurnal
    INTEGER*4 surfPrecipTotRateDiurnalAllObs(28,72,2,3,24)
    REAL*4 surfPrecipTotRateUn(28,72,2)
    REAL*4 surfPrecipLiqRateUn(28,72,2)
    REAL*4 surfPrecipTotRateProb(28,72,2)
    REAL*4 surfPrecipLiqRateProb(28,72,2)
END STRUCTURE

STRUCTURE /L3CMB_GRIDS/
    RECORD /L3CMB_G1/ G1
    RECORD /L3CMB_G2/ G2
END STRUCTURE
```

5.36 3GSMAPH - GSMaP Hourly

3GSMAPH, "GSMaP Hourly", provides precipitation estimates at 0.1 degrees by the Global Satellite Mapping of Precipitation (GSMaP). GSMaP provides high-precision, high-resolution global precipitation maps using satellite data. The PI is JAXA. The

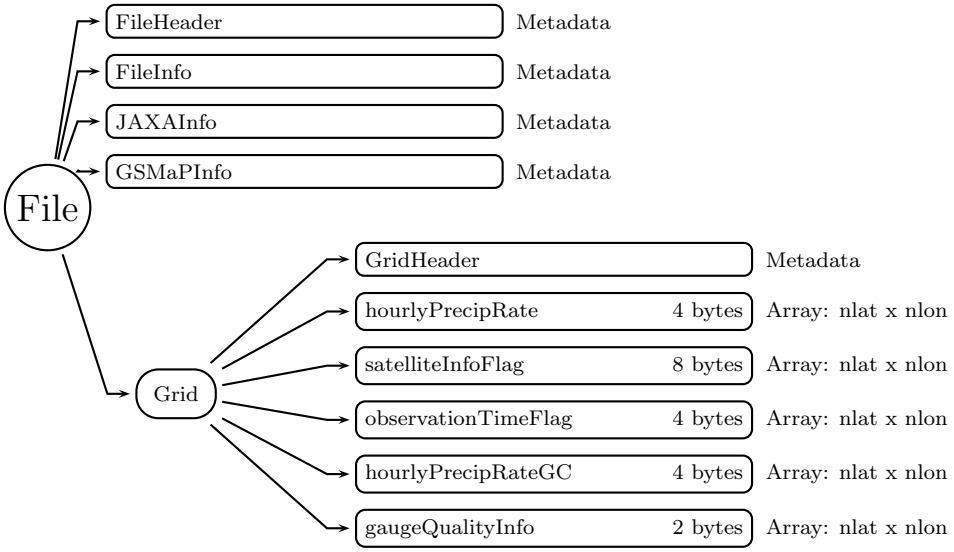


Figure 509: Data Format Structure for 3GSMAPH, GSMaP Hourly

granule size is 1 hour. The following sections describe the structure and contents of the format.

Dimension definitions:

nlat	1800	Number of 0.1^o grid intervals of latitude from 90° N to 90° S.
nlon	3600	Number of 0.1^o grid intervals of longitude from 180° W to 180° E.
n8	8	Number 8.

Figure 509 shows the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

GSMaPInfo (Metadata):
GSMaPinfo contains metadata required by GSMaP. Used by GSMaP products only. See Metadata for GPM Products for details.

Grid (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

hourlyPrecipRate (4-byte float, array size: nlat x nlon):
hourlyPrecipRate indicates hourly precipitation rate at each pixel. Unit is [mm/hr]. Negative value denotes missing in observation data or no precipitation rate was retrieved within microwave algorithms. Detailed description for missing data is shown below.

```
Value    Description
(0.0 or positive) Hourly precipitation rate [mm/hr].
-4       Missing due to sea ice within microwave algorithms.
-8       Missing due to low temperature within microwave algorithms.
-9999.9  Missing due to no observation by IR and/or microwave sensor.
```

satelliteInfoFlag (8-byte integer, array size: nlat x nlon):
satelliteInfoFlag indicates the information of all satellite/sensor which are used in estimation of precipitation rate at each pixel during one-hour time period. Data are stored in signed 8-byte integer (64-bit). Satellite and sensor name are assigned to each bit. If the flag shows value of 0, there is no satellite observation by both microwave and geo-stationary IR sensor. Missing value is defined as -99. Negative values indicates no microwave radiometer observation at that pixel. Below is a list of pixel values, bit, and corresponding instrument.

```
Value     Bit Sensor Category          Satellite/Sensor
1         0   Infrared Imager          NOAA/CPC
              aboard Geo-stationary    Globally Merged IR data
              meteorological satellite
2         1   Microwave radiometer     TRMM/TMI
              (imager/sounder) aboard
              low orbital satellite

4         2                            GPM-Core/GMI
8         3                            Megha-Tropiques/MADRAS
16        4                            Megha-Tropiques/SAPHIR
32        5                            ADEOS-II/AMSR
64        6                            Aqua/AMSR-E
128       7                            GCOM-W1/AMSR2
256       8                            GCOM-W2/AMSR2 f/o (TBD)
512       9                            GCOM-W3/AMSR2 f/o (TBD)
1024      10                           DMSP-F11/SSM/I
```

```
2048      11                          DMSP-F13/SSM/I
4096      12                          DMSP-F14/SSM/I
8192      13                          DMSP-F15/SSM/I
16384     14                          DMSP-F16/SSMIS
32768     15                          DMSP-F17/SSMIS
65536     16                          DMSP-F18/SSMIS
131072    17                          DMSP-F19/SSMIS
262144    18                          DMSP-F20/SSMIS
524288    19                          NOAA-15/AMSU-A/B
1048576   20                          NOAA-16/AMSU-A/B
2097152   21                          NOAA-17/AMSU-A/B
4194304   22                          NOAA-18/AMSU-A/MHS
8388608   23                          NOAA-19/AMSU-A/MHS
16777216  24                          NPP/ATMS
33554432  25                          JPSS-1/ATMS
67108864  26                          MetOp-A/AMSU-A/MHS
134217728 27                          MetOp-B/AMSU-A/MHS
268435456 28                          MetOp-C/AMSU-A/MHS
          29-63  Spare                Spare
```

observationTimeFlag (4-byte float, array size: nlat x nlon):
observationTimeFlag indicates relative time of nearest microwave radiometer (imager/sounder) observation to start time of the file at each pixel. Data are stored in 4-byte float. Value of 0 means start time of the file (HH in file name). Missing value is defined as -9999.9. Detailed description is below.

```
Value         Description

0 LE X LT 1   If value is positive and smaller
              than 1,  microwave radiometer
              observation  is available at the
              pixel during  current one-hour
              period. X indicates  relative
              observation time of latest
              microwave radiometer,  and is
              stored as difference from the
              start time of the file.  For
              example, if UTC of the file (HH)
              = 01 and X = 0.2,  observation
              time of the pixel will be 01:12
              UTC.

1 LE X        If value is equal to or larger
```

```
                than 1,  NO microwave radiometer
                observation  is available at the
                pixel during  time period of the
                file. X indicates  relative
                observation time of coming
                microwave radiometer,  and stored
                as differences from the start
                time of the file.  For example,
                if UTC of the file (HH) = 01 and
                X= 2.5, coming observation time
                of microwave radiometer at the
                pixel will be 3:30 UTC.

X LT 0          If value is negative, NO
                microwave radiometer observation
                is available at the pixel during
                time period of the file. X (X LT
                0) indicates relative observation
                time of latest microwave
                radiometer, and stored as
                differences from the start time
                of the file.  For example, if UTC
                of the file (HH) = 01
                and X = -2.5, latest
                observation time of microwave
                radiometer at the pixel will be
                22:30 UTC of previous day. X =
                -9999.9 No microwave observation
                (Missing)
```

hourlyPrecipRateGC (4-byte float, array size: nlat x nlon):
hourlyPrecipRateGC indicates hourly precipitation rate that was corrected by rain gauge data (NOAA CPC Unified Gauge-Based Analysis of Global Daily Precipitation, in daily and 0.5-degree grid) at each pixel. Data are stored in 4-byte float. Unit is [mm/hr]. Missing value is defined as -9999.9.

gaugeQualityInfo (2-byte integer, array size: nlat x nlon):
gaugeQualityInfo indicates the number of gauge data in original 0.5-degree pixel and daily, which was used in calculation of hourlyPrecipRateGC. Data are stored in 4-byte integer. Unit is [counts/day]. Missing value is defined as -9999.

C Structure Header file:

```
#ifndef _TK_3GSMAPH_H_
#define _TK_3GSMAPH_H_

#ifndef _L3GSMAPH_GRID_
#define _L3GSMAPH_GRID_

typedef struct {
    float hourlyPrecipRate[3600][1800];
    long long satelliteInfoFlag[3600][1800];
    float observationTimeFlag[3600][1800];
    float hourlyPrecipRateGC[3600][1800];
    short gaugeQualityInfo[3600][1800];
} L3GSMAPH_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3GSMAPH_GRID/
    REAL*4 hourlyPrecipRate(1800,3600)
    INTEGER*8 satelliteInfoFlag(1800,3600)
    REAL*4 observationTimeFlag(1800,3600)
    REAL*4 hourlyPrecipRateGC(1800,3600)
    INTEGER*2 gaugeQualityInfo(1800,3600)
END STRUCTURE
```

5.37 3GSMAPM - GSMaP Monthly

3GSMAPM, "GSMaP Monthly", provides precipitation estimates at 0.1 degrees by the Global Satellite Mapping of Precipitation (GSMaP). GSMaP provides high-precision, high-resolution global precipitation maps using satellite data. The PI is JAXA. The granule size is 1 month. The following sections describe the structure and contents of the format.

Dimension definitions:

nlat	1800	Number of 0.1^o grid intervals of latitude from 90° N to 90° S.
nlon	3600	Number of 0.1^o grid intervals of longitude from 180° W to 180° E.

Figure 510 shows the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

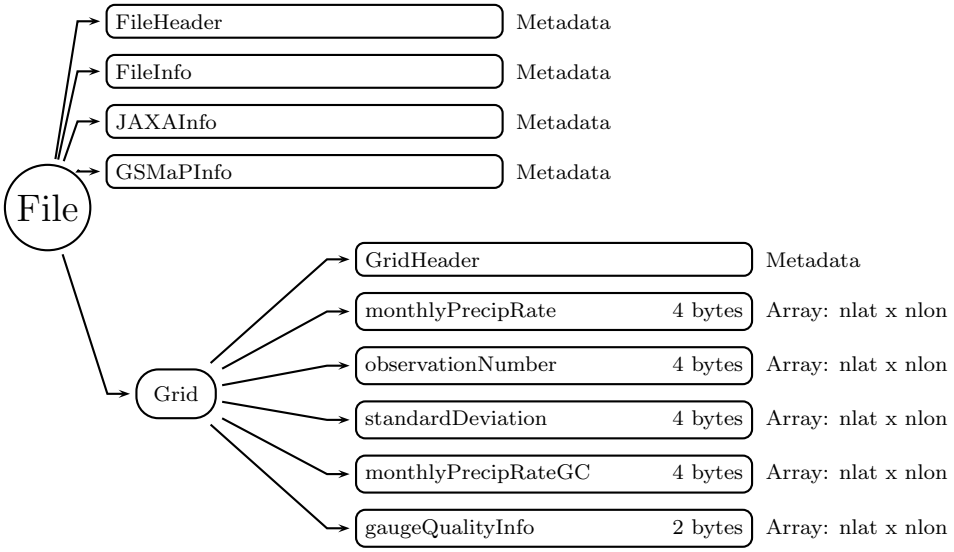


Figure 510: Data Format Structure for 3GSMAPM, GSMaP Monthly

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

GSMaPInfo (Metadata):
GSMaPinfo contains metadata required by GSMaP. Used by GSMaP products only. See Metadata for GPM Products for details.

Grid (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

monthlyPrecipRate (4-byte float, array size: nlat x nlon):
monthlyPrecipRate indicates monthly precipitation rate at each pixel. Unit is [mm/hr]. Negative value denotes missing in observation data or no precipitation rate was retrieved within microwave algorithms. Detailed description for missing data is shown below.

```
Value    Description
(0.0 or positive) Monthly precipitation rate [mm/hr].
-4       Missing due to sea ice within microwave algorithms.
-8       Missing due to low temperature within microwave algorithms.
-9999.9  Missing due to no observation by IR and/or microwave sensor.
```

observationNumber (4-byte integer, array size: nlat x nlon):
observationNumber indicates the number of observation that was used in the estimation of monthly mean precipitation rate at each pixel during one month. Data are stored in 4-byte integer. Unit is [counts/month]. Missing value is defined as -9999.

standardDeviation (4-byte float, array size: nlat x nlon):
standardDeviation indicates monthly standard deviation of precipitation rate at each pixel. Data are stored in 4-byte float. Unit is [mm/hr]. Missing value is defined as -9999.9.

monthlyPrecipRateGC (4-byte float, array size: nlat x nlon):
monthlyPrecipRateGC indicates monthly mean precipitation rate of hourlyPrecipRateGC. Data are stored in 4-byte float. Unit is [mm/hr]. Missing value is defined as -9999.9.

gaugeQualityInfo (2-byte integer, array size: nlat x nlon):
gaugeQualityInfo indicates the number of gauge data in original 0.5-degree pixel, which was used in calculation of monthlyPrecipRateGC. Data are stored in 4-byte integer. Unit is [counts/month]. Missing value is defined as -9999. Special values are defined as:
-9999 Missing value

C Structure Header file:

```
#ifndef _TK_3GSMAPM_H_
#define _TK_3GSMAPM_H_

#ifndef _L3GSMAPM_GRID_
#define _L3GSMAPM_GRID_

typedef struct {
    float monthlyPrecipRate[3600][1800];
    int observationNumber[3600][1800];
    float standardDeviation[3600][1800];
    float monthlyPrecipRateGC[3600][1800];
    short gaugeQualityInfo[3600][1800];
} L3GSMAPM_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3GSMAPM_GRID/
    REAL*4 monthlyPrecipRate(1800,3600)
    INTEGER*4 observationNumber(1800,3600)
    REAL*4 standardDeviation(1800,3600)
    REAL*4 monthlyPrecipRateGC(1800,3600)
    INTEGER*2 gaugeQualityInfo(1800,3600)
END STRUCTURE
```

5.38 3IMERGHH - IMERG 30-minute

3IMERGHH, "IMERG 30-minute", provides precipitation estimates at 0.1 degrees by the Integrated Multi-satellitE Retrievals for GPM (IMERG). IMERG is intended to intercalibrate, merge, and interpolate satellite microwave precipitation estimates, together with microwave-calibrated infrared (IR) satellite estimates, and precipitation gauge analyses. The PI is Dr. George Huffman. The granule size is 30 minutes. The following sections describe the structure and contents of the format.

Dimension definitions:

lat	1800	Number of 0.1^o grid intervals of latitude from 90° N to 90° S.
lon	3600	Number of 0.1^o grid intervals of longitude from 180° W to 180° E.

Figure 511 shows the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

Grid (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

lon (4-byte float, array size: lon):
Longitude of the center of the grid box. Values range from -180 to 180 degrees_east.

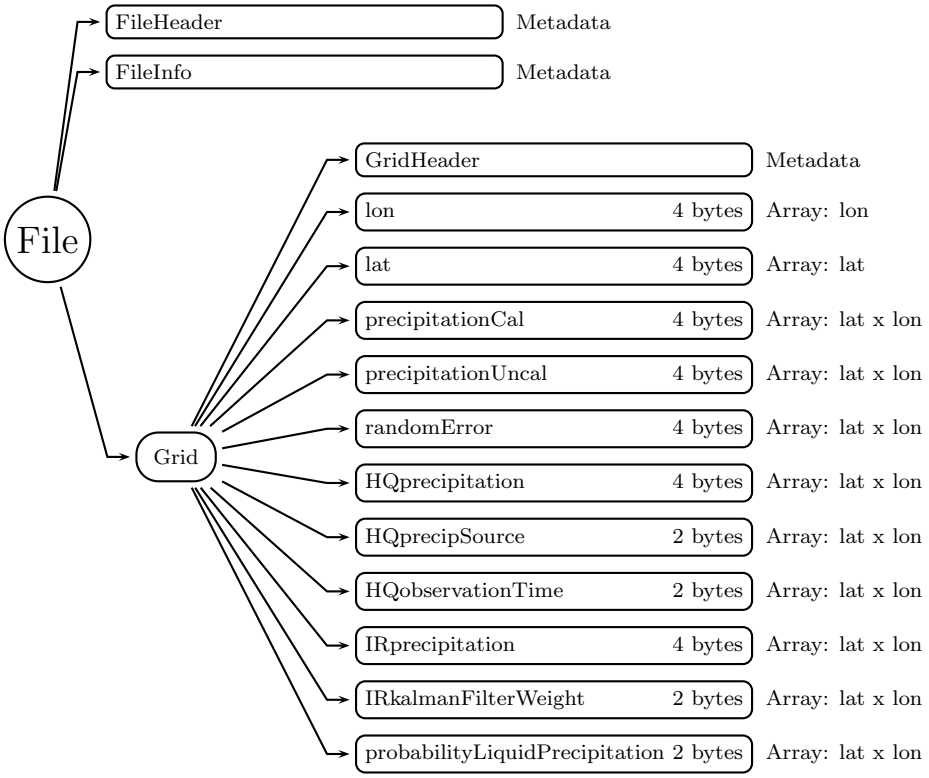


Figure 511: Data Format Structure for 3IMERGHH, IMERG 30-minute

Special values are defined as:
-9999.9 Missing value

lat (4-byte float, array size: lat):
Latitude of the center of the grid box. Values range from -90 to 90 degrees_north. Special values are defined as:
-9999.9 Missing value

precipitationCal (4-byte float, array size: lat x lon):
Precipitation estimate using gauge calibration over land. Values range from 0 to 1000 mm/hr. Special values are defined as:
-9999.9 Missing value

precipitationUncal (4-byte float, array size: lat x lon):
Precipitation estimate with no gauge calibration. Values range from 0 to 1000 mm/hr. Special values are defined as:
-9999.9 Missing value

randomError (4-byte float, array size: lat x lon):
Random error estimate of precipitation. Values range from 0 to 1000 mm/hr. Special values are defined as:
-9999.9 Missing value

HQprecipitation (4-byte float, array size: lat x lon):
Instananeous microwave-only precipitation estimate covering the current 30-minute period. Values range from 0 to 1000 mm/hr. Special values are defined as:
-9999.9 Missing value

HQprecipSource (2-byte integer, array size: lat x lon):

```
HQprecipSource values are as follows:
      0 = no observation
      1 = TMI
      2 = TCI
      3 = AMSR
      4 = SSMI
      5 = SSMIS
      6 = AMSU
      7 = MHS
      8 = Megha-Tropiques
      9 = GMI
      10 = GCI
      11 = ATMS
      12 = AIRS
      13 = TOVS
      14 = CrlS
      15 = future microwave scanner
```

```
16 = future microwave scanner
17 = future microwave scanner
18 = future microwave scanner
19 = future microwave scanner
20 = future microwave sounder
21 = future microwave sounder
22 = future microwave sounder
23 = future microwave sounder
24 = future microwave sounder
```

Satellite ID of the instantaneous microwave-only precipitation estimate covering the current 30-minute period. Values range from 0 to 24.

HQobservationTime (2-byte integer, array size: lat x lon):
Observation time (from the beginnning of the current half hour) of the instantaneous microwave-only precipitation estimate covering the current 30-minute period. Values range from 0 to 29 minutes. Special values are defined as:
-9999 Missing value

IRprecipitation (4-byte float, array size: lat x lon):
Microwave-calibrated IR precipitation estimate covering the current 30-minute period. Values range from 0 to 1000 mm/hr. Special values are defined as:
-9999.9 Missing value

IRkalmanFilterWeight (2-byte integer, array size: lat x lon):
IR weighting in the final precipitation estimate. The values range from 0 to 100, where 0 is no IR weighting and 100 is entirely based on IR. A value of 0 is provided as well in areas of no precipitation.

probabilityLiquidPrecipitation (2-byte integer, array size: lat x lon):
Probability of liquid precipitation. 0=definitely frozen. 100=definitely liquid. 50=equal probability frozen or liquid. This field is globally complete and provided irrespective of the presence of precipitation. Values range from 0 to 100 percent.

C Structure Header file:

```
#ifndef _TK_3IMERGHH_H_
#define _TK_3IMERGHH_H_

#ifndef _L3IMERGHH_GRID_
#define _L3IMERGHH_GRID_

typedef struct {
    float lon[3600];
    float lat[1800];
    float precipitationCal[3600][1800];
```

```
    float precipitationUncal[3600][1800];
    float randomError[3600][1800];
    float HQprecipitation[3600][1800];
    short HQprecipSource[3600][1800];
    short HQobservationTime[3600][1800];
    float IRprecipitation[3600][1800];
    short IRkalmanFilterWeight[3600][1800];
    short probabilityLiquidPrecipitation[3600][1800];
} L3IMERGHH_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3IMERGHH_GRID/
    REAL*4 lon(3600)
    REAL*4 lat(1800)
    REAL*4 precipitationCal(1800,3600)
    REAL*4 precipitationUncal(1800,3600)
    REAL*4 randomError(1800,3600)
    REAL*4 HQprecipitation(1800,3600)
    INTEGER*2 HQprecipSource(1800,3600)
    INTEGER*2 HQobservationTime(1800,3600)
    REAL*4 IRprecipitation(1800,3600)
    INTEGER*2 IRkalmanFilterWeight(1800,3600)
    INTEGER*2 probabilityLiquidPrecipitation(1800,3600)
END STRUCTURE
```

5.39 3IMERGM - IMERG monthly

3IMERGM, "IMERG monthly", provides precipitation estimates at 0.1 degrees by the Integrated Multi-satellitE Retrievals for GPM (IMERG). IMERG is intended to intercalibrate, merge, and interpolate satellite microwave precipitation estimates, together with microwave-calibrated infrared (IR) satellite estimates, and precipitation gauge analyses. The PI is Dr. George Huffman. The granule size is 1 month. The following sections describe the structure and contents of the format.

Dimension definitions:

lat	1800	Number of 0.1^o grid intervals of latitude from 90° N to 90° S.
lon	3600	Number of 0.1^o grid intervals of longitude from 180° W to 180° E.

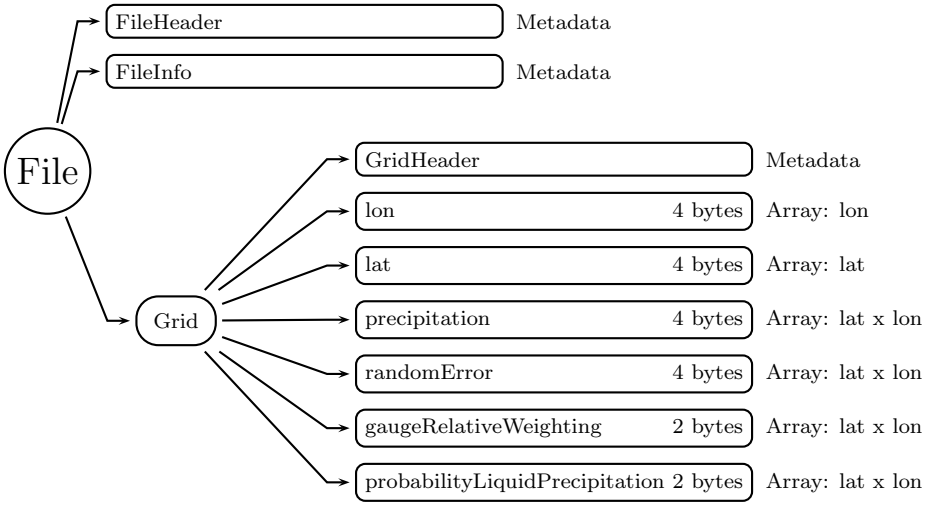


Figure 512: Data Format Structure for 3IMERGM, IMERG monthly

Figure 512 shows the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

Grid (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

lon (4-byte float, array size: lon):
Longitude of the center of the grid box. Values range from -180 to 180 degrees_east. Special values are defined as:
-9999.9 Missing value

lat (4-byte float, array size: lat):
Latitude of the center of the grid box. Values range from -90 to 90 degrees_north. Special values are defined as:
-9999.9 Missing value

precipitation (4-byte float, array size: lat x lon):
Precipitation estimate using gauge calibration over land. Values range from 0 to 1000 mm/hr. Special values are defined as:
-9999.9 Missing value

randomError (4-byte float, array size: lat x lon):
Random error estimate of precipitation. Values range from 0 to 1000 mm/hr. Special values are defined as:
-9999.9 Missing value

gaugeRelativeWeighting (2-byte integer, array size: lat x lon):
Surface gauge weighting in the final precipitation estimate. The values range from 0 to 100, where 0 is no gauge weighting and 100 is entirely based on gauge. Values range from 0 to 100 percent. Special values are defined as:
-9999 Missing value

probabilityLiquidPrecipitation (2-byte integer, array size: lat x lon):
Probability of liquid precipitation. 0=definitely frozen. 100=definitely liquid. 50=equal probability frozen or liquid. This field is globally complete and provided irrespective of the presence of precipitation. Values range from 0 to 100 percent.

C Structure Header file:

```
#ifndef _TK_3IMERGM_H_
#define _TK_3IMERGM_H_

#ifndef _L3IMERGM_GRID_
#define _L3IMERGM_GRID_

typedef struct {
    float lon[3600];
    float lat[1800];
    float precipitation[3600][1800];
    float randomError[3600][1800];
    short gaugeRelativeWeighting[3600][1800];
    short probabilityLiquidPrecipitation[3600][1800];
} L3IMERGM_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3IMERGM_GRID/
```

```
    REAL*4 lon(3600)
    REAL*4 lat(1800)
    REAL*4 precipitation(1800,3600)
    REAL*4 randomError(1800,3600)
    INTEGER*2 gaugeRelativeWeighting(1800,3600)
    INTEGER*2 probabilityLiquidPrecipitation(1800,3600)
END STRUCTURE
```

5.40 2HSLH - Spectral Latent Heating

2HSLH, "Spectral Latent Heating," produces latent heating, Q1-QR, and Q2 profiles from DPR rain. The PI is Dr. Takayabu and the Co-PI is Dr. Shige. The granule size is one orbit. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nray	49	Number of angle bins in each scan.
nlayer	19	Number of layers at the fixed heights of 0.0-0.5 km, 0.5-1 km, 1-2 km, ..., 17-18 km.

Figure 513 through Figure 515 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

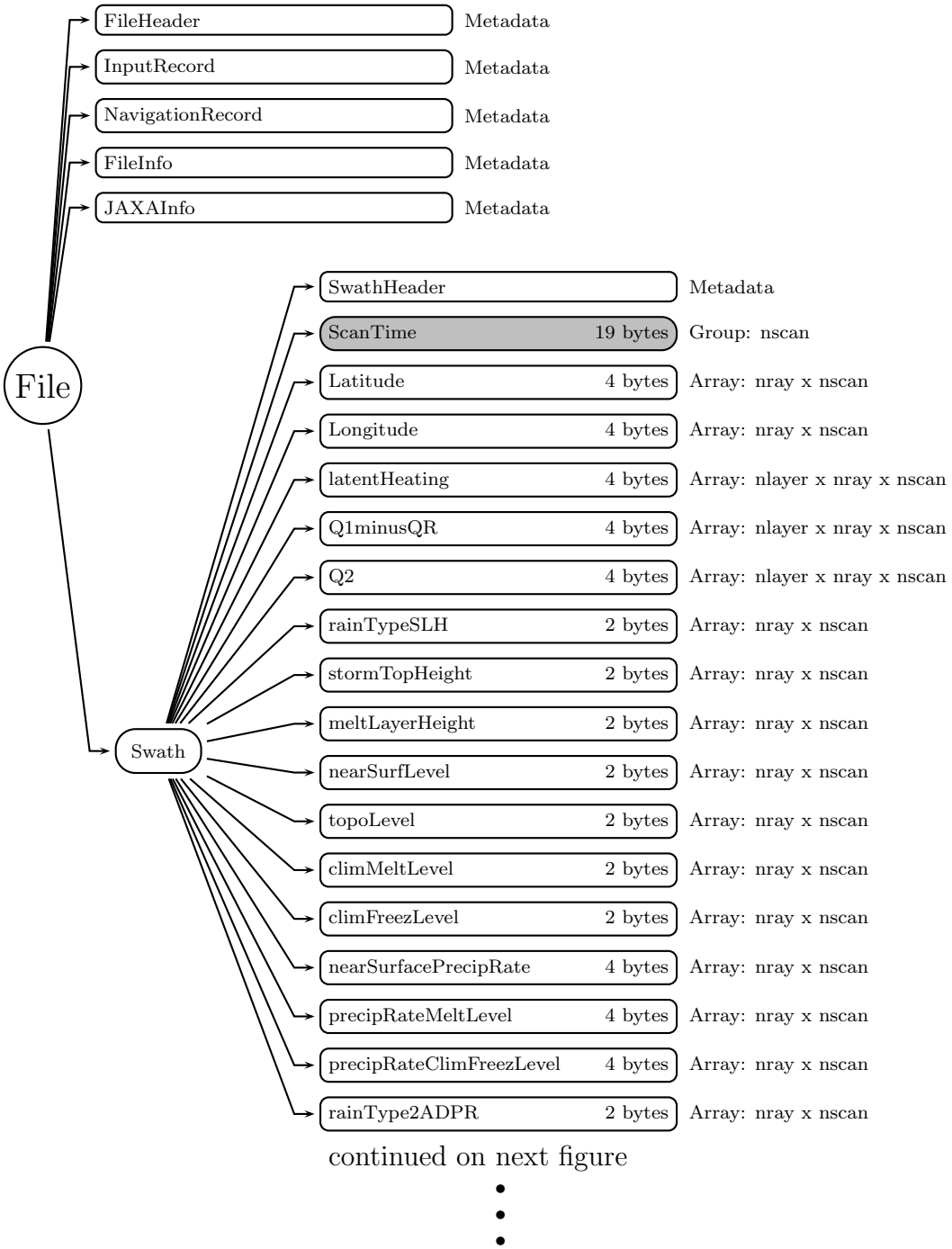
FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.



continued on next figure

Figure 513: Data Format Structure for 2HSLH, Spectral Latent Heating

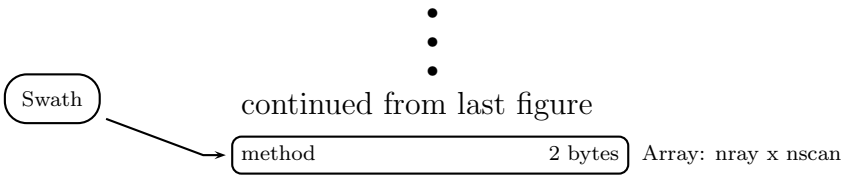


Figure 514: Data Format Structure for 2HSLH, Spectral Latent Heating

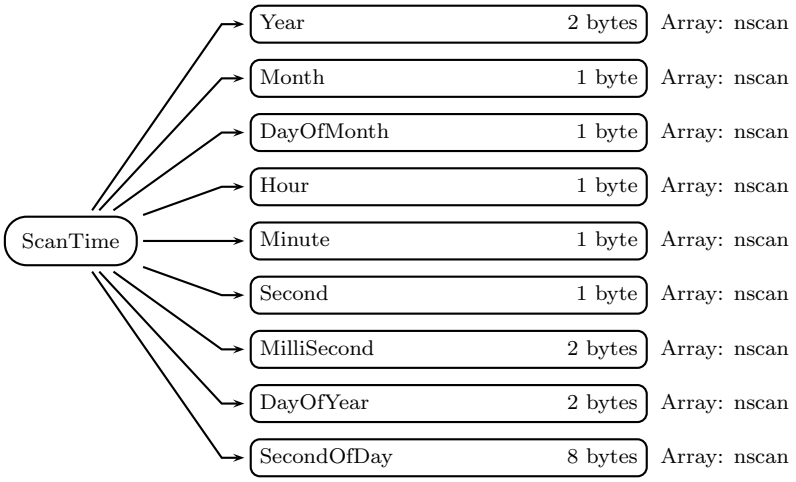


Figure 515: Data Format Structure for 2HSLH, ScanTime

Swath (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nray x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nray x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

latentHeating (4-byte float, array size: nlayer x nray x nscan):
Latent Heating. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

Q1minusQR (4-byte float, array size: nlayer x nray x nscan):
Q1 - QR. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

Q2 (4-byte float, array size: nlayer x nray x nscan):
Apparent moisture sink. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

rainTypeSLH (2-byte integer, array size: nray x nscan):
Rain type decided by SLH. Special values are defined as:
-9999 Missing value

stormTopHeight (2-byte integer, array size: nray x nscan):
Height of storm top. Values range from 0 to 32000 m. Special values are defined as:
-9999 Missing value

meltLayerHeight (2-byte integer, array size: nray x nscan):
Height of melting layer. Values range from 0 to 32000 m. Special values are defined as:
-9999 Missing value

nearSurfLevel (2-byte integer, array size: nray x nscan):
Level of near surface rain. Values range from 0 to 32000 m. Special values are defined as:
-9999 Missing value

topoLevel (2-byte integer, array size: nray x nscan):
Level of topography. Values range from 0 to 32000 m. Special values are defined as:
-9999 Missing value

climMeltLevel (2-byte integer, array size: nray x nscan):
Climatological melting level. Values range from 0 to 32000 m. Special values are defined as:
-9999 Missing value

climFreezLevel (2-byte integer, array size: nray x nscan):
Climatological freezing level. Values range from 0 to 32000 m. Special values are defined as:
-9999 Missing value

nearSurfacePrecipRate (4-byte float, array size: nray x nscan):
Precipitation rate at the near surface. Values range from 0 to 500 mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateMeltLevel (4-byte float, array size: nray x nscan):
Precipitation rate at the melting level. Values range from 0 to 500 mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateClimFreezLevel (4-byte float, array size: nray x nscan):
Precipitation rate at the freezing level. Values range from 0 to 500 mm/hr. Special values are defined as:
-9999.9 Missing value

rainType2ADPR (2-byte integer, array size: nray x nscan):
Rain Type from 2ADPR. Special values are defined as:
-9999 Missing value

method (2-byte integer, array size: nray x nscan):
Method from 2ADPR. Special values are defined as:
-9999 Missing value

C Structure Header file:

```
#ifndef _TK_2HSLH_H_
#define _TK_2HSLH_H_

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2HSLH_SWATH_
#define _L2HSLH_SWATH_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[49];
    float Longitude[49];
    float latentHeating[49][19];
    float Q1minusQR[49][19];
    float Q2[49][19];
    short rainTypeSLH[49];
    short stormTopHeight[49];
    short meltLayerHeight[49];
    short nearSurfLevel[49];
    short topoLevel[49];
    short climMeltLevel[49];
    short climFreezLevel[49];
    float nearSurfacePrecipRate[49];
```

```
    float precipRateMeltLevel[49];
    float precipRateClimFreezLevel[49];
    short rainType2ADPR[49];
    short method[49];
} L2HSLH_SWATH;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2HSLH_SWATH/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(49)
    REAL*4 Longitude(49)
    REAL*4 latentHeating(19,49)
    REAL*4 Q1minusQR(19,49)
    REAL*4 Q2(19,49)
    INTEGER*2 rainTypeSLH(49)
    INTEGER*2 stormTopHeight(49)
    INTEGER*2 meltLayerHeight(49)
    INTEGER*2 nearSurfLevel(49)
    INTEGER*2 topoLevel(49)
    INTEGER*2 climMeltLevel(49)
    INTEGER*2 climFreezLevel(49)
    REAL*4 nearSurfacePrecipRate(49)
    REAL*4 precipRateMeltLevel(49)
    REAL*4 precipRateClimFreezLevel(49)
    INTEGER*2 rainType2ADPR(49)
    INTEGER*2 method(49)
```

```
END STRUCTURE
```

5.41 3GSLH - Gridded Orbital Spectral Latent Heating

3GSLH, "Gridded Orbital Spectral Latent Heating", produces 0.25^o x 0.25^o latent heating, Q1-QR, and Q2 profiles from DPR rain. The PI is Dr. Takayabu and the Co-PI is Dr. Shige. The granule size is one orbit. The following sections describe the structure and contents of the format.

Dimension definitions:

nlat	536	Number of 0.25^o grid intervals of latitude from 67^oN to 67^oS.
nlon	1440	Number of 0.25^o grid intervals of longitude from 180^oW to 180^oE.
nlayer	19	Number of layers at the fixed heights of 0.0-0.5 km, 0.5-1 km, 1-2 km, ..., 17-18 km.

Figure 516 through Figure 517 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

Grid (Grid)

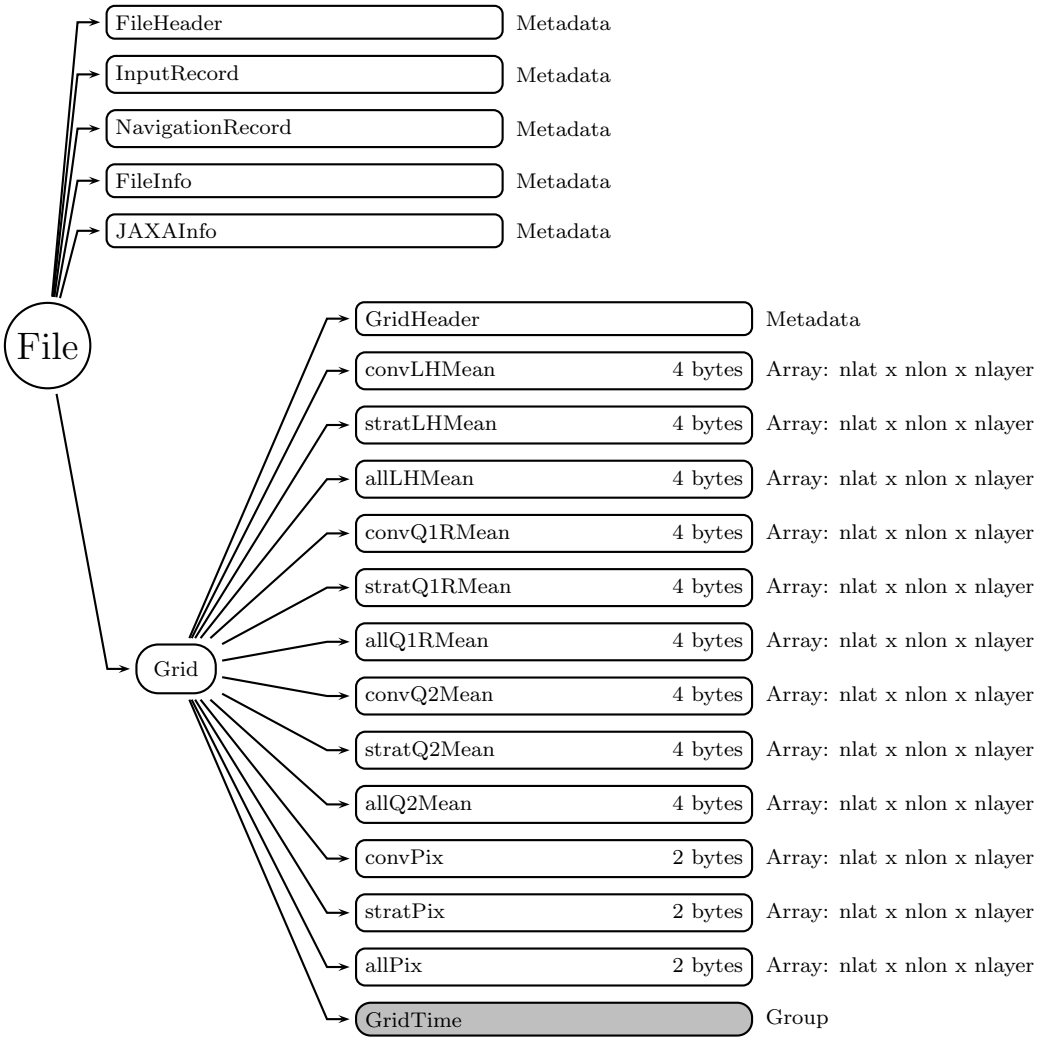


Figure 516: Data Format Structure for 3GSLH, Gridded Orbital Spectral Latent Heating

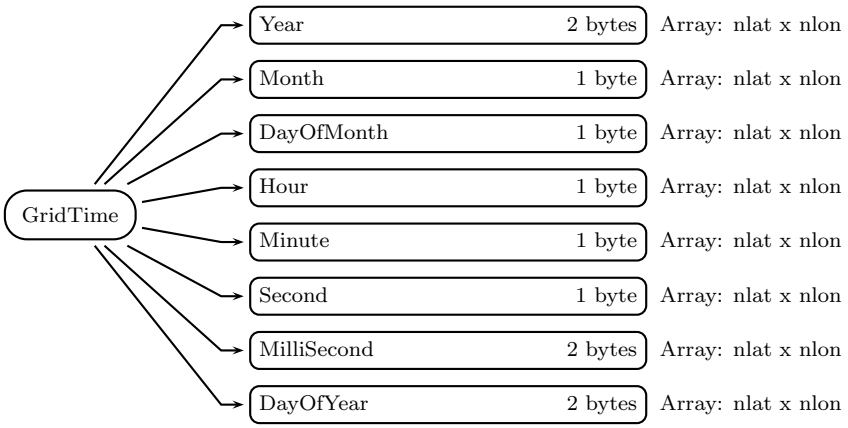


Figure 517: Data Format Structure for 3GSLH, GridTime

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

convLHMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating convective conditional mean. Values range from -400 to 400 K/h. Special values are defined as:
-9999.9 Missing value

stratLHMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating deep-stratiform and shallow-stratiform conditional mean. Values range from -400 to 400 K/h. Special values are defined as:
-9999.9 Missing value

allLHMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating all pixel mean. Values range from -400 to 400 K/h. Special values are defined as:
-9999.9 Missing value

convQ1RMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR convective conditional mean. Values range from -400 to 400 K/h. Special values are defined as:
-9999.9 Missing value

stratQ1RMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR deep-stratiform and shallow-stratiform conditional mean. Values range from -400 to 400 K/h. Special values are defined as:
-9999.9 Missing value

allQ1RMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR all pixel mean. Values range from -400 to 400 K/h. Special values are defined as:
-9999.9 Missing value

convQ2Mean (4-byte float, array size: nlat x nlon x nlayer):
Q2 convective conditional mean. Values range from -400 to 400 K/h. Special values are defined as:
-9999.9 Missing value

stratQ2Mean (4-byte float, array size: nlat x nlon x nlayer):
Q2 deep-stratiform and shallow-stratiform conditional mean. Values range from -400 to 400 K/h. Special values are defined as:
-9999.9 Missing value

allQ2Mean (4-byte float, array size: nlat x nlon x nlayer):
Q2 all pixel mean. Values range from -400 to 400 K/h. Special values are defined as:
-9999.9 Missing value

convPix (2-byte integer, array size: nlat x nlon x nlayer):
Convective pixel counts in the 0.25^o x 0.25^o box. Values range from 0 to 500000. Special

values are defined as:
-9999 Missing value

stratPix (2-byte integer, array size: nlat x nlon x nlayer):
Deep-stratiform and shallow-stratiform pixel counts in the 0.25^o x 0.25^o box. Values range from 0 to 500000. Special values are defined as:
-9999 Missing value

allPix (2-byte integer, array size: nlat x nlon x nlayer):
All pixel counts in the 0.25^o x 0.25^o box. Values range from 0 to 500000. Special values are defined as:
-9999 Missing value

GridTime (Group)

A UTC time associated with the grid box.

Year (2-byte integer, array size: nlat x nlon):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nlat x nlon):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nlat x nlon):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nlat x nlon):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nlat x nlon):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nlat x nlon):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nlat x nlon):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nlat x nlon):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

C Structure Header file:

```
#ifndef _TK_3GSLH_H_
#define _TK_3GSLH_H_

#ifndef _L3GSLH_GRIDTIME_
#define _L3GSLH_GRIDTIME_

typedef struct {
    short Year[1440][536];
    signed char Month[1440][536];
    signed char DayOfMonth[1440][536];
    signed char Hour[1440][536];
    signed char Minute[1440][536];
    signed char Second[1440][536];
    short MilliSecond[1440][536];
    short DayOfYear[1440][536];
} L3GSLH_GRIDTIME;

#endif

#ifndef _L3GSLH_GRID_
#define _L3GSLH_GRID_

typedef struct {
    float convLHMean[19][1440][536];
    float stratLHMean[19][1440][536];
    float allLHMean[19][1440][536];
    float convQ1RMean[19][1440][536];
    float stratQ1RMean[19][1440][536];
    float allQ1RMean[19][1440][536];
    float convQ2Mean[19][1440][536];
    float stratQ2Mean[19][1440][536];
    float allQ2Mean[19][1440][536];
    short convPix[19][1440][536];
    short stratPix[19][1440][536];
    short allPix[19][1440][536];
    L3GSLH_GRIDTIME GridTime;
} L3GSLH_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3GSLH_GRIDTIME/
    INTEGER*2 Year(536,1440)
    BYTE Month(536,1440)
    BYTE DayOfMonth(536,1440)
    BYTE Hour(536,1440)
    BYTE Minute(536,1440)
    BYTE Second(536,1440)
    INTEGER*2 MilliSecond(536,1440)
    INTEGER*2 DayOfYear(536,1440)
END STRUCTURE

STRUCTURE /L3GSLH_GRID/
    REAL*4 convLHMean(536,1440,19)
    REAL*4 stratLHMean(536,1440,19)
    REAL*4 allLHMean(536,1440,19)
    REAL*4 convQ1RMean(536,1440,19)
    REAL*4 stratQ1RMean(536,1440,19)
    REAL*4 allQ1RMean(536,1440,19)
    REAL*4 convQ2Mean(536,1440,19)
    REAL*4 stratQ2Mean(536,1440,19)
    REAL*4 allQ2Mean(536,1440,19)
    INTEGER*2 convPix(536,1440,19)
    INTEGER*2 stratPix(536,1440,19)
    INTEGER*2 allPix(536,1440,19)
    RECORD /L3GSLH_GRIDTIME/ GridTime
END STRUCTURE
```

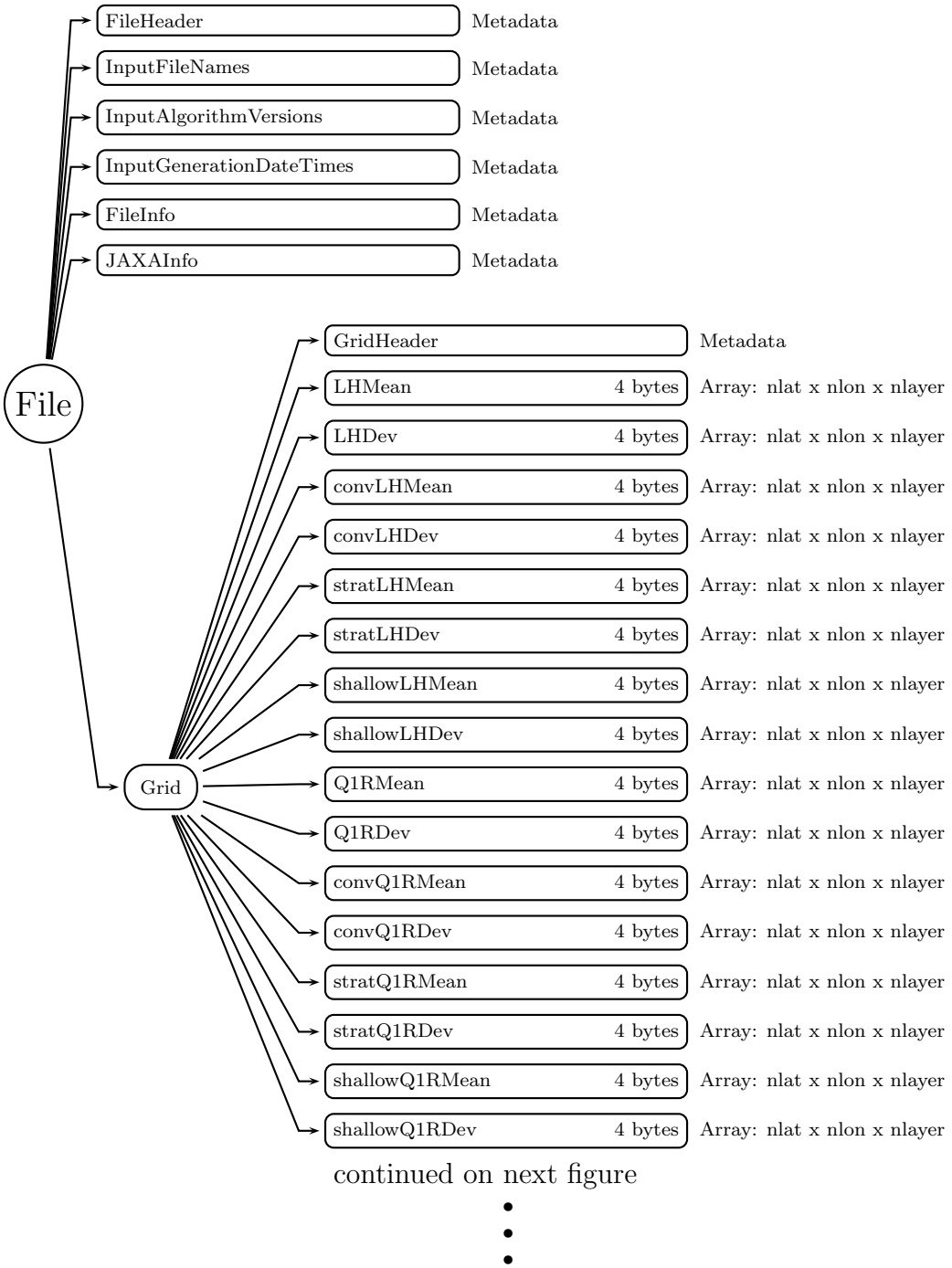
5.42 3HSLH - Monthly Spectral Latent Heating

3HSLH, "Monthly Spectral Latent Heating", produces 0.25^o x 0.25^o latent heating, Q1-QR, and Q2 profiles from DPR rain. The PI is Dr. Takayabu and the Co-PI is Dr. Shige. The granule size is one month. The following sections describe the structure and contents of the format.

Dimension definitions:

nlat	536	Number of 0.25^o grid intervals of latitude from 67°N to 67°S.
nlon	1440	Number of 0.25^o grid intervals of longitude from 180°W to 180°E.
nlayer	19	Number of layers at the fixed heights of 0.0-0.5 km, 0.5-1 km, 1-2 km, ..., 17-18 km.

Figure 518 through Figure 519 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.



continued on next figure

Figure 518: Data Format Structure for 3HSLH, Monthly Spectral Latent Heating

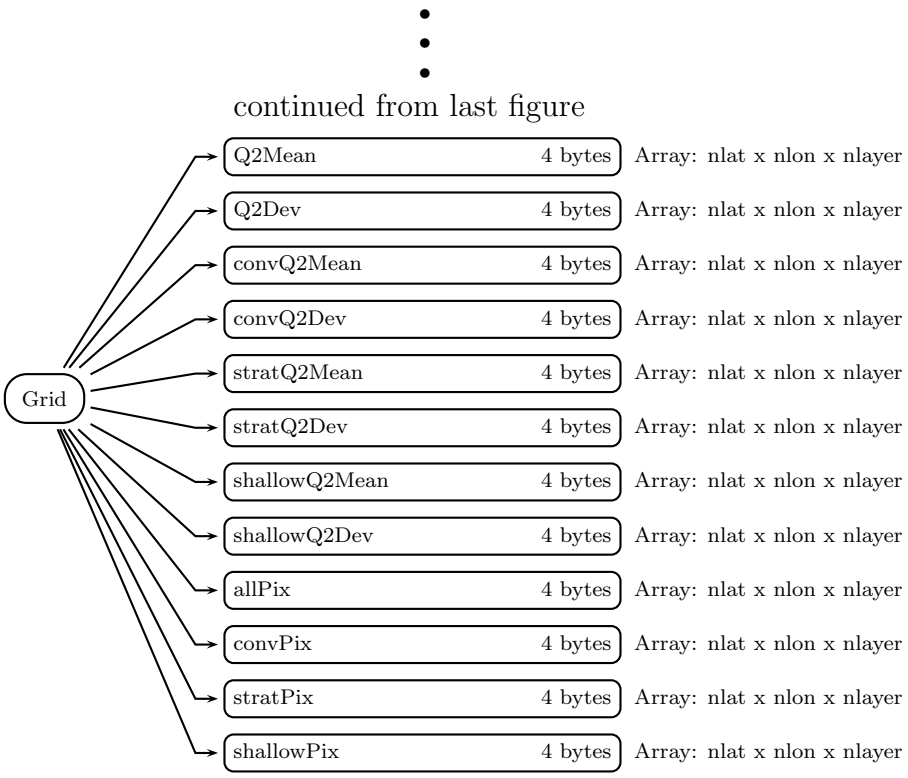


Figure 519: Data Format Structure for 3HSLH, Monthly Spectral Latent Heating

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputFileNames (Metadata):
InputFileNames contains a list of input file names for this granule. See Metadata for GPM Products for details.

InputAlgorithmVersions (Metadata):
InputAlgorithmVersions contains a list of input algorithm versions for this granule. See Metadata for GPM Products for details.

InputGenerationDateTimes (Metadata):
InputGenerationDateTimes contains a list of input generation datetimes. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

Grid (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

LHMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating conditional mean. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

LHDev (4-byte float, array size: nlat x nlon x nlayer):
Latent heating conditional standard deviation. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

convLHMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating convective conditional mean. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

convLHDev (4-byte float, array size: nlat x nlon x nlayer):
Latent heating convective conditional standard deviation. Values range from -50 to 100

K/hr. Special values are defined as:
-9999.9 Missing value

stratLHMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating deep-stratiform conditional mean. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

stratLHDev (4-byte float, array size: nlat x nlon x nlayer):
Latent heating deep-stratiform conditional standard deviation. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

shallowLHMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating shallow-stratiform conditional mean. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

shallowLHDev (4-byte float, array size: nlat x nlon x nlayer):
Latent heating shallow-stratiform conditional standard deviation. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

Q1RMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR conditional mean. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

Q1RDev (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR conditional standard deviation. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

convQ1RMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR convective conditional mean. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

convQ1RDev (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR convective conditional standard deviation. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

stratQ1RMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR deep-stratiform conditional mean. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

stratQ1RDev (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR deep-stratiform conditional standard deviation. Values range from -50 to 100

K/hr. Special values are defined as:
-9999.9 Missing value

shallowQ1RMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR shallow-stratiform conditional mean. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

shallowQ1RDev (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR shallow-stratiform conditional standard deviation. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

Q2Mean (4-byte float, array size: nlat x nlon x nlayer):
Q2 conditional mean. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

Q2Dev (4-byte float, array size: nlat x nlon x nlayer):
Q2 conditional standard deviation. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

convQ2Mean (4-byte float, array size: nlat x nlon x nlayer):
Q2 convective conditional mean. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

convQ2Dev (4-byte float, array size: nlat x nlon x nlayer):
Q2 convective conditional standard deviation. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

stratQ2Mean (4-byte float, array size: nlat x nlon x nlayer):
Q2 deep-stratiform conditional mean. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

stratQ2Dev (4-byte float, array size: nlat x nlon x nlayer):
Q2 deep-stratiform conditional standard deviation. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

shallowQ2Mean (4-byte float, array size: nlat x nlon x nlayer):
Q2 shallow-stratiform conditional mean. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

shallowQ2Dev (4-byte float, array size: nlat x nlon x nlayer):
Q2 shallow-stratiform conditional standard deviation. Values range from -50 to 100 K/hr.

Special values are defined as:
-9999.9 Missing value

allPix (4-byte float, array size: nlat x nlon x nlayer):
All pixel counts. Values range from 0 to 2000000000. Special values are defined as:
-9999.9 Missing value

convPix (4-byte float, array size: nlat x nlon x nlayer):
Convective pixel counts. Values range from 0 to 2000000000. Special values are defined as:
-9999.9 Missing value

stratPix (4-byte float, array size: nlat x nlon x nlayer):
Deep-stratiform pixel counts. Values range from 0 to 2000000000. Special values are defined as:
-9999.9 Missing value

shallowPix (4-byte float, array size: nlat x nlon x nlayer):
Shallow-stratiform pixel counts. Values range from 0 to 2000000000. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_3HSLH_H_
#define _TK_3HSLH_H_

#ifndef _L3HSLH_GRID_
#define _L3HSLH_GRID_

typedef struct {
    float LHMean[19][1440][536];
    float LHDev[19][1440][536];
    float convLHMean[19][1440][536];
    float convLHDev[19][1440][536];
    float stratLHMean[19][1440][536];
    float stratLHDev[19][1440][536];
    float shallowLHMean[19][1440][536];
    float shallowLHDev[19][1440][536];
    float Q1RMean[19][1440][536];
    float Q1RDev[19][1440][536];
    float convQ1RMean[19][1440][536];
    float convQ1RDev[19][1440][536];
    float stratQ1RMean[19][1440][536];
    float stratQ1RDev[19][1440][536];
    float shallowQ1RMean[19][1440][536];
```

```
    float shallowQ1RDev[19][1440][536];
    float Q2Mean[19][1440][536];
    float Q2Dev[19][1440][536];
    float convQ2Mean[19][1440][536];
    float convQ2Dev[19][1440][536];
    float stratQ2Mean[19][1440][536];
    float stratQ2Dev[19][1440][536];
    float shallowQ2Mean[19][1440][536];
    float shallowQ2Dev[19][1440][536];
    float allPix[19][1440][536];
    float convPix[19][1440][536];
    float stratPix[19][1440][536];
    float shallowPix[19][1440][536];
} L3HSLH_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3HSLH_GRID/
    REAL*4 LHMean(536,1440,19)
    REAL*4 LHDev(536,1440,19)
    REAL*4 convLHMean(536,1440,19)
    REAL*4 convLHDev(536,1440,19)
    REAL*4 stratLHMean(536,1440,19)
    REAL*4 stratLHDev(536,1440,19)
    REAL*4 shallowLHMean(536,1440,19)
    REAL*4 shallowLHDev(536,1440,19)
    REAL*4 Q1RMean(536,1440,19)
    REAL*4 Q1RDev(536,1440,19)
    REAL*4 convQ1RMean(536,1440,19)
    REAL*4 convQ1RDev(536,1440,19)
    REAL*4 stratQ1RMean(536,1440,19)
    REAL*4 stratQ1RDev(536,1440,19)
    REAL*4 shallowQ1RMean(536,1440,19)
    REAL*4 shallowQ1RDev(536,1440,19)
    REAL*4 Q2Mean(536,1440,19)
    REAL*4 Q2Dev(536,1440,19)
    REAL*4 convQ2Mean(536,1440,19)
    REAL*4 convQ2Dev(536,1440,19)
    REAL*4 stratQ2Mean(536,1440,19)
```

```
    REAL*4 stratQ2Dev(536,1440,19)
    REAL*4 shallowQ2Mean(536,1440,19)
    REAL*4 shallowQ2Dev(536,1440,19)
    REAL*4 allPix(536,1440,19)
    REAL*4 convPix(536,1440,19)
    REAL*4 stratPix(536,1440,19)
    REAL*4 shallowPix(536,1440,19)
END STRUCTURE
```

5.43 2HCSH - Convective Stratiform Heating

2HCSH, "Convective Stratiform Heating," produces orbital apparent heating profiles from surface convective rainfall rate and surface stratiform rainfall rate. The PI is Dr. Tao. The granule size is one orbit. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nray	49	Number of angle bins in each scan.
nlayer	19	Number of layers at 0.0-0.5 km, 0.5-1 km, 1-2 km, ..., 17-18 km.

Figure 520 through Figure 521 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

Swath (Swath)

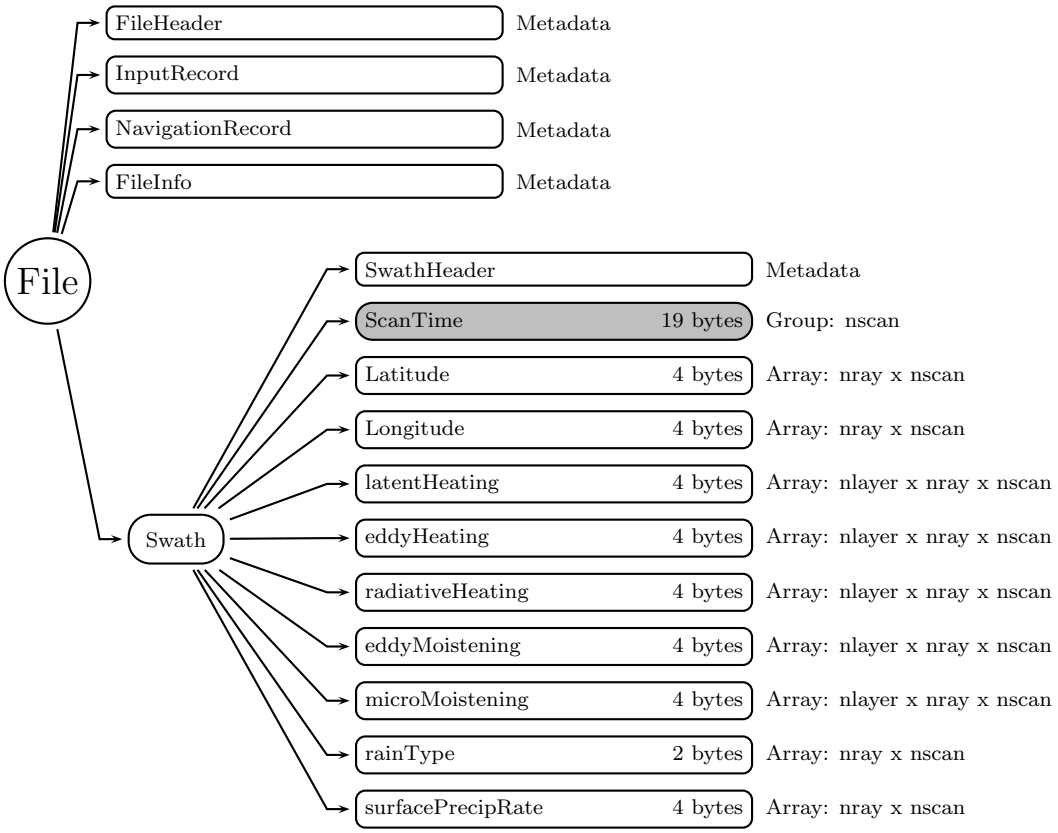


Figure 520: Data Format Structure for 2HCSH, Convective Stratiform Heating

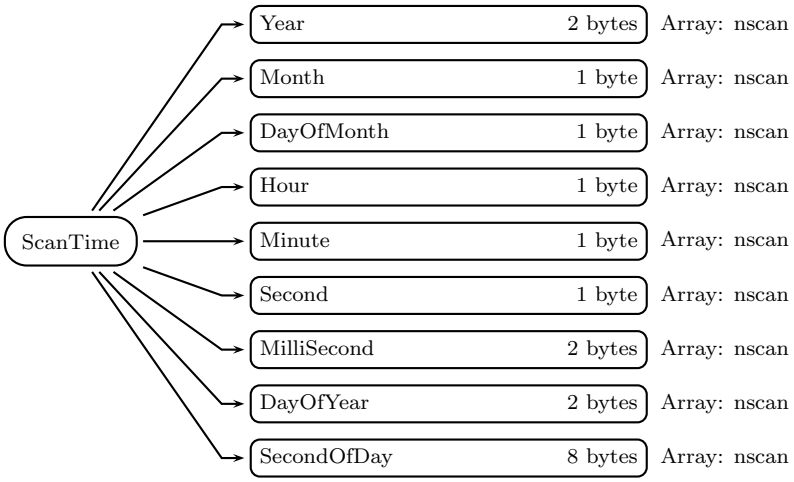


Figure 521: Data Format Structure for 2HCSH, ScanTime

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nray x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are

defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nray x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

latentHeating (4-byte float, array size: nlayer x nray x nscan):
Latent Heating. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

eddyHeating (4-byte float, array size: nlayer x nray x nscan):
Eddy flux heating. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

radiativeHeating (4-byte float, array size: nlayer x nray x nscan):
Radiative heating. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

eddyMoistening (4-byte float, array size: nlayer x nray x nscan):
Apparent moistening due to eddy processes. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

microMoistening (4-byte float, array size: nlayer x nray x nscan):
Apparent moistening due to microphysical processes. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

rainType (2-byte integer, array size: nray x nscan):
Rain type from Level 2 PR Rain Type. Special values are defined as:
-9999 Missing value

surfacePrecipRate (4-byte float, array size: nray x nscan):
Mean estimated surface precipitation rate from Level 2 Combined. Values range from 0 to 500 mm/hr. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_2HCSH_H_
#define _TK_2HCSH_H_

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
```

```
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2HCSH_SWATH_
#define _L2HCSH_SWATH_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[49];
    float Longitude[49];
    float latentHeating[49][19];
    float eddyHeating[49][19];
    float radiativeHeating[49][19];
    float eddyMoistening[49][19];
    float microMoistening[49][19];
    short rainType[49];
    float surfacePrecipRate[49];
} L2HCSH_SWATH;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
```

```
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2HCSH_SWATH/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(49)
    REAL*4 Longitude(49)
    REAL*4 latentHeating(19,49)
    REAL*4 eddyHeating(19,49)
    REAL*4 radiativeHeating(19,49)
    REAL*4 eddyMoistening(19,49)
    REAL*4 microMoistening(19,49)
    INTEGER*2 rainType(49)
    REAL*4 surfacePrecipRate(49)
END STRUCTURE
```

5.44 3GCSH - Gridded Orbital Convective Stratiform Heating from Combined

3GCSH, "Gridded Orbital Convective Stratiform Heating from Combined", produces 0.25^o x 0.25^o orbital apparent heating profiles from surface convective rainfall rate and surface stratiform rainfall rate. The PI is Dr. Wei-Kuo Tao. The granule size is one orbit. The following sections describe the structure and contents of the format.

Dimension definitions:

nlat	536	Number of 0.25^o grid intervals of latitude from 67^oN to 67^oS.
nlon	1440	Number of 0.25^o grid intervals of longitude from 180^oW to 180^oE.
nlayer	19	Number of layers at 0.0-0.5 km, 0.5-1 km, 1-2 km, ..., 17-18 km.

Figure 522 through Figure 523 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

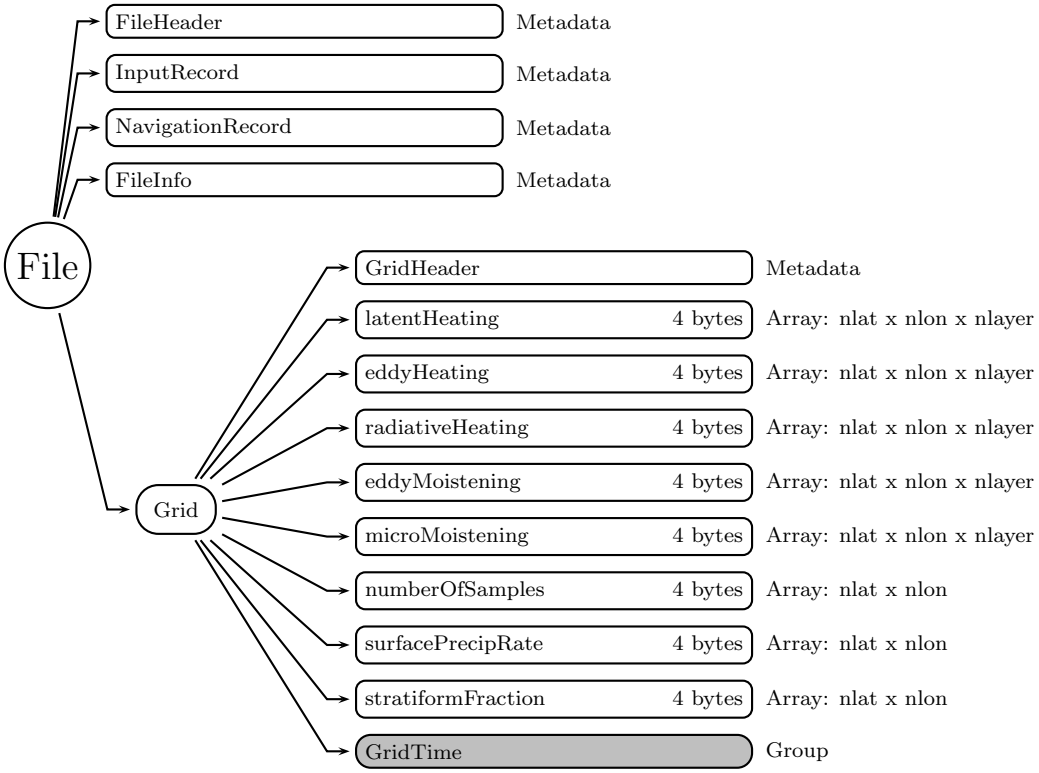


Figure 522: Data Format Structure for 3GCSH, Gridded Orbital Convective Stratiform Heating from Combined

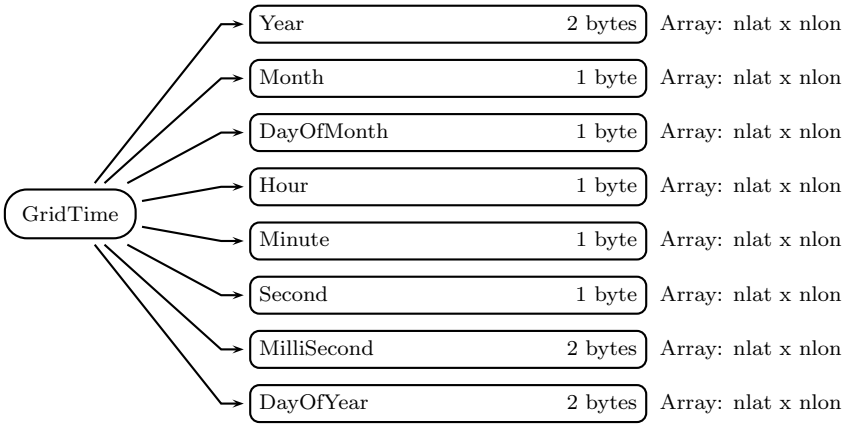


Figure 523: Data Format Structure for 3GCSH, GridTime

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

Grid (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

latentHeating (4-byte float, array size: nlat x nlon x nlayer):
Latentheating. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

eddyHeating (4-byte float, array size: nlat x nlon x nlayer):
Eddy flux heating. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

radiativeHeating (4-byte float, array size: nlat x nlon x nlayer):
Radiative heating. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

eddyMoistening (4-byte float, array size: nlat x nlon x nlayer):
Apparent moistening due to eddy processes. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

microMoistening (4-byte float, array size: nlat x nlon x nlayer):
Apparent moistening due to microphysical processes. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

numberOfSamples (4-byte integer, array size: nlat x nlon):
Number of samples in 0.25^o x 0.25^o boxes. Values range from 0 to 500000. Special values are defined as:
-9999 Missing value

surfacePrecipRate (4-byte float, array size: nlat x nlon):
Mean estimated surface precipitation rate from Level 2 Combined. Values range from 0 to 3000 mm/hr. Special values are defined as:
-9999.9 Missing value

stratiformFraction (4-byte float, array size: nlat x nlon):
Ratio of stratiform to total surface rain rate from Level 2 PR. Values range from 0 to 1.

Special values are defined as:
-9999.9 Missing value

GridTime (Group)

A UTC time associated with the grid box.

Year (2-byte integer, array size: nlat x nlon):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nlat x nlon):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nlat x nlon):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nlat x nlon):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nlat x nlon):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nlat x nlon):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nlat x nlon):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nlat x nlon):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

C Structure Header file:

```
#ifndef _TK_3GCSH_H_
#define _TK_3GCSH_H_

#ifndef _L3GCSH_GRIDTIME_
#define _L3GCSH_GRIDTIME_
```

```
typedef struct {
    short Year[1440][536];
    signed char Month[1440][536];
    signed char DayOfMonth[1440][536];
    signed char Hour[1440][536];
    signed char Minute[1440][536];
    signed char Second[1440][536];
    short MilliSecond[1440][536];
    short DayOfYear[1440][536];
} L3GCSH_GRIDTIME;

#endif

#ifndef _L3GCSH_GRID_
#define _L3GCSH_GRID_

typedef struct {
    float latentHeating[19][1440][536];
    float eddyHeating[19][1440][536];
    float radiativeHeating[19][1440][536];
    float eddyMoistening[19][1440][536];
    float microMoistening[19][1440][536];
    int numberOfSamples[1440][536];
    float surfacePrecipRate[1440][536];
    float stratiformFraction[1440][536];
    L3GCSH_GRIDTIME GridTime;
} L3GCSH_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3GCSH_GRIDTIME/
    INTEGER*2 Year(536,1440)
    BYTE Month(536,1440)
    BYTE DayOfMonth(536,1440)
    BYTE Hour(536,1440)
    BYTE Minute(536,1440)
    BYTE Second(536,1440)
    INTEGER*2 MilliSecond(536,1440)
    INTEGER*2 DayOfYear(536,1440)
```

```
END STRUCTURE

STRUCTURE /L3GCSH_GRID/
    REAL*4 latentHeating(536,1440,19)
    REAL*4 eddyHeating(536,1440,19)
    REAL*4 radiativeHeating(536,1440,19)
    REAL*4 eddyMoistening(536,1440,19)
    REAL*4 microMoistening(536,1440,19)
    INTEGER*4 numberOfSamples(536,1440)
    REAL*4 surfacePrecipRate(536,1440)
    REAL*4 stratiformFraction(536,1440)
    RECORD /L3GCSH_GRIDTIME/ GridTime
END STRUCTURE
```

5.45 3HCSH - Monthly Convective Stratiform Heating from Combined

3HCSH, "Monthly Convective Stratiform Heating from Combined", produces 0.25^o x 0.25^o monthly apparent heating profiles from surface convective rainfall rate and surface stratiform rainfall rate. The PI is Dr. Wei-Kuo Tao. The granule size is one month. The following sections describe the structure and contents of the format.

Dimension definitions:

nlat	536	Number of 0.25^o grid intervals of latitude from 67^oN to 67^oS.
nlon	1440	Number of 0.25^o grid intervals of longitude from 180^oW to 180^oE.
nlayer	19	Number of layers at 0.0-0.5 km, 0.5-1 km, 1-2 km, ..., 17-18 km.

Figure 524 shows the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputFileNames (Metadata):
InputFileNames contains a list of input file names for this granule. See Metadata for GPM Products for details.

InputAlgorithmVersions (Metadata):
InputAlgorithmVersions contains a list of input algorithm versions for this granule. See Metadata for GPM Products for details.

InputGenerationDateTimes (Metadata):
InputGenerationDateTimes contains a list of input generation datetimes. See Metadata for GPM Products for details.

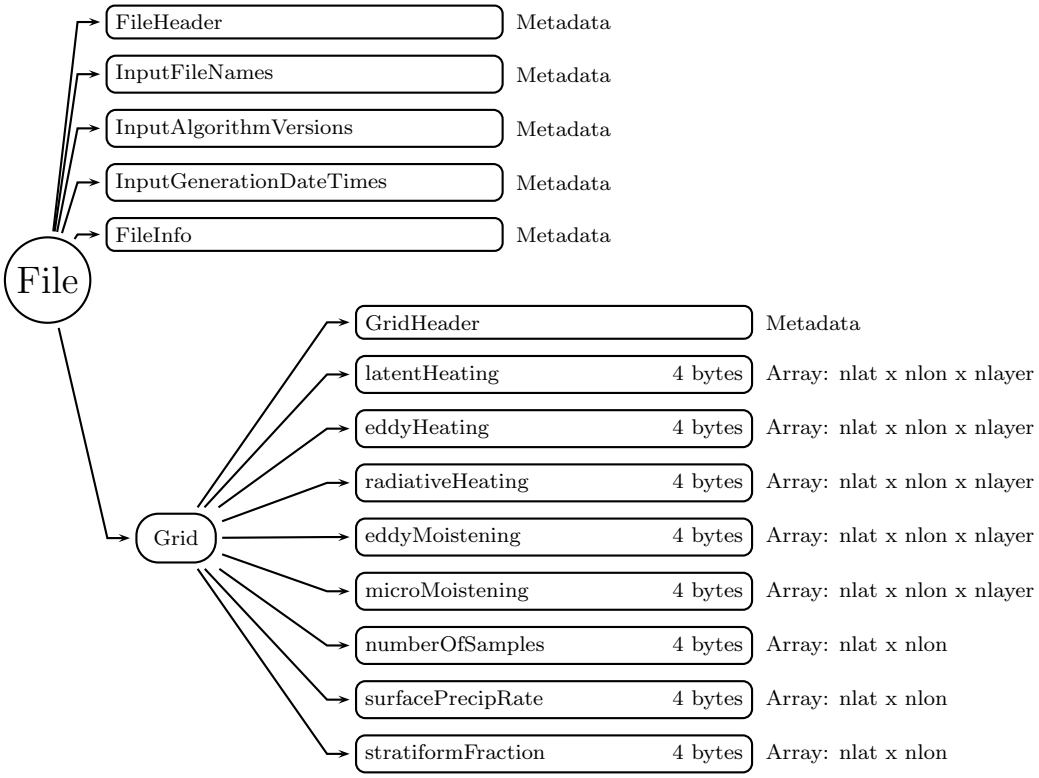


Figure 524: Data Format Structure for 3HCSH, Monthly Convective Stratiform Heating from Combined

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

Grid (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

latentHeating (4-byte float, array size: nlat x nlon x nlayer):
Latentheating. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

eddyHeating (4-byte float, array size: nlat x nlon x nlayer):
Eddy flux heating. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

radiativeHeating (4-byte float, array size: nlat x nlon x nlayer):
Radiative heating. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

eddyMoistening (4-byte float, array size: nlat x nlon x nlayer):
Apparent moistening due to eddy processes. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

microMoistening (4-byte float, array size: nlat x nlon x nlayer):
Apparent moistening due to microphysical processes. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

numberOfSamples (4-byte integer, array size: nlat x nlon):
Number of samples in 0.25^o x 0.25^o boxes for one month. Values range from 0 to 500000. Special values are defined as:
-9999 Missing value

surfacePrecipRate (4-byte float, array size: nlat x nlon):
Monthly estimated surface precipitation rate from Level 3 combined. Values range from 0 to 3000 mm/hr. Special values are defined as:
-9999.9 Missing value

stratiformFraction (4-byte float, array size: nlat x nlon):
Ratio of stratiform to total surface rain rate from Level 3 PR. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_3HCSH_H_
#define _TK_3HCSH_H_

#ifndef _L3HCSH_GRID_
#define _L3HCSH_GRID_

typedef struct {
    float latentHeating[19][1440][536];
    float eddyHeating[19][1440][536];
    float radiativeHeating[19][1440][536];
    float eddyMoistening[19][1440][536];
    float microMoistening[19][1440][536];
    int numberOfSamples[1440][536];
    float surfacePrecipRate[1440][536];
    float stratiformFraction[1440][536];
} L3HCSH_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3HCSH_GRID/
    REAL*4 latentHeating(536,1440,19)
    REAL*4 eddyHeating(536,1440,19)
    REAL*4 radiativeHeating(536,1440,19)
    REAL*4 eddyMoistening(536,1440,19)
    REAL*4 microMoistening(536,1440,19)
    INTEGER*4 numberOfSamples(536,1440)
    REAL*4 surfacePrecipRate(536,1440)
    REAL*4 stratiformFraction(536,1440)
END STRUCTURE
```

5.46 3GTRAIN - TRAIN Gridded Orbital Heating

3GTRAIN, "TRAIN Gridded Orbital Heating", produces 0.25^o x 0.25^o monthly oceanic heating maps using GMI Level-1 data. The PI is Dr. William Olson. The following sections describe the structure and contents of the format.

Dimension definitions:

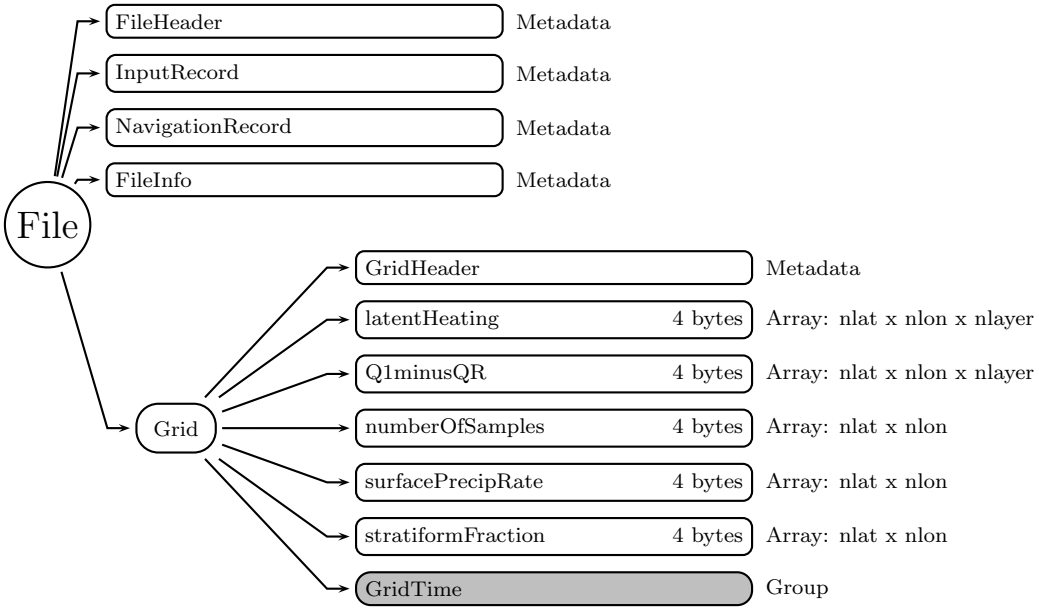


Figure 525: Data Format Structure for 3GTRAIN, TRAIN Gridded Orbital Heating

nlat	560	Number of 0.25^o grid intervals of latitude from 70°N to 70°S.
nlon	1440	Number of 0.25^o grid intervals of longitude from 180°W to 180°E.
nlayer	19	Number of layers at 0.0-0.5 km, 0.5-1 km, 1-2 km, ..., 17-18 km.

Figure 525 through Figure 526 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

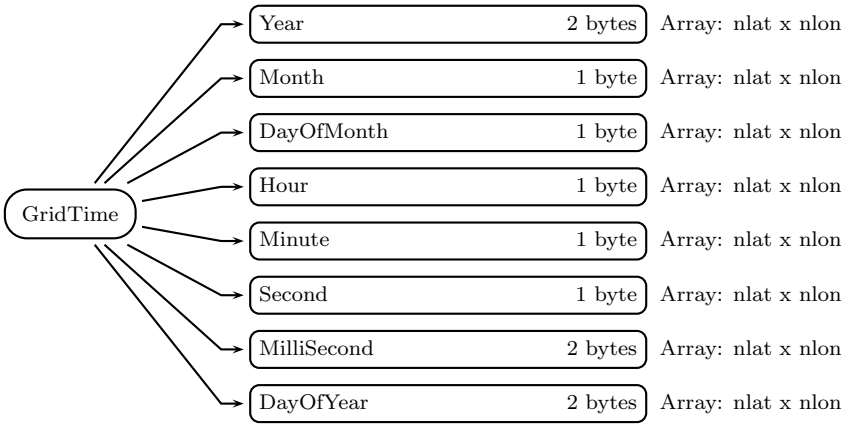


Figure 526: Data Format Structure for 3GTRAIN, GridTime

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

Grid (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

latentHeating (4-byte float, array size: nlat x nlon x nlayer):
Monthly latent heating in precipitation over oceans in 0.25^o x 0.25^oboxes. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

Q1minusQR (4-byte float, array size: nlat x nlon x nlayer):
Monthly Q1 - QR heating (or latent + eddy heating) in precipitation over oceans in 0.25^o x 0.25^oboxes. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

numberOfSamples (4-byte integer, array size: nlat x nlon):
Number of samples in 0.25^o x 0.25^o boxes. Values range from 0 to 500000. Special values are defined as:
-9999 Missing value

surfacePrecipRate (4-byte float, array size: nlat x nlon):
Monthly surface precipitation rate over oceans from the TRAIN algorithm in 0.25^o x 0.25^oboxes. Values range from 0 to 3000 mm/hr. Special values are defined as:
-9999.9 Missing value

stratiformFraction (4-byte float, array size: nlat x nlon):
Monthly stratiform to total ratio of rainfall rate in precipitation over oceans from the TRAIN algorithm in 0.25^o x 0.25^oboxes. Values range from 0 to 100 percent. Special values are defined as:
-9999.9 Missing value

GridTime (Group)

A UTC time associated with the grid box.

Year (2-byte integer, array size: nlat x nlon):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nlat x nlon):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nlat x nlon):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nlat x nlon):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nlat x nlon):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nlat x nlon):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nlat x nlon):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nlat x nlon):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

C Structure Header file:

```
#ifndef _TK_3GTRAIN_H_
#define _TK_3GTRAIN_H_

#ifndef _L3GTRAIN_GRIDTIME_
#define _L3GTRAIN_GRIDTIME_

typedef struct {
    short Year[1440][560];
    signed char Month[1440][560];
    signed char DayOfMonth[1440][560];
    signed char Hour[1440][560];
```

```
    signed char Minute[1440][560];
    signed char Second[1440][560];
    short MilliSecond[1440][560];
    short DayOfYear[1440][560];
} L3GTRAIN_GRIDTIME;

#endif

#ifndef _L3GTRAIN_GRID_
#define _L3GTRAIN_GRID_

typedef struct {
    float latentHeating[19][1440][560];
    float Q1minusQR[19][1440][560];
    int numberOfSamples[1440][560];
    float surfacePrecipRate[1440][560];
    float stratiformFraction[1440][560];
    L3GTRAIN_GRIDTIME GridTime;
} L3GTRAIN_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3GTRAIN_GRIDTIME/
    INTEGER*2 Year(560,1440)
    BYTE Month(560,1440)
    BYTE DayOfMonth(560,1440)
    BYTE Hour(560,1440)
    BYTE Minute(560,1440)
    BYTE Second(560,1440)
    INTEGER*2 MilliSecond(560,1440)
    INTEGER*2 DayOfYear(560,1440)
END STRUCTURE

STRUCTURE /L3GTRAIN_GRID/
    REAL*4 latentHeating(560,1440,19)
    REAL*4 Q1minusQR(560,1440,19)
    INTEGER*4 numberOfSamples(560,1440)
    REAL*4 surfacePrecipRate(560,1440)
    REAL*4 stratiformFraction(560,1440)
```

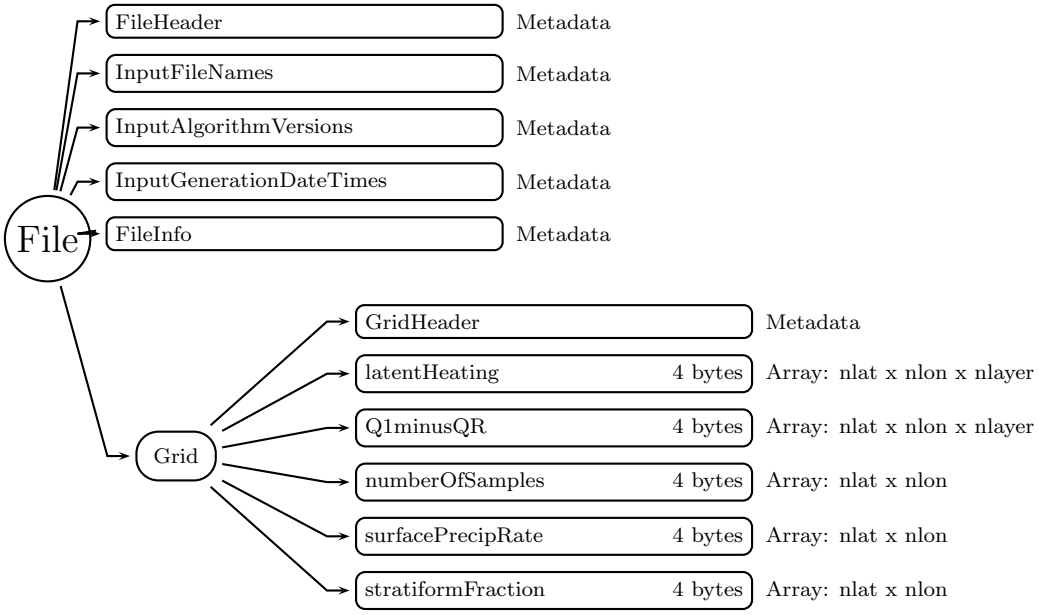


Figure 527: Data Format Structure for 3HTRAIN, TRAIN Monthly Heating

```
    RECORD /L3GTRAIN_GRIDTIME/ GridTime
END STRUCTURE
```

5.47 3HTRAIN - TRAIN Monthly Heating

3HTRAIN, "TRAIN Monthly Heating", produces 0.25^o x 0.25^o monthly oceanic heating maps using TMI Level-1 data. The PI is Dr. William Olson. The following sections describe the structure and contents of the format.

Dimension definitions:

nlat	560	Number of 0.25^o grid intervals of latitude from 70°N to 70°S.
nlon	1440	Number of 0.25^o grid intervals of longitude from 180°W to 180°E.
nlayer	19	Number of layers at 0.0-0.5 km, 0.5-1 km, 1-2 km, ..., 17-18 km.

Figure 527 shows the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputFileNames (Metadata):
InputFileNames contains a list of input file names for this granule. See Metadata for GPM Products for details.

InputAlgorithmVersions (Metadata):
InputAlgorithmVersions contains a list of input algorithm versions for this granule. See Metadata for GPM Products for details.

InputGenerationDateTimes (Metadata):
InputGenerationDateTimes contains a list of input generation datetimes. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

Grid (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

latentHeating (4-byte float, array size: nlat x nlon x nlayer):
Monthly latent heating in precipitation over oceans in 0.25^o x 0.25^oboxes. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

Q1minusQR (4-byte float, array size: nlat x nlon x nlayer):
Monthly Q1 - QR heating (or latent + eddy heating) in precipitation over oceans in 0.25^o x 0.25^oboxes. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

numberOfSamples (4-byte integer, array size: nlat x nlon):
Number of samples in 0.25^o x 0.25^o boxes for one month. Values range from 0 to 500000. Special values are defined as:
-9999 Missing value

surfacePrecipRate (4-byte float, array size: nlat x nlon):
Monthly surface precipitation rate over oceans from the TRAIN algorithm in 0.25^o x 0.25^oboxes. Values range from 0 to 3000 mm/hr. Special values are defined as:
-9999.9 Missing value

stratiformFraction (4-byte float, array size: nlat x nlon):
Monthly stratiform to total ratio of rainfall rate in precipitation over oceans from the TRAIN algorithm in 0.25^o x 0.25^oboxes. Values range from 0 to 100 percent. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_3HTRAIN_H_
#define _TK_3HTRAIN_H_

#ifndef _L3HTRAIN_GRID_
#define _L3HTRAIN_GRID_

typedef struct {
    float latentHeating[19][1440][560];
    float Q1minusQR[19][1440][560];
    int numberOfSamples[1440][560];
    float surfacePrecipRate[1440][560];
    float stratiformFraction[1440][560];
} L3HTRAIN_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3HTRAIN_GRID/
    REAL*4 latentHeating(560,1440,19)
    REAL*4 Q1minusQR(560,1440,19)
    INTEGER*4 numberOfSamples(560,1440)
    REAL*4 surfacePrecipRate(560,1440)
    REAL*4 stratiformFraction(560,1440)
END STRUCTURE
```