

# **Combined Product Format**

**Version 2.0**

**March, 2016**

**Japan Aerospace Exploration Agency**

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### Revision history

revision	date	section	content, reason
Version 1.0	Sept. 2 <sup>nd</sup> 2014	ALL	New
Version 2.0	Mar. 29 <sup>th</sup> 2016	Addition of New Products, 3GCSH and 3HCSH	Chapter 3. 3GCSH - Gridded Orbital Convective Stratiform Heating from Combined Chapter 4. 3HCSH - Monthly Convective Stratiform Heating from Combined

#### Reference

- (1) PRECIPITATION PROCESSING SYSTEM GLOBAL PRECIPITATION MEASUREMENT “File Specification for GPM Products”, Version 1.07 TKIO 3.60.4, August 1, 2014
- (2) PRECIPITATION PROCESSING SYSTEM GLOBAL PRECIPITATION MEASUREMENT “Metadata for GPM Products”, Version 1.00 February 27, 2014
- (3) PRECIPITATION PROCESSING SYSTEM, GLOBALPRECIPITATION MEASUREMENT, File Specification for GPM Products, Version Preliminary for V04 TKIO 3.70.7, November 18, 2015

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## Contents

<b>1. 2BCMB – Level-2 DPR and GMI Combined.....</b>	<b>1</b>
1.1. Data Format Structure .....	2
1.1.1. Dimension definition.....	2
1.1.2. Data Format Structure for 2BCMB – Level-2 DPR and GMI Combined .....	3
1.1.3. Data Format Structure for each Group .....	4
1.1.3.1 Data Format Structure for NS Group .....	4
1.1.3.2 Data Format Structure for MS Group.....	8
1.2. Contents of objects in each Group .....	12
1.2.1. Metadata .....	12
1.2.1.1 FileHeader .....	12
1.2.1.2 nputRecord .....	13
1.2.1.3 AlgorithmRuntimeInfo .....	13
1.2.1.4 NavigationRecord.....	13
1.2.1.5 FileInfo .....	14
1.2.2. Data Group .....	15
1.2.2.1 NS (Swath) .....	15
1.2.2.2 MS (Swath) .....	34
<b>2. 3CMB – Combined precipitation.....</b>	<b>53</b>
2.1. Data Format Structure .....	54
2.1.1. Dimension definition.....	54
2.1.2. Data Format Structure for 3CMB – Combined precipitation .....	55
2.1.3. Data Format Structure for each Group .....	56
2.1.3.1 Data Format Structure for G1 Group.....	56
2.1.3.2 Data Format Structure for G2 Group.....	58
2.2. Contents of objects in each Group .....	60
2.2.1. Metadata .....	60
2.2.1.1 FileHeader .....	60
2.2.1.2 InputRecord.....	61
2.2.1.3 InputAlgorithmVersioins .....	61
2.2.1.4 InputGenerationDataTimes .....	61
2.2.1.5 FileInfo .....	61
2.2.2. Data Group .....	62
2.2.2.1 G1 (Group).....	62
2.2.2.2 G2 (Group).....	69
<b>3. 3GCSH–Gridded Orbital Convective Stratiform Heating from Combined .....</b>	<b>76</b>
3.1. Data Format Structure .....	77
3.1.1. Dimension definition.....	77
3.1.2. Data format Structure for 3GCSH - Gridded Orbital Convective Stratiform Heating from Combined .....	78
3.1.3. Data Format Structure for each Group .....	79
3.1.3.1 Data Format Structure for GridTime .....	79
3.2. Contents of objectives in each Group.....	80
3.2.1. Metadata .....	80

---

3.2.1.1 FileHeader .....	80
3.2.1.2 InputRecord.....	81
3.2.1.3 NavigationRecord.....	81
3.2.1.4 FileInfo .....	82
3.2.2. Data Group .....	82
3.2.2.1 Grid (Group).....	83
<b>4. 3HCSH – Monthly Convective Stratiform Heating from Combined.....</b>	<b>87</b>
4.1. Data Format Structure .....	88
4.1.1. Dimension definition.....	88
4.1.2. Data Format Structure of 3HCSH – Monthly Convective Stratiform Heating from Combined .	89
4.2. Contents of objectives in each Group.....	90
4.2.1. Metadata .....	90
4.2.1.1 FileHeader .....	90
4.2.1.2 InputFileNames .....	91
4.2.1.3 InputAlgorithmVersions .....	91
4.2.1.4 InputGenerationDateTimes .....	91
4.2.1.5 FileInfo .....	91
4.2.2. Data Group .....	92
4.2.2.1 Grid (Group).....	92
<b>Index.....</b>	<b>95</b>

# **1. 2BCMB – Level-2 DPR and GMI Combined**

## 1.1. Data Format Structure

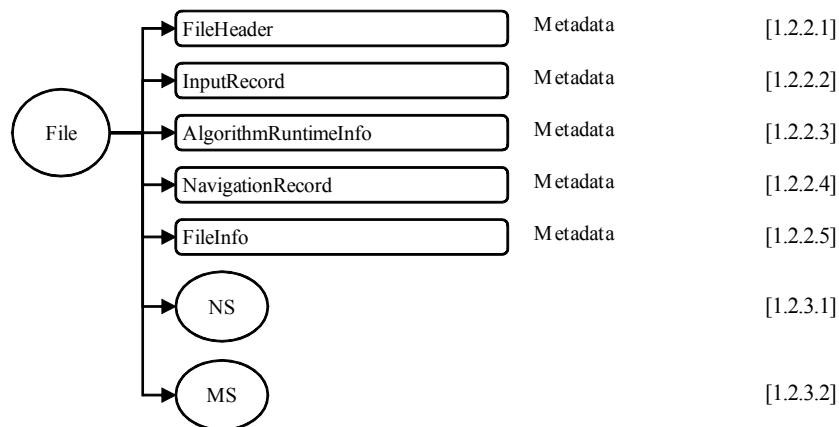
### 1.1.1. Dimension definition

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.
- 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

## 1.1.2. Data Format Structure for 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, contain 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.

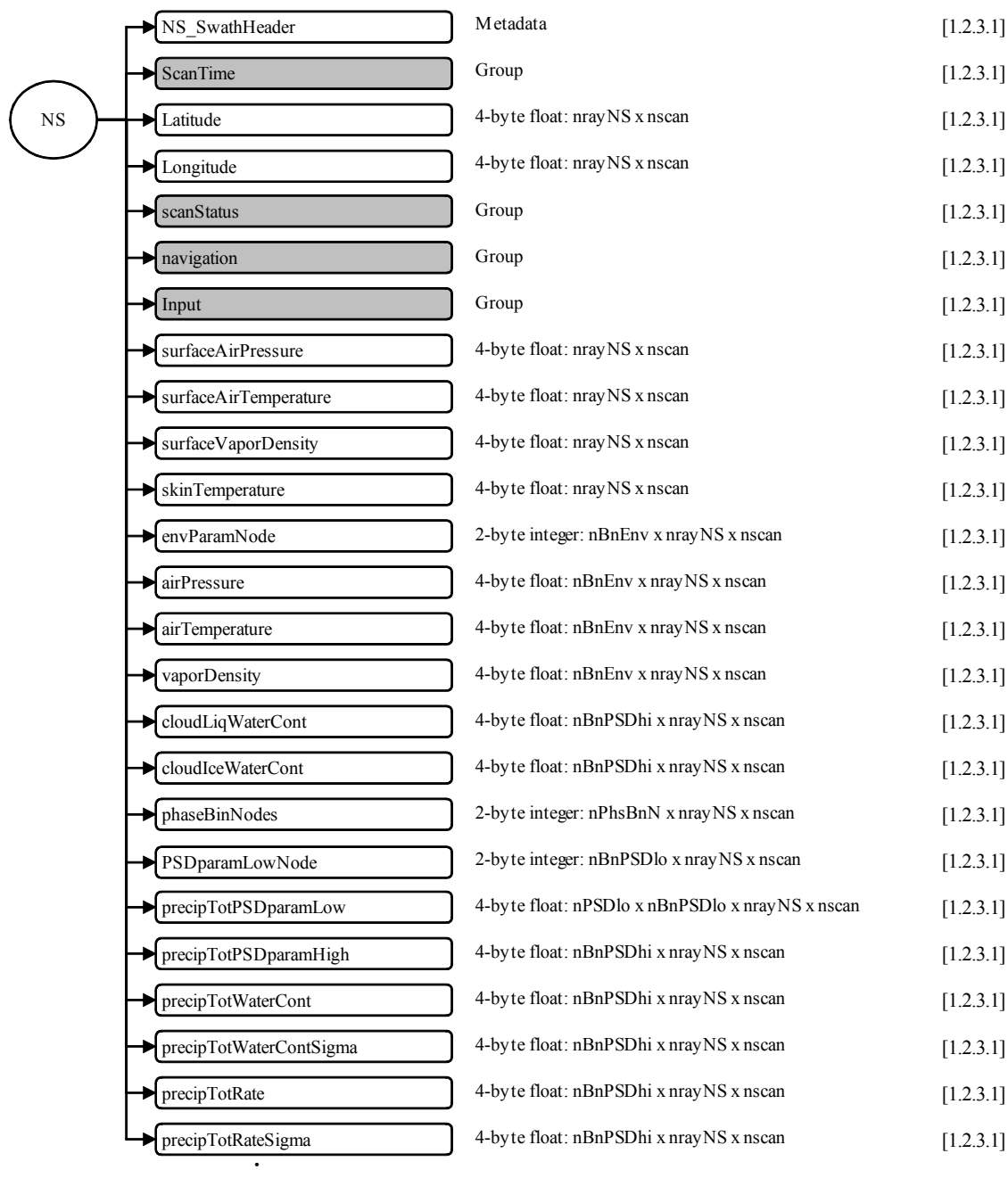


**Figure 1.1-1 Data Format Structure for 2BCMB – Level-2 DPR and GMI Combined**

## 1.1.3. Data Format Structure for each Group

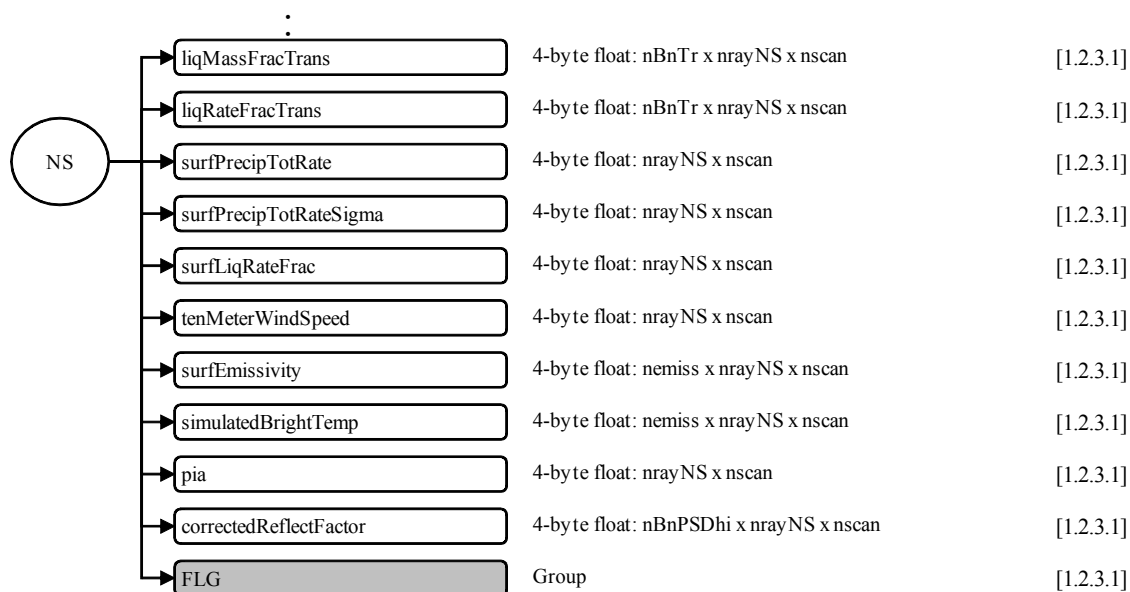
### 1.1.3.1 Data Format Structure for NS Group

NS Group's structure is shown in this section.

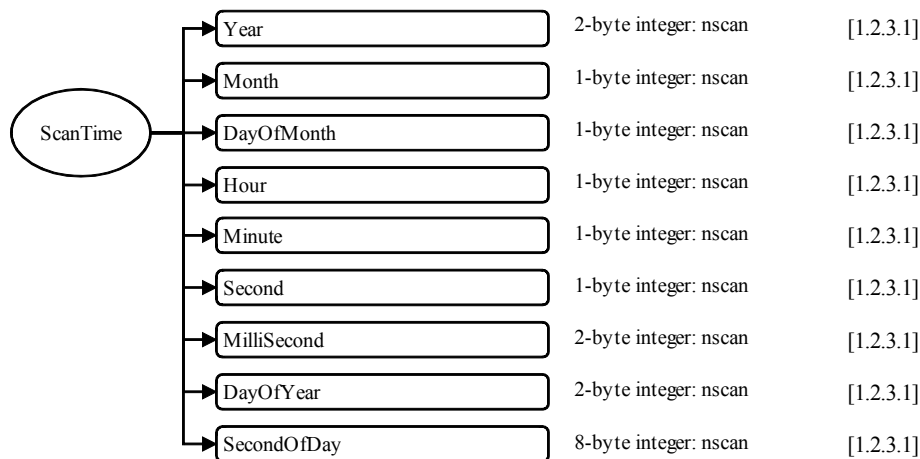


**Figure 1.1-2 Data Format Structure for 2BCMB, NS**

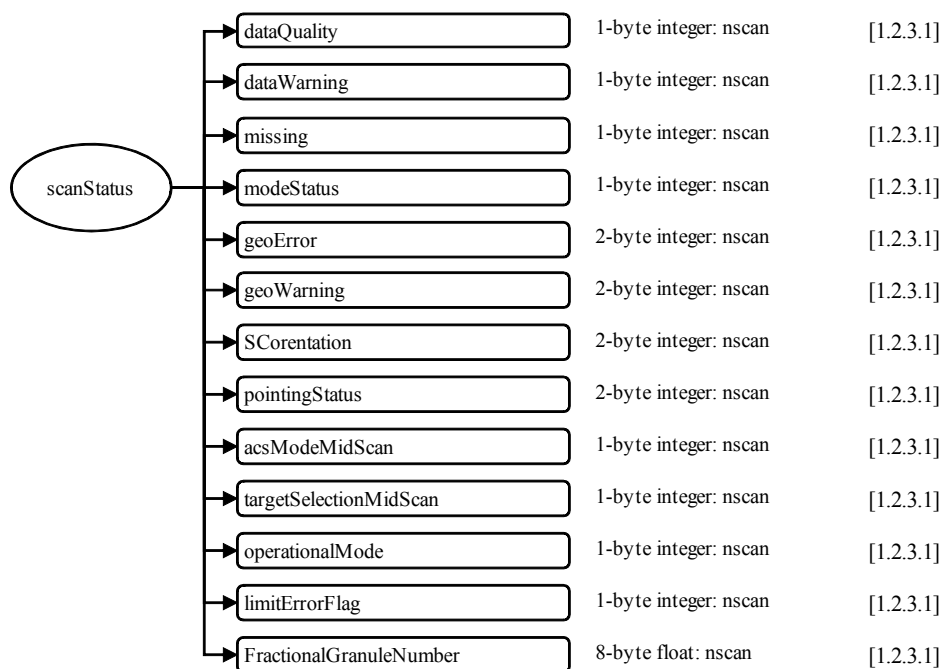




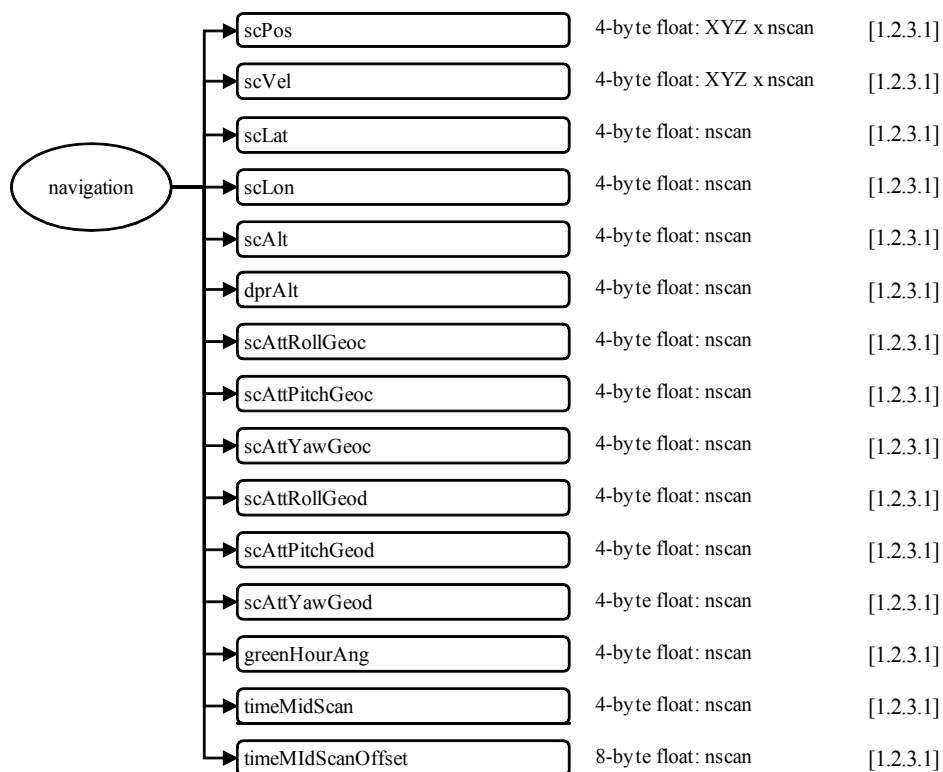
**Figure 1.1-3 Data Format Structure for 2BCMB, NS**



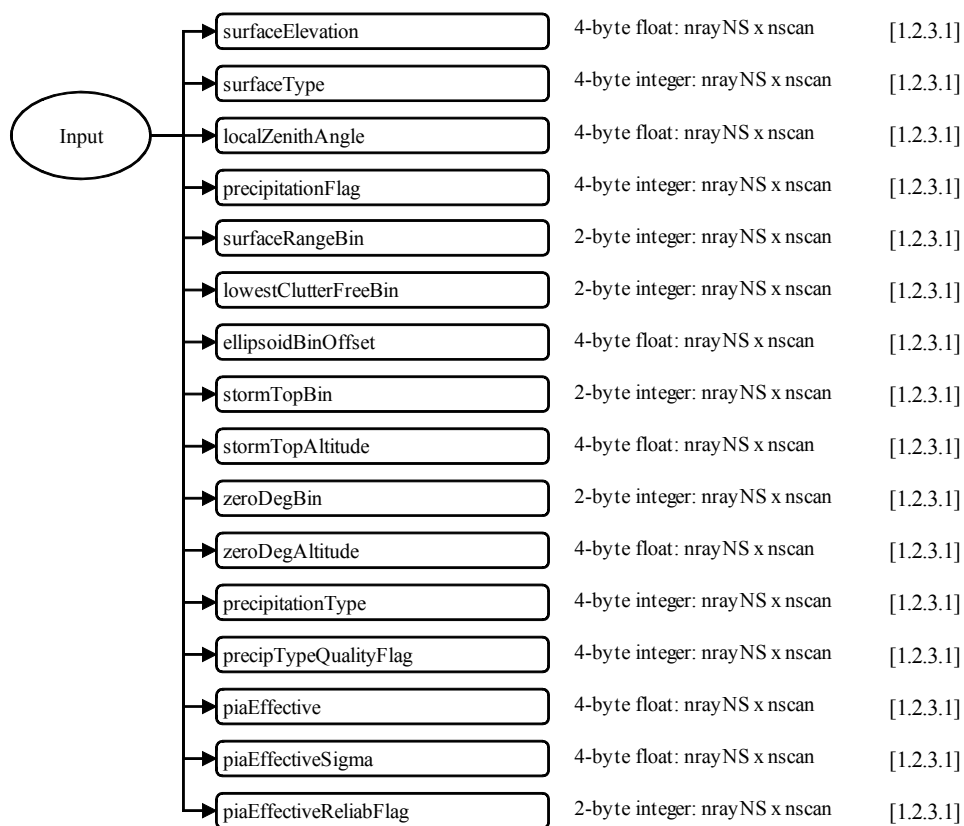
**Figure 1.1-4 Data Format Structure for 2BCMB, NS, ScanTime**



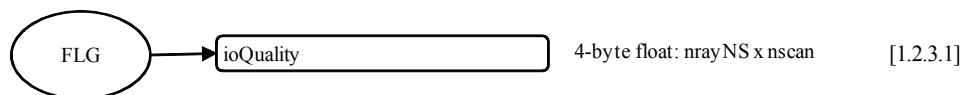
**Figure 1.1-5 Data Format Structure for 2BCMB, NS, scanStatus**



**Figure 1.1-6 Data Format Structure for 2BCMB, NS, navigation**



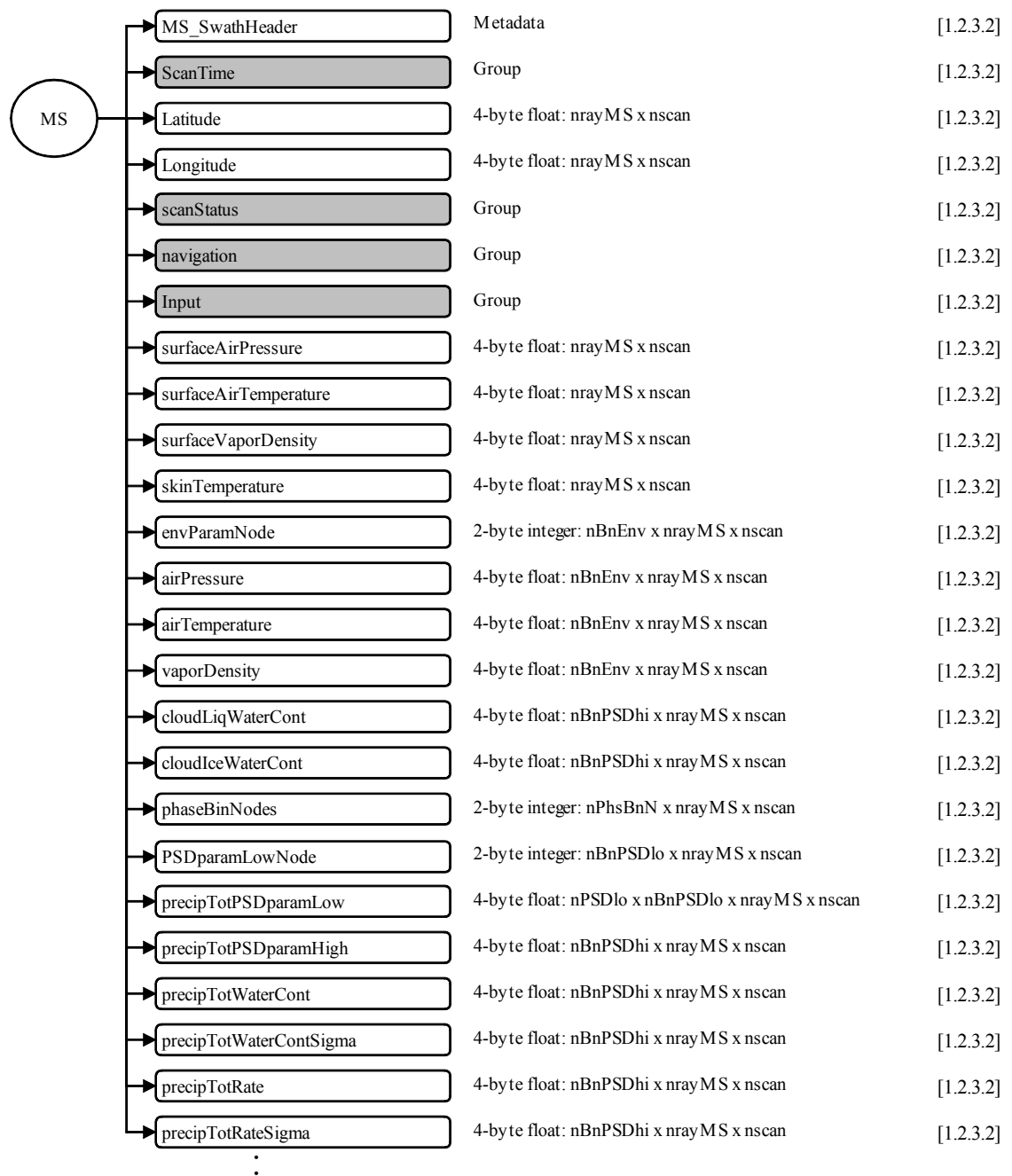
**Figure 1.1-7 Data Format Structure for 2BCMB, NS, Input**



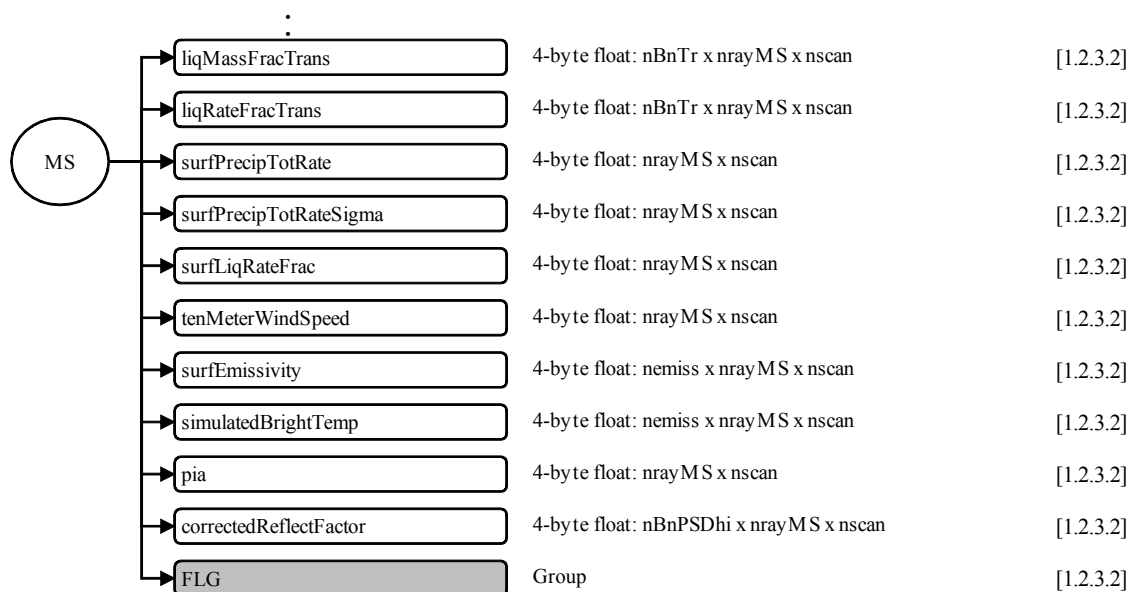
**Figure 1.1-8 Data Format Structure for 2BCMB, NS, FLG**

### 1.1.3.2 Data Format Structure for MS Group

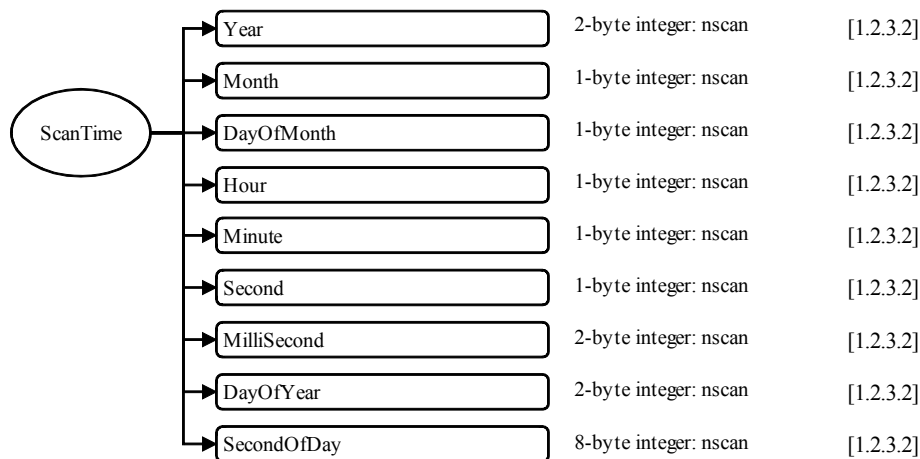
MS Group's structure is shown in this section.



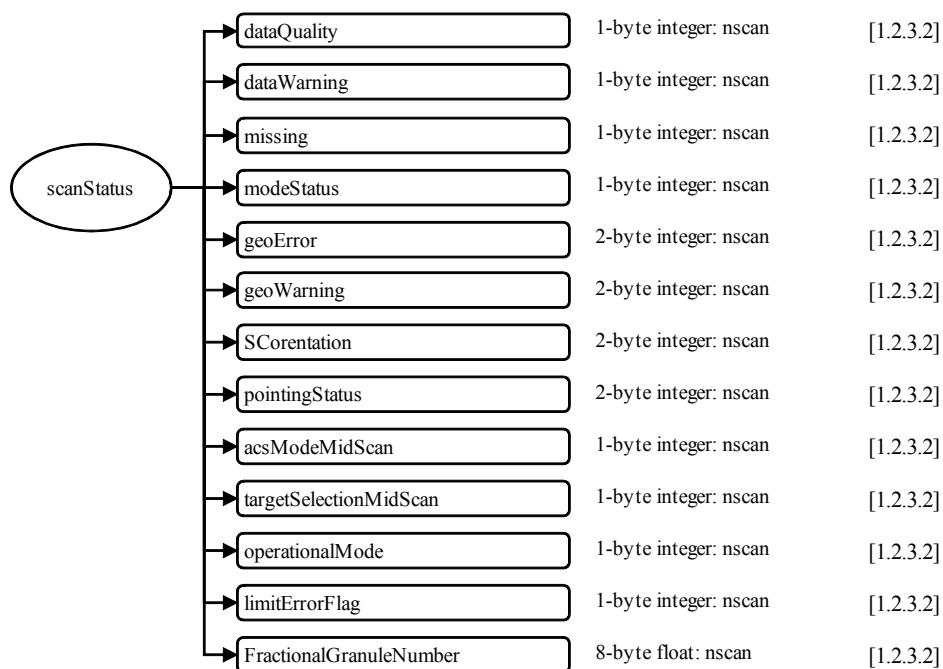
**Figure 1.1-9 Data Format Structure for 2BCMB, MS**



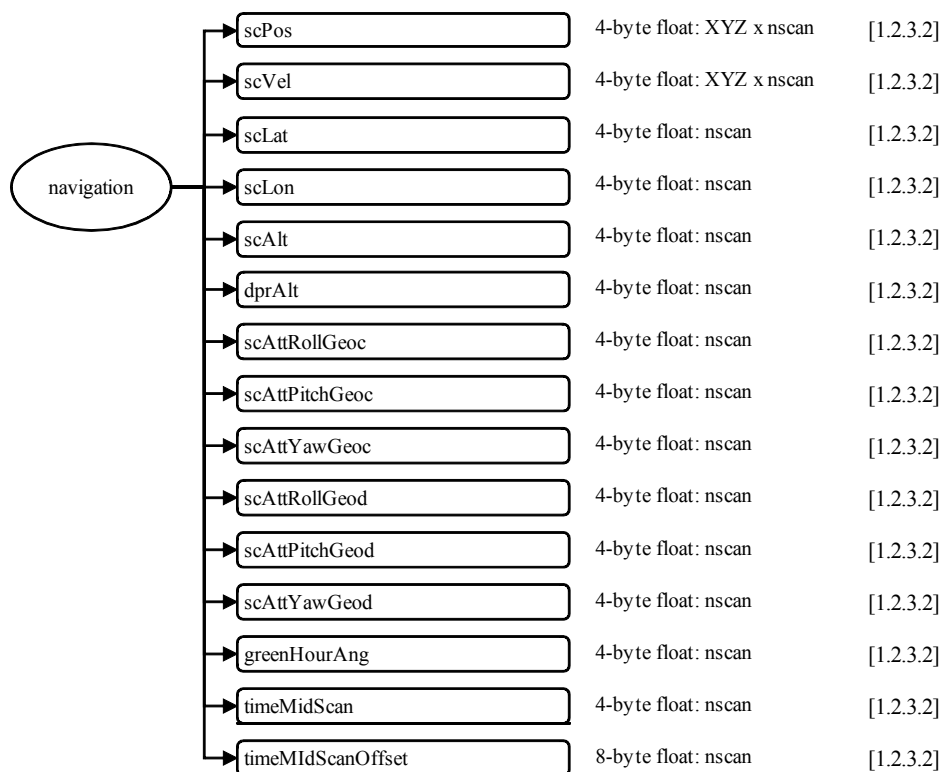
**Figure 1.1-10 Data Format Structure for 2BCMB, MS**



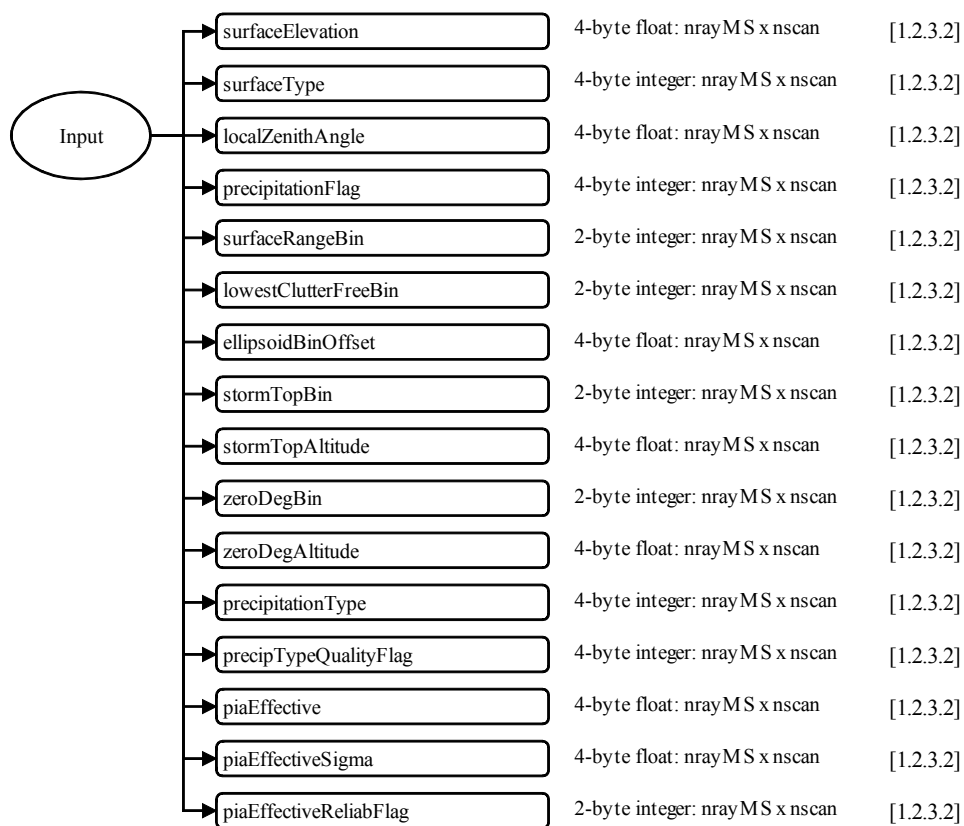
**Figure 1.1-11 Data Format Structure for 2BCMB, MS, ScanTime**



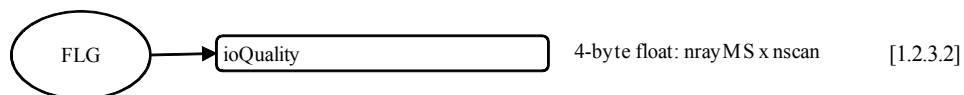
**Figure 1.1-12 Data Format Structure for 2BCMB, MS, scanStatus**



**Figure 1.1-13 Data Format Structure for 2BCMB, MS, navigation**



**Figure 1.1-14 Data Format Structure for 2BCMB, MS, Input**



**Figure 1.1-15 Data Format Structure for 2BCMB, MS, FLG**

## 1.2. Contents of objects in each Group

### 1.2.1. Metadata

#### 1.2.1.1 FileHeader

FileHeader contains metadata of general interest. Table 1.2-1 shows each metadata elements in FileHeader.

**Table 1.2-1 FileHeader Group**

Metadata Element	Estimated Size (bytes)	Description
DOI	256	Digital Object Identifier
AlgorithmID	50	The algorithm that generated this product, e.g., 2A12.
AlgorithmVersion	50	The version of the algorithm that generated this product.
FileName	50	The file name of this granule.
SatelliteName	10	Values are: TRMM GPM MULTI F10 ... F18 AQUA GCOMW1 CORIOLIS MT1 NOAA15 ... NOAA19 METOPANPP. More values will be added as they are known.
InstrumentName	10	Values are: PR TMI VIRS PRTMI KU KA DPR GMI DPRGMI MERGED SSMI SSMIS AMSRE AMSR2 WIND-SAT MADRAS AMSUA AMSUB SAPHIR MHS ATMS. More values will be added as they are known.
GenerationDateTime	50	The date and time this granule was generated. The format is YYYY-MM-DDTHH:MM:SS.sssZ, where YYYY is 4-digit year, MM is month number, DD is day of month, T is "T", HH is hour, MM is minute, SS is second, sss is millisecond, and Z is "Z". All fields are zero-filled. The missing value is constructed by replacing all digits with 9, i.e., 9999-99-99T99:99:99.999Z
StartGranuleDateTime	50	The start time defining this granule. The format is the same as GenerationDateTime. DETAILS: An orbital granule starts when the satellite is at the position defined by GranuleStart. Thus the start time is not the first scan time. Some algorithms have overlap scans in the file before the start time as defined in SwathHeader. A monthly granule starts on the first ms of the month, for example March 1998 would be 1998-03-01T00:00:00.000Z
StopGranuleDateTime	50	The stop time defining this granule. The format is the same as GenerationDateTime. DETAILS: An orbital granule stops when the satellite is at the position defined by GranuleStart. Thus the stop time is not the last scan time. Some algorithms have overlap scans in the file after the stop time as defined in SwathHeader. A monthly granule stops on the last ms of the month, for example March 1998 would be 1998-03-31T23:59:59.999Z
GranuleNumber	50	The number of this granule, which starts as in GranuleStart. If the GranuleStart is identical to the orbit start, then the GranuleNumber will be the same as the orbit number. The GranuleNumber will have 6 digits, including leading zeroes, for example 001234.
NumberOfSwaths	50	The number of swaths in this granule.
NumberOfGrids	50	The number of grid structures in this granule.
GranuleStart	50	The starting place in the orbit of this granule. Currently defined values are "SOUTHERNMOST LATITUDE" and "NORTHBOUND EQUATOR CROSSING".
TimeInterval	50	The time interval covered by this granule. Values are "ORBIT", "HALF ORBIT", "HALF HOUR", "HOUR", "3 HOUR", "DAY", "MONTH", "CONTACT".
ProcessingSystem	50	The name of the processing system, e.g., "PPS", "JAXA".
ProductVersion	50	The data version assigned by the processing system.
EmptyGranule	50	Whether a granule is empty. Values are "EMPTY" or "NOT EMPTY".
MissingData	50	The number of missing scans.



### 1.2.1.2 nputRecord

InputRecord contains a record of input files for this granule. Table 1.2-2 shows each metadata elements in InputRecord.

**Table 1.2-2 InputRecord Group**

Metadata Element	Estimated Size (bytes)	Description
InputFileName	1000	A list of input file names for this granule.
InputAlgorithmVersions	1000	A list of algorithm versions of the input files for this granule.
InputGenerationDateTimes	1000	A list of generation date times of the input files for this granule. The format is the same as GenerationDateTime.

### 1.2.1.3 AlgorithmRuntimeInfo

AlgorithmRuntimeInfo contains text runtime information written by the algorithm. This group is a "Long Metadata Group", which has no elements. This group appears in products if the algorithm developer asks for it.

### 1.2.1.4 NavigationRecord

NavigationRecord contains navigation metadata for this granule. Table 1.2-3 shows each metadata elements in NavigationRecord.

**Table 1.2-3 NavigationRecord Group**

Metadata Element	Estimated Size (bytes)	Description
LongitudeOnEquator	50	The longitude where the satellite crosses the equator going from south to north.
UTCDateTimeOnEquator	50	The UTC time when the satellite crosses the equator going from south to north. The format is the same as GenerationDate Time.
MeanSolarBetaAngle	50	The average solar beta angle in this granule.
EphemerisFileName	50	Name of the ephemeris file input for processing.
AttitudeFileName	50	Name of the attitude file input for processing.
GeoControlFileName	50	Name of the GeoTK Control Parameters File input for processing.
EphemerisSource	50	Values are "0 CONSTANT INPUT TEST VALUE", "1 GROUND ESTIMATED STATE (GES)", "2 GPS FILTERED SOLUTION (GEONS)", "3 GPS POINT SOLUTION (PVT)", "4 ON BOARD PROPAGATED (OBP)", "5 OEM GROUND EPHEMERIS FILE", "6 GEONS WITH FALLBACK AS FLAGGED", "7 PVT WITH FALLBACK AS FLAGGED", "8 OBP WITH FALLBACK AS FLAGGED", "9 GES WITH FALLBACK AS FLAGGED"
AttitudeSource	50	Values are "0 CONSTANT INPUTS FOR TESTING", "1 ON BOARD CALCULATED PITCH ROLL YAW"
GeoToolkitVersion	50	Version of the GeoToolkit
SensorAlignmentFirstRotationAngle	50	Alignment angle, first rotation, in degrees. Rotation adjustment from sensor coordinates to the Attitude Control System Flight Coordinates.
SensorAlignmentSecondRotationAngle	50	Alignment angle, second rotation, in degrees.
SensorAlignmentThirdRotationAngle	50	Alignment angle, third rotation, in degrees.
SensorAlignmentFirstRotationAxis	50	Euler rotation sequence, first rotation axis. Values are "1", "2", "3" (representing X, Y, Z).

1.2. Contents of objects in each Group

1.2.1. Metadata

1.2.1.5. FileInfo

Metadata Element	Estimated Size (bytes)	Description
SensorAlignmentSecondRotationAxis	50	Euler rotation sequence, second rotation axis. Values are "1", "2", "3" (representing X, Y, Z).
SensorAlignmentThirdRotationAxis	50	Euler rotation sequence, third rotation axis. Values are "1", "2", "3" (representing X, Y, Z).

**1.2.1.5 FileInfo**

FileInfo contains metadata used by the PPS I/O Toolkit. Table 1.2-4 shows each metadata elements in FileInfo.

**Table 1.2-4 FileInfo Group**

Metadata Element	Estimated Size (bytes)	Description
DataFormatVersion	50	The version of the data format used to write this file. This version is separate for each AlgorithmID. The order is: "a" "b" ... "z" "aa" "ab" ... "az" "ba" "bb" ...
TKCodeBuildVersion	50	Usually TK CodeBuildVersion is "1". If the I/O routines built by TKIO change even though the DataFormatVersion is unchanged, then TK CodeBuildVersion increments to "2", "3", ... If subsequently DataFormatVersion changes, TKCodeBuildVersion becomes "1" again.
MetadataVersion	50	The version of metadata used to write this file. This version is separate for each AlgorithmID. The order is: "a" "b" ... "z" "aa" "ab" ... "az" "ba" "bb" ...
FormatPackage	50	The underlying format of this granule. Values are "HDF4", "HDF5", "NETCDF", "TKBINARY"
BlueprintFilename	50	The filename of the primary blueprint file that defined the format used to write this file.
BlueprintVersion	10	The BlueprintVersion of the format definition
TKIOVersion	50	The version of TKIO used to create I/O routines to write this file. TKIOVersion does not define the format used to write this file.
MetadataStyle	50	The style in which the metadata was written, e.g., "PVL". "PVL" means < parameter >=< value >;
EndianType	50	The endian type of the system that wrote this file. Values are "BIG ENDIAN" and "LITTLE ENDIAN".

## 1.2.2. Data Group

Elements of data group are explained in detail in this section.

### 1.2.2.1 NS (Swath)

#### (1) NS\_SwathHeader (Metadata)

NS\_SwathHeader contains metadata for swaths.

**Table 1.2-5 NS\_SwathHeader Group**

Metadata Element	Estimated Size (bytes)	Description
NumberScansInSet	50	The scans read by TKreadScan are a "set". For single swath data, one scan is read so NumberScansInSet=1. For multiple swath data, one TKreadScan may read more than one scan. For example, for SSM/I data one TKreadScan reads one low frequency scan and two high frequency scans. Therefore NumberScansInSet=1 for the low frequency swath and NumberScansInSet=2 for the high frequency swath.
MaximumNumberScansTotal	50	The maximum allowed number of total scans in this swath. Total scans = overlap scans before granule + scans in granule + overlap scans after granule.
NumberScansBeforeGranule	50	The number of overlap scans before the first scan of the granule in this swath.
NumberScansGranule	50	The number of scans in the granule in this swath.
NumberScansAfterGranule	50	The number of overlap scans after the last scan of the granule in this swath.
NumberPixels	50	The number of IFOV in each scan in this swath.
ScanType	50	The type of scan in this swath. Values are: "CROSSTRACK" and "CONICAL"

#### (2) ScanTime (Group in NS)

A UTC time associated with the scan.

##### Year

Type	Array	Unit
2-byte integer	nscan	year

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

##### Month

Type	Array	Unit
1-byte integer	nscan	month

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

##### DayOfMonth

Type	Array	Unit
1-byte integer	nscan	day

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

### Hour

Type	Array	Unit
1-byte integer	nscan	hour

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

### Minute

Type	Array	Unit
1-byte integer	nscan	minute

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

### Second

Type	Array	Unit
1-byte integer	nscan	s

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

### MilliSecond

Type	Array	Unit
2-byte integer	nscan	ms

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:

-9999 Missing value

### DayOfYear

Type	Array	Unit
2-byte integer	nscan	day

Day of the year. Values range from 1 to 366 days. Special values are defined as:

-9999 Missing value

### SecondOfDay

Type	Array	Unit
8-byte float	nscan	s

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

(3) **Latitude**

Type	Array	Unit
4-byte float	nrayNS x nscan	degree

The earth latitude of the center of the IFOV at the altitude of the earth ellipsoid. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

(4) **Longitude**

Type	Array	Unit
4-byte float	nrayNS x nscan	degree

The earth longitude of the center of the IFOV at the altitude of the earth ellipsoid. 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

(5) **scanStatus (Group in NS)**

**dataQuality**

Type	Array	Unit
1-byte integer	nscan	N/A

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**

Type	Array	Unit
1-byte integer	nscan	N/A

Flag of data warning for each scan. Bit Meaning is below

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**

Type	Array	Unit
1-byte integer	nscan	N/A

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

Type	Array	Unit
1-byte integer	nscan	N/A

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 asfar 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

Type	Array	Unit
2-byte integer	nscan	N/A

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

Type	Array	Unit
2-byte integer	nscan	N/A

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

Type	Array	Unit
2-byte integer	nscan	N/A

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**

Type	Array	Unit
2-byte integer	nscan	N/A

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**

Type	Array	Unit
1-byte integer	nscan	N/A

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**

Type	Array	Unit
1-byte integer	nscan	N/A

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**

Type	Array	Unit
1-byte integer	nscan	N/A

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**

Type	Array	Unit
1-byte integer	nscan	N/A

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.

Bit Meaning

- 0 noise power limit error
- 1 binEllipsoid is missing
- 2 Spare (always 0)
- 3 Spare (always 0)
- 4 Spare (always 0)
- 5 Spare (always 0)
- 6 Spare (always 0)
- 7 Spare (always 0)

### FractionalGranuleNumber

Type	Array	Unit
8-byte float	nscan	N/A

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

### (6) navigation (Group in NS)

#### scPos

Type	Array	Unit
4-byte float	XYZ x nscan	m

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

Type	Array	Unit
4-byte float	XYZ x nscan	m/s

The velocity vector ( $\text{ms}^{-1}$ ) 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

Type	Array	Unit
4-byte float	nscan	degrees

The geodetic 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

Type	Array	Unit
4-byte float	nscan	degrees

The geodetic 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**

Type	Array	Unit
4-byte float	nscan	m

The altitude (m) of the spacecraft above the Earth Ellipsoid at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:

-9999.9 Missing value

**dprAlt**

Type	Array	Unit
4-byte float	nscan	m

The altitude (m) of the spacecraft above the Earth Ellipsoid 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**

Type	Array	Unit
4-byte float	nscan	degrees

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**

Type	Array	Unit
4-byte float	nscan	degrees

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**

Type	Array	Unit
4-byte float	nscan	degrees

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**

Type	Array	Unit
4-byte float	nscan	degrees

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**

Type	Array	Unit
4-byte float	nscan	degrees

The geodetic 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**

Type	Array	Unit
4-byte float	nscan	degrees

The geodetic 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**

Type	Array	Unit
4-byte float	nscan	degrees

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**

Type	Array	Unit
8-byte float	nscan	s

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**

Type	Array	Unit
8-byte float	nscan	s

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

### **(7) Input (Group in NS)**

#### **surfaceElevation**

Type	Array	Unit
4-byte float	nrayNS x nscan	m

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**

Type	Array	Unit
4-byte integer	nrayNS x nscan	N/A

Surface type from 2AKu. Special values are defined as:

-9999 Missing value

**localZenithAngle**

Type	Array	Unit
4-byte float	nrayNS x nscan	degree

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**

Type	Array	Unit
4-byte integer	nrayNS x nscan	N/A

Precipitation flag from 2AKu. Special values are defined as:

-9999          Missing value

**surfaceRangeBin**

Type	Array	Unit
2-byte integer	nrayNS x nscan	N/A

Index of the surface range bin from 2AKu. Special values are defined as:

-9999          Missing value

**lowestClutterFreeBin**

Type	Array	Unit
2-byte integer	nrayNS x nscan	N/A

Index of lowest clutter-free bin from 2AKu. Special values are defined as:

-9999          Missing value

**ellipsoidBinOffset**

Type	Array	Unit
4-byte float	nrayNS x nscan	N/A

Offset of surface bin from the earth ellipsoid from 2AKu. Values are in m. Special values are defined as:

-9999.9          Missing value

**stormTopBin**

Type	Array	Unit
2-byte integer	nrayNS x nscan	N/A

Index of storm top bin from 2AKu. Special values are defined as:

-9999 Missing value

**stormTopAltitude**

Type	Array	Unit
4-byte float	nrayNS x nscan	N/A

Altitude of storm top bin from 2AKu. Values are in m. Special values are defined as:

-9999.9 Missing value

**zeroDegBin**

Type	Array	Unit
2-byte integer	nrayNS x nscan	N/A

Range bin of the freezing level. Special values are defined as:

-9999 Missing value

**zeroDegAltitude**

Type	Array	Unit
4-byte float	nrayNS x nscan	m

Altitude of the freezing level. Values are in m. Special values are defined as:

-9999.9 Missing value

**precipitationType**

Type	Array	Unit
4-byte integer	nrayNS x nscan	N/A

Precipitation type classification from 2AKu. Special values are defined as:

-9999 Missing value

**precipTypeQualityFlag**

Type	Array	Unit
4-byte integer	nrayNS x nscan	N/A

Quality flag of precipitation type from 2AKu. Special values are defined as:

-9999 Missing value

**piaEffective**

Type	Array	Unit
4-byte float	nrayNS x nscan	dB

Effective 2-way PIA from 2AKu. Values are in dB. Special values are defined as:

-9999.9 Missing value

**piaEffectiveSigma**

Type	Array	Unit
4-byte float	nrayNS x nscan	dB

Effective PIA uncertainty from 2AKu. Values are in dB. Special values are defined as:

-9999.9          Missing value

**piaEffectiveReliabFlag**

Type	Array	Unit
2-byte integer	nrayNS x nscan	N/A

Reliability flag of effective PIA from 2AKu. Special values are defined as:

-9999          Missing value

(8) **SurfaceAirPressure**

Type	Array	Unit
4-byte float	nrayNS x nscan	hPa

Surface air pressure. Values range from 300 to 1100 hPa. Special values are defined as:

-9999.9          Missing value

(9) **surfaceAirTemperture**

Type	Array	Unit
4-byte float	nrayNS x nscan	K

Surface air temperature. Values range from 150 to 350 K. Special values are defined as:

-9999.9          Missing value

(10) **surfaceVaporDensity**

Type	Array	Unit
4-byte float	nrayNS x nscan	g/m <sup>3</sup>

Surface vapor density. Values range from 0 to 60 g/m<sup>3</sup>. Special values are defined as:

-9999.9          Missing value

(11) **skinTemperature**

Type	Array	Unit
4-byte float	nrayNS x nscan	K

Surface skin temperature. Values range from 150 to 350 K. Special values are defined as:

-9999.9          Missing value



(12) **envParamNode**

Type	Array	Unit
2-byte integer	nBnEnv x nrayNS x nscan	N/A

Bin indices for environmental parameters. Special values are defined as:

-9999 Missing value

(13) **airPressure**

Type	Array	Unit
4-byte float	nBnEnv x nrayNS x nscan	hPa

Air pressure. Values range from 50 to 1100 hPa. Special values are defined as:

-9999.9 Missing value

(14) **airTemperature**

Type	Array	Unit
4-byte float	nBnEnv x nrayNS x nscan	K

Air temperature. Values range from 150 to 350 K. Special values are defined as:

-9999.9 Missing value

(15) **vaporDensity**

Type	Array	Unit
4-byte float	nBnEnv x nrayNS x nscan	$\text{g/m}^3$

Vapor density. Values range from 0 to 60  $\text{g/m}^3$ . Special values are defined as:

-9999.9 Missing value

(16) **cloudLiqWaterCont**

Type	Array	Unit
4-byte float	nBnPSDhi x nrayNS x nscan	$\text{g/m}^3$

Cloud liquid water content. Values range from 0 to 60  $\text{g/m}^3$ . Special values are defined as:

-9999.9 Missing value

(17) **cloudIceWaterCont**

Type	Array	Unit
4-byte float	nBnPSDhi x nrayNS x nscan	$\text{g/m}^3$

Cloud ice water content. Values range from 0 to 18  $\text{g/m}^3$ . Special values are defined as:

-9999.9 Missing value

(18) **phaseBinNodes**

Type	Array	Unit
2-byte integer	nPhsBnN x nrayNS x nscan	N/A

Precipitation phase transition bin nodes. Special values are defined as:

-9999 Missing value

(19) **PSDparamLowNode**

Type	Array	Unit
2-byte integer	nBnPSDlo x nrayNS x nscan	N/A

Bin indices for low-resolution PSD parameters. Special values are defined as:

-9999 Missing value

(20) **PrecipTotPSDparamLow**

Type	Array	Unit
4-byte float	nPSDlo x nBnPSDlo x nrayNS x nscan	Nw_mu

Total precipitation low-resolution PSD parameters. Values are in Nw\_mu. Special values are defined as:

-9999.9 Missing value

(21) **precipTotPSDparamHigh**

Type	Array	Unit
4-byte float	nBnPSDhi x nrayNS x nscan	mm_Dm

Total precipitation high-resolution PSD parameters. Values range from 0 to 20 mm\_Dm. Special values are defined as:

-9999.9 Missing value

(22) **precipTotWaterCont**

Type	Array	Unit
4-byte float	nBnPSDhi x nrayNS x nscan	g/m <sup>3</sup>

Total precipitation liquid water content. Values range from 0 to 18 g/m<sup>3</sup>. Special values are defined as:

-9999.9 Missing value

**(23) precipTotWaterContSigma**

Type	Array	Unit
4-byte float	nBnPSDhi x nrayNS x nscan	g/m <sup>3</sup>

Total precipitation liquid water content uncertainty. Values range from 0 to 18 g/m<sup>3</sup>. Special values are defined as:

-9999.9 Missing value

**(24) precipTotRate**

Type	Array	Unit
4-byte float	nBnPSDhi x nrayNS x nscan	mm/hr

Total precipitation rate. Values range from 0 to 300 mm/hr. Special values are defined as:

-9999.9 Missing value

**(25) precipTotRateSigma**

Type	Array	Unit
4-byte float	nBnPSDhi x nrayNS x nscan	mm/hr

Total precipitation rate uncertainty. Values range from 0 to 300 mm/hr. Special values are defined as:

-9999.9 Missing value

**(26) liqMassFracTrans**

Type	Array	Unit
4-byte float	nBnTr x nrayNS x nscan	N/A

Liquid precipitation mass fraction in phase transition. Values range from 0 to 1. Special values are defined as:

-9999.9 Missing value

**(27) liqRateFracTrans**

Type	Array	Unit
4-byte float	nBnTr x nrayNS x nscan	N/A

Liquid precipitation rate fraction in phase transition. Values range from 0 to 1. Special values are defined as:

-9999.9 Missing value

(28) **surfPrecipTotRate**

Type	Array	Unit
4-byte float	nrayNS x nscan	mm/hr

Surface rain rate. Values range from 0 to 300 mm/hr. Special values are defined as:

-9999.9 Missing value

(29) **surfPrecipTotRateSigma**

Type	Array	Unit
4-byte float	nrayNS x nscan	mm/hr

Surface rain rate uncertainty. Values range from 0 to 300 mm/hr. Special values are defined as:

-9999.9 Missing value

(30) **surfLiqRateFrac**

Type	Array	Unit
4-byte float	nrayNS x nscan	mm/hr

Surface liquid precipitation rate fraction. Values range from 0 to 1 mm/hr. Special values are defined as:

-9999.9 Missing value

(31) **tenMeterWindSpeed**

Type	Array	Unit
4-byte float	nrayNS x nscan	m/s

Ten meter altitude wind speed magnitude. Values range from 0 to 100 m/s. Special values are defined as:

-9999.9 Missing value

(32) **surfEmissivity**

Type	Array	Unit
4-byte float	nemiss x nrayNS x nscan	N/A

GMI emissivities. Values range from 0 to 1. Special values are defined as:

-9999.9 Missing value

(33) **simulatedBrightTemp**

Type	Array	Unit
4-byte float	nemiss x nrayNS x nscan	K

GMI simulated brightness temperatures. Values range from 20 to 350 K. Special values are defined as:

-9999.9 Missing value

(34) **pia**

Type	Array	Unit
4-byte float	nrayNS x nscan	dB

Two-way path-integrated attenuation at Ku. Values range from 0 to 1000 dB. Special values are defined as:

-9999.9 Missing value

**(35) correctedReflectFactor**

Type	Array	Unit
4-byte float	nBnPSDhi x nrayNS x nscan	dBZ

Corrected radar reflectivities at Ku band. Values range from -20 to 100 dBZ. Special values are defined as:

-9999.9 Missing value

**(36) FLG (Group in NS)**

**ioQuality**

Type	Array	Unit
4-byte integer	nrayNS x nscan	N/A

Quality flag for input and output.

0 nominal; data available and valid

1 otherwise

Future version will have more detailed information. Special values are defined as:

-9999 Missing value

### 1.2.2.2 MS (Swath)

#### (1) MS\_SwathHeader (Metadata)

MS\_SwathHeader contains metadata for swaths.

**Table 1.2-6 MS\_SwathHeader Group**

Metadata Element	Estimated Size (bytes)	Description
NumberScansInSet	50	The scans read by TKreadScan are a "set". For single swath data, one scan is read so NumberScansInSet=1. For multiple swath data, one TKreadScan may read more than one scan. For example, for SSM/I data one TKreadScan reads one low frequency scan and two high frequency scans. Therefore NumberScansInSet=1 for the low frequency swath and NumberScansInSet=2 for the high frequency swath.
MaximumNumberScansTotal	50	The maximum allowed number of total scans in this swath. Total scans = overlap scans before granule + scans in granule + overlap scans after granule.
NumberScansBeforeGranule	50	The number of overlap scans before the first scan of the granule in this swath.
NumberScansGranule	50	The number of scans in the granule in this swath.
NumberScansAfterGranule	50	The number of overlap scans after the last scan of the granule in this swath.
NumberPixels	50	The number of IFOV in each scan in this swath.
ScanType	50	The type of scan in this swath. Values are: "CROSSTRACK" and "CONICAL"

#### (2) ScanTime (Group in MS)

##### Year

Type	Array	Unit
2-byte integer	nscan	year

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:  
 -9999 Missing value

##### Month

Type	Array	Unit
1-byte integer	nscan	month

Month of the year. Values range from 1 to 12 months. Special values are defined as:  
 -99 Missing value

##### DayOfMonth

Type	Array	Unit
1-byte integer	nscan	day

Day of the month. Values range from 1 to 31 days. Special values are defined as:  
 -99 Missing value

### Hour

Type	Array	Unit
1-byte integer	nscan	hours

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

### Minute

Type	Array	Unit
1-byte integer	nscan	minutes

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

### Second

Type	Array	Unit
1-byte integer	nscan	s

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

### MilliSecond

Type	Array	Unit
2-byte integer	nscan	ms

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:

-9999 Missing value

### DayOfYear

Type	Array	Unit
2-byte integer	nscan	day

Day of the year. Values range from 1 to 366 days. Special values are defined as:

-9999 Missing value

### SecondOfDay

Type	Array	Unit
8-byte float	nscan	s

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

### (3) Latitude

Type	Array	Unit
4-byte float	nrayMS x nscan	degrees

The earth latitude of the center of the IFOV at the altitude of the earth ellipsoid. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:

-9999.9            Missing value

**(4) Longitude**

Type	Array	Unit
4-byte float	nrayMS x nscan	degrees

The earth longitude of the center of the IFOV at the altitude of the earth ellipsoid. 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

**(5) scanStatus (Group in MS)**

**dataQuality**

Type	Array	Unit
1-byte integer	nscan	N/A

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**

Type	Array	Unit
1-byte integer	nscan	N/A

Flag of data warning for each scan. Bit Meaning is below

Bit Meaning

- 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**

Type	Array	Unit
1-byte integer	nscan	N/A

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**

Type	Array	Unit
1-byte integer	nscan	N/A

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 asfar 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**

Type	Array	Unit
2-byte integer	nscan	N/A

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

Type	Array	Unit
2-byte integer	nscan	N/A

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

Type	Array	Unit
2-byte integer	nscan	N/A

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**

Type	Array	Unit
2-byte integer	nscan	N/A

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**

Type	Array	Unit
1-byte integer	nscan	N/A

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**

Type	Array	Unit
1-byte integer	nscan	N/A

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**

Type	Array	Unit
1-byte integer	nscan	N/A

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**

Type	Array	Unit
1-byte integer	nscan	N/A

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.

Bit Meaning

- 0 noise power limit error
- 1 binEllipsoid is missing
- 2 Spare (always 0)
- 3 Spare (always 0)
- 4 Spare (always 0)
- 5 Spare (always 0)
- 6 Spare (always 0)
- 7 Spare (always 0)

**FractionalGranuleNumber**

Type	Array	Unit
8-byte float	nscan	N/A

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

**(6) navigation (Group in MS)**

**scPos**

Type	Array	Unit
4-byte float	XYZ x nscan	m

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**

Type	Array	Unit
4-byte float	XYZ x nscan	m/s

The velocity vector (ms<sup>-1</sup>) 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**

Type	Array	Unit
4-byte float	nscan	degrees

The geodetic 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**

Type	Array	Unit
4-byte float	nscan	degrees

The geodetic 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**

Type	Array	Unit
4-byte float	nscan	m

The altitude (m) of the spacecraft above the Earth Ellipsoid at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:

-9999.9 Missing value

#### **dprAlt**

Type	Array	Unit
4-byte float	nscan	m

The altitude (m) of the spacecraft above the Earth Ellipsoid 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**

Type	Array	Unit
4-byte float	nscan	degrees

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**

Type	Array	Unit
4-byte float	nscan	degrees

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

Type	Array	Unit
4-byte float	nscan	degrees

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

Type	Array	Unit
4-byte float	nscan	degrees

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

Type	Array	Unit
4-byte float	nscan	degrees

The geodetic 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

Type	Array	Unit
4-byte float	nscan	degrees

The geodetic 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

Type	Array	Unit
4-byte float	nscan	degrees

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**

Type	Array	Unit
8-byte float	nscan	s

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**

Type	Array	Unit
8-byte float	nscan	s

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

**(7) input (Group in MS)**

**surfaceElevation**

Type	Array	Unit
4-byte float	nrayMS x nscan	m

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**

Type	Array	Unit
4-byte integer	nrayMS x nscan	N/A

Surface type from 2ADPR. Special values are defined as:

-9999 Missing value

**localZenithAngle**

Type	Array	Unit
4-byte float	nrayMS x nscan	degrees

Zenith angle of the ray at the earth's surface from 2ADPR. Values are in degrees. Special values are defined as:

-9999.9 Missing value



**precipitationFlag**

Type	Array	Unit
4-byte integer	nKuKa x nrayMS x nscan	N/A

Precipitation flag from 2ADPR (Ku/Ka). Special values are defined as:

-9999            Missing value

**surfaceRangeBin**

Type	Array	Unit
2-byte integer	nKuKa x nrayMS x nscan	N/A

Index of the surface range bin from 2ADPR (Ku/Ka). Special values are defined as:

-9999            Missing value

**lowestClutterFreeBin**

Type	Array	Unit
2-byte integer	nKuKa x nrayMS x nscan	N/A

Index of lowest clutter-free bin from 2ADPR (Ku/Ka). Special values are defined as:

-9999            Missing value

**ellipsoidBinOffset**

Type	Array	Unit
4-byte float	nKuKa x nrayMS x nscan	m

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**

Type	Array	Unit
2-byte integer	nKuKa x nrayMS x nscan	N/A

Index of storm top bin from 2ADPR (Ku/Ka). Special values are defined as:

-9999            Missing value

**stormTopAltitude**

Type	Array	Unit
4-byte float	nKuKa x nrayMS x nscan	m

Altitude of storm top bin from 2ADPR (Ku/Ka). Values are in m. Special values are defined as:

-9999.9          Missing value

**zeroDegBin**

Type	Array	Unit
2-byte integer	nKuKa x nrayMS x nscan	N/A

Range bin of the freezing level. Special values are defined as:

-9999          Missing value

**zeroDegAltitude**

Type	Array	Unit
4-byte float	nrayMS x nscan	m

Altitude of the freezing level. Values are in m. Special values are defined as:

-9999.9          Missing value

**precipitationType**

Type	Array	Unit
4-byte integer	nrayMS x nscan	N/A

Precipitation type classification from 2ADPR. Special values are defined as:

-9999          Missing value

**precipTypeQualityFlag**

Type	Array	Unit
4-byte integer	nrayMS x nscan	N/A

Quality flag of precipitation type from 2ADPR. Special values are defined as:

-9999          Missing value

**piaEffective**

Type	Array	Unit
4-byte integer	nKuKa x nrayMS x nscan	dB

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**

Type	Array	Unit
4-byte float	nKuKa x nrayMS x nscan	dB

Effective PIA uncertainty at Ku band from 2ADPR (Ku/Ka). Values are in dB. Special values are defined as:

-9999.9 Missing value

**piaEffectiveReliabFlag**

Type	Array	Unit
2-byte integer	nKuKa x nrayMS x nscan	N/A

Reliability flag of effective PIA from 2ADPR (Ku/Ka). Special values are defined as:

-9999 Missing value

**(8) surfaceAirPressure**

Type	Array	Unit
4-byte float	nrayMS x nscan	hPa

Surface air pressure. Values range from 300 to 1100 hPa. Special values are defined as:

-9999.9 Missing value

**(9) surfaceAirTemperature**

Type	Array	Unit
4-byte float	nrayMS x nscan	K

Surface air temperature. Values range from 150 to 350 K. Special values are defined as:

-9999.9 Missing value

**(10) surfaceVaporDensity**

Type	Array	Unit
4-byte float	nrayMS x nscan	g/m <sup>3</sup>

Surface vapor density. Values range from 0 to 60 g/m<sup>3</sup>. Special values are defined as:

-9999.9 Missing value

**(11) skinTemperature**

Type	Array	Unit
4-byte float	nrayMS x nscan	K

Surface skin temperature. Values range from 150 to 350 K. Special values are defined as:

-9999.9 Missing value

**(12) envParamNode**

Type	Array	Unit
2-byte integer	nBnEnv x nrayMS x nscan	N/A

Bin indices for environmental parameters. Special values are defined as:

-9999 Missing value

**(13) airPressure**

Type	Array	Unit
4-byte float	nBnEnv x nrayMS x nscan	hPa

Air pressure. Values range from 50 to 1100 hPa. Special values are defined as:

-9999.9 Missing value

**(14) airTemperature**

型	Array	Unit
4-byte float	nBnEnv x nrayMS x nscan	K

Air temperature. Values range from 150 to 350 K. Special values are defined as:

-9999.9 Missing value

**(15) vaporDensity**

Type	Array	Unit
4-byte float	nBnEnv x nrayMS x nscan	$\text{g/m}^3$

Vapor density. Values range from 0 to  $60 \text{ g/m}^3$ . Special values are defined as:

-9999.9 Missing value

**(16) cloudLiqWaterCont**

Type	Array	Unit
4-byte float	nBnPSDhi x nrayMS x nscan	$\text{g/m}^3$

Cloud liquid water content. Values range from 0 to  $60 \text{ g/m}^3$ . Special values are defined as:

-9999.9 Missing value

**(17) cloudIceWaterCont**

Type	Array	Unit
4-byte float	nBnPSDhi x nrayMS x nscan	g/m <sup>3</sup>

Cloud ice water content. Values range from 0 to 18 g/m<sup>3</sup>. Special values are defined as:

-9999.9 Missing value

**(18) phaseBinNodes**

Type	Array	Unit
2-byte integer	nPhsBnN x nrayMS x nscan	N/A

Precipitation phase transition bin nodes. Special values are defined as:

-9999 Missing value

**(19) PSDparamLowNode**

Type	Array	Unit
2-byte integer	nBnPSDlo x nrayMS x nscan	N/A

Bin indices for low-resolution PSD parameters. Special values are defined as:

-9999 Missing value

**(20) precipTotPSDparamLow**

Type	Array	Unit
4-byte float	nPSDlo x nBnPSDlo x nrayMS x nscan	Nw_mu

Total precipitation low-resolution PSD parameters. Values are in Nw\_mu. Special values are defined as:

-9999.9 Missing value

**(21) precipTotPSDparamHigh**

Type	Array	Unit
4-byte float	nBnPSDhi x nrayMS x nscan	mm_Dm

Total precipitation high-resolution PSD parameters. Values range from 0 to 20 mm\_Dm. Special values are defined as:

-9999.9 Missing value

**(22) precipTotWaterCont**

Type	Array	Unit
4-byte float	nBnPSDhi x nrayMS x nscan	g/m <sup>3</sup>

Total precipitation liquid water content. Values range from 0 to 18 g/m<sup>3</sup>. Special values are defined as:  
 -9999.9 Missing value

**(23) precipTotWaterContSigma**

Type	Array	Unit
4-byte float	nBnPSDhi x nrayMS x nscan	g/m <sup>3</sup>

Total precipitation liquid water content uncertainty. Values range from 0 to 18 g/m<sup>3</sup>. Special values are defined as:

-9999.9 Missing value

**(24) precipTotRate**

Type	Array	Unit
4-byte float	nBnPSDhi x nrayMS x nscan	mm/hr

Total precipitation rate. Values range from 0 to 300 mm/hr. Special values are defined as:

-9999.9 Missing value

**(25) precipTotRateSigma**

Type	Array	Unit
4-byte float	nBnPSDhi x nrayMS x nscan	mm/hr

Total precipitation rate uncertainty. Values range from 0 to 300 mm/hr. Special values are defined as:

-9999.9 Missing value

**(26) liqMassFracTrans**

Type	Array	Unit
4-byte float	nBnTr x nrayMS x nscan	N/A

Liquid precipitation mass fraction in phase transition. Values range from 0 to 1. Special values are defined as:

-9999.9 Missing value

**(27) liqRateFracTrans**

Type	Array	Unit
4-byte float	nBnTr x nrayMS x nscan	N/A

Liquid precipitation rate fraction in phase transition. Values range from 0 to 1. Special values are defined as:

-9999.9 Missing value

**(28) surfPrecipTotRate**

Type	Array	Unit
4-byte float	nrayMS x nscan	mm/hr

Surface rain rate. Values range from 0 to 300 mm/hr. Special values are defined as:

-9999.9 Missing value

**(29) surfPrecipTotRateSigma**

Type	Array	Unit
4-byte float	nrayMS x nscan	mm/hr

Surface rain rate uncertainty. Values range from 0 to 300 mm/hr. Special values are defined as:

-9999.9 Missing value

**(30) surfLiqRateFrac**

Type	Array	Unit
4-byte float	nrayMS x nscan	mm/hr

Surface liquid precipitation rate fraction. Values range from 0 to 1 mm/hr. Special values are defined as:

-9999.9 Missing value

**(31) tenMeterWindSpeed**

Type	Array	Unit
4-byte float	nrayMS x nscan	m/s

Ten meter altitude wind speed magnitude. Values range from 0 to 100 m/s. Special values are defined as:

-9999.9 Missing value

**(32) surfEmissivity**

Type	Array	Unit
4-byte float	nemiss x nrayMS x nscan	N/A

GMI emissivities. Values range from 0 to 1. Special values are defined as:

-9999.9 Missing value

**(33) simulatedBrightTemp**

Type	Array	Unit
4-byte float	nemiss x nrayMS x nscan	K

GMI simulated brightness temperatures. Values range from 20 to 350 K. Special values are defined as:

-9999.9 Missing value

**(34) pia**

Type	Array	Unit
4-byte float	nKuKa x nrayMS x nscan	dB

Two-way path-integrated attenuation (Ku/Ka). Values range from 0 to 1000 dB. Special values are defined as:

-9999.9 Missing value

**(35) correctedReflectFactor**

Type	Array	Unit
4-byte float	nKuKa x nBnPSDhi x nrayMS x nscan	dBZ

Corrected radar reflectivities (Ku/Ka). Values range from -20 to 100 dBZ. Special values are defined as:

-9999.9 Missing value

**(36) FLG (Group in MS)**

**ioQuality**

Type	Array	Unit
4-byte integer	nrayMS x nscan	N/A

Quality flag for input and output.

0 nominal; data available and valid

1 otherwise

Future version will have more detailed information. Special values are defined as:

-9999 Missing value



## **2. 3CMB – Combined precipitation**

## 2.1. Data Format Structure

### 2.1.1. Dimension definition

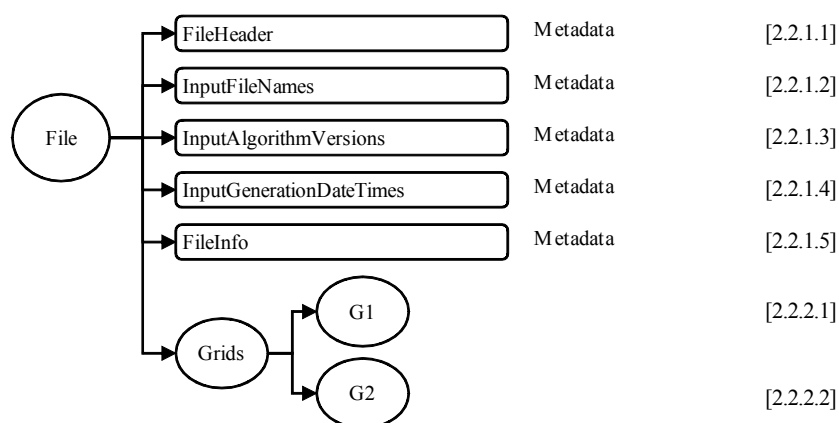
Dimension definitions:

- ltL
  - 28 Number of low resolution 5 degree grid intervals of latitude from 70S to 70N.
- lnL
  - 72 Number of low resolution 5 degree grid intervals of longitude from 180W to 180E.
- ltH
  - 536 Number of high resolution 0.25 degree grid intervals of latitude from 67S to 67N.
- lnH
  - 1440 Number of high resolution 0.25 degree grid intervals of longitude from 180W to 180E.
- 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.

## 2.1.2. Data Format Structure for 3CMB – Combined precipitation

3CMB, "Combined precipitation", computes statistics of the Combined measurements at both a low horizontal resolution (G1, 5 degree x 5 degree latitude/longitude) and a high horizontal resolution (G2, 0.25 degree x 0.25 degree 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.

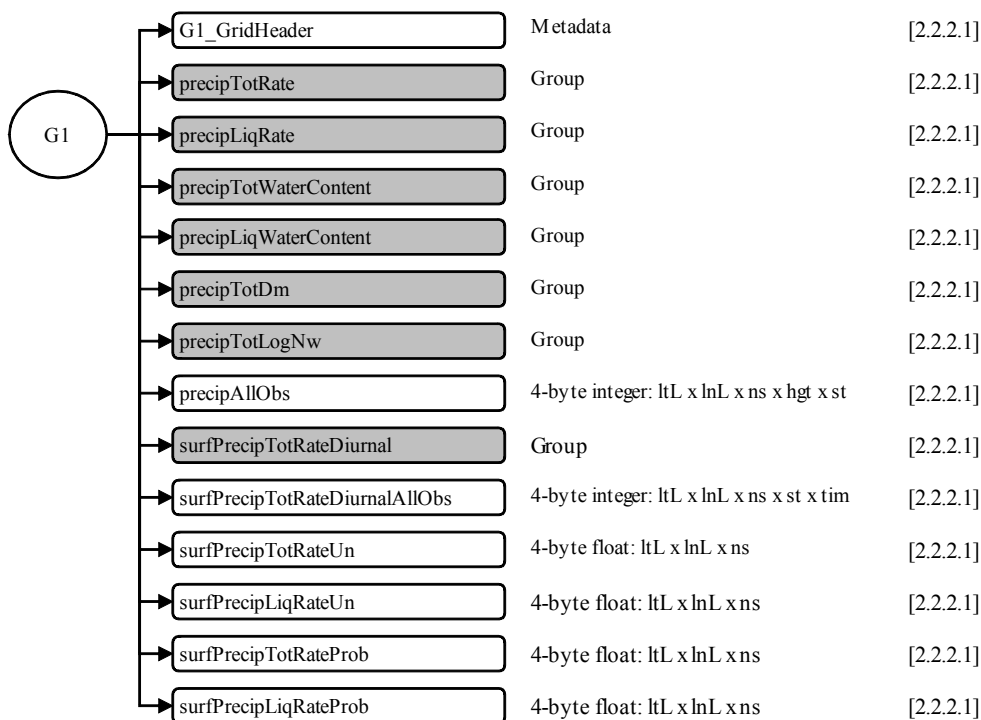


**Figure 2.1-1 Data Format Structure for 3CMB – Combined precipitation**

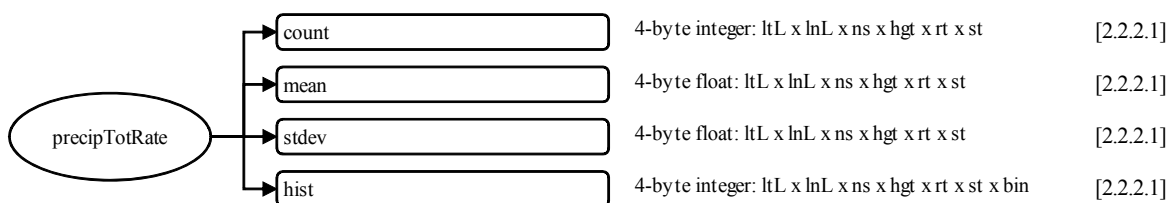
## 2.1.3. Data Format Structure for each Group

### 2.1.3.1 Data Format Structure for G1 Group

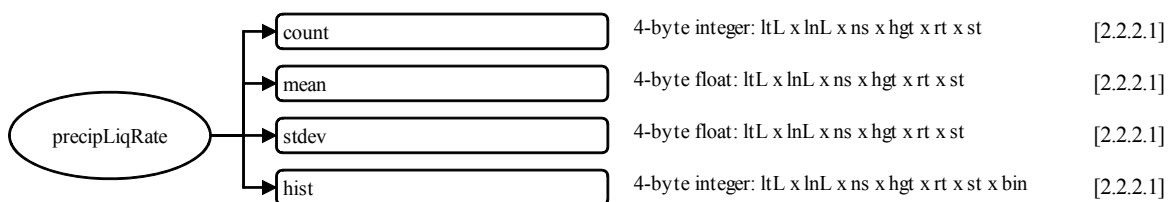
G1 Group's structure is shown in this section.



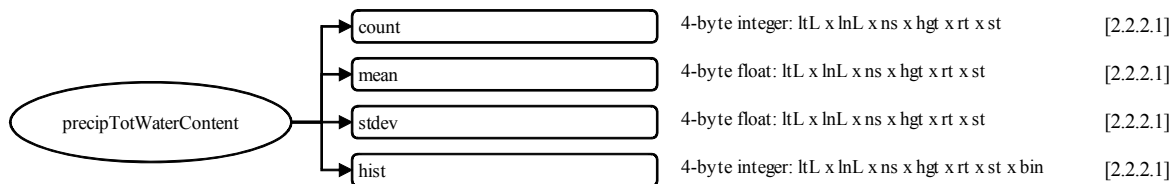
**Figure 2.1-2 Data Format Structure for 3CMB, G1**



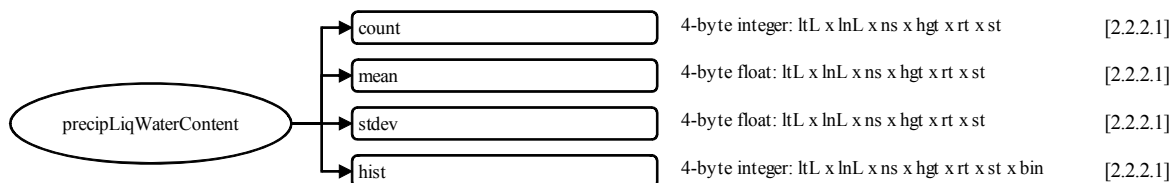
**Figure 2.1-3 Data Format Structure for 3CMB, precipTotRate**



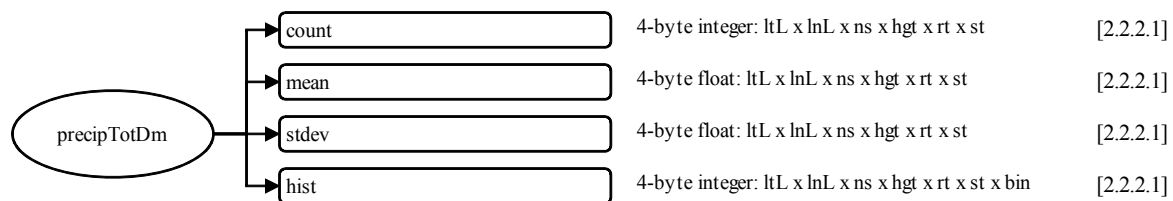
**Figure 2.1-4 Data Format Structure for 3CMB, precipLiqRate**



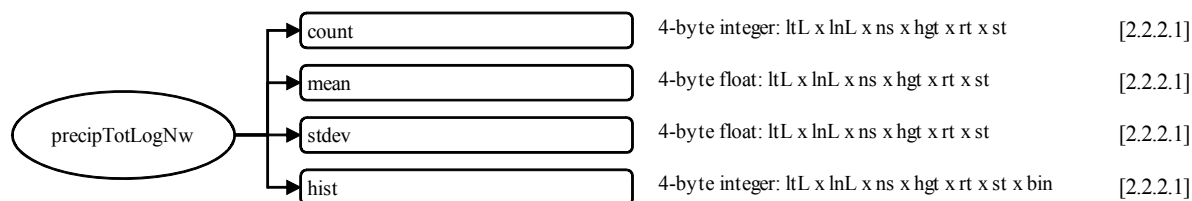
**Figure 2.1-5 Data Format Structure for 3CMB, precipTotWaterContent**



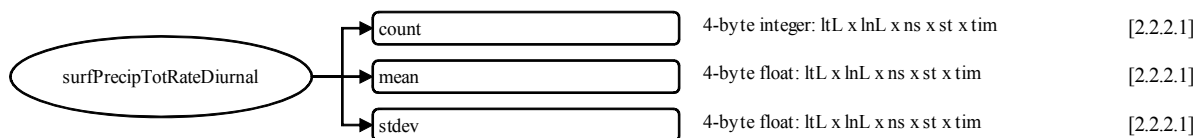
**Figure 2.1-6 Data Format Structure for 3CMB, precipLiqWaterContent**



**Figure 2.1-7 Data Format Structure for 3CMB, precipTotDm**



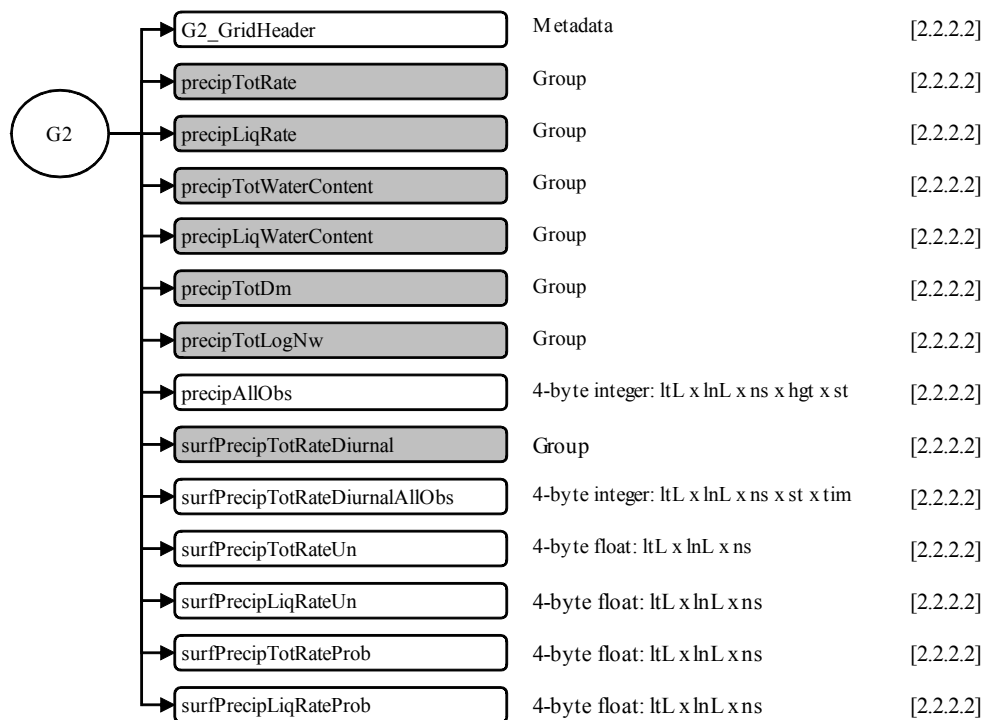
**Figure 2.1-8 Data Format Structure for 3CMB, precipTotLogNw**



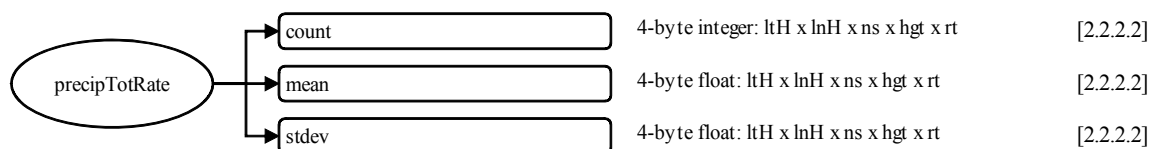
**Figure 2.1-9 Data Format Structure for 3CMB, surfPrecipTotRateDiurnal**

### 2.1.3.2 Data Format Structure for G2 Group

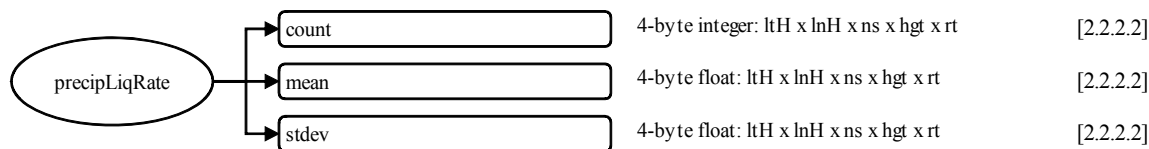
G2 Group's structure is shown in this section.



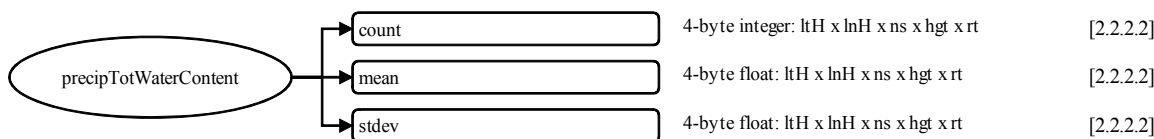
**Figure 2.1-10 Data Format Structure for 3CMB, G2**



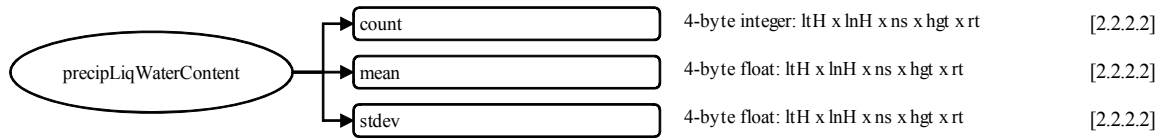
**Figure 2.1-11 Data Format Structure for 3CMB, G2, precipTotRate**



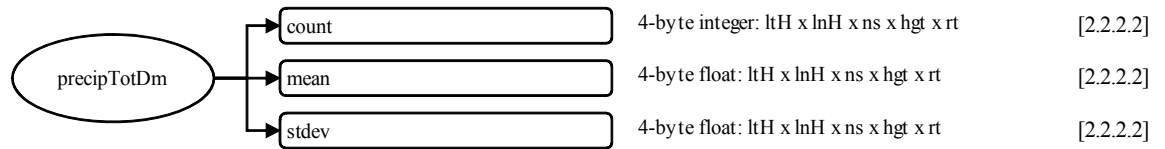
**Figure 2.1-12 Data Format Structure for 3CMB, G2, precipLiqRate**



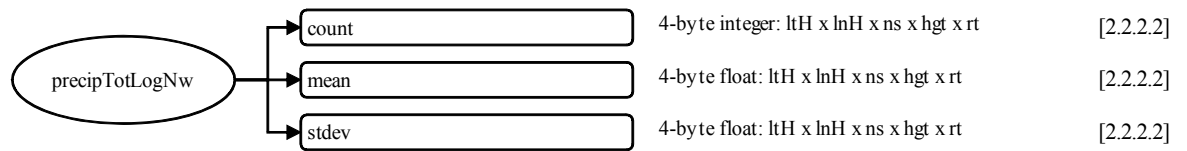
**Figure 2.1-13 Data Format Structure for 3CMB, G2, precipTotWaterContent**



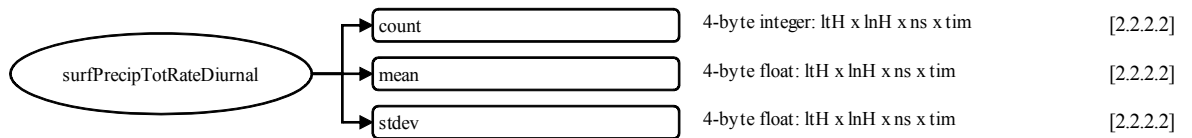
**Figure 2.1-14 Data Format Structure for 3CMB, G2, precipLiqWaterContent**



**Figure 2.1-15 Data Format Structure for 3CMB, G2, precipTotDm**



**Figure 2.1-16 Data Format Structure for 3CMB, G2, precipTotLogNw**



**Figure 2.1-17 Data Format Structure for 3CMB, G2, surfPrecipTotRateDiurnal**

## 2.2. Contents of objects in each Group

### 2.2.1. Metadata

#### 2.2.1.1 FileHeader

FileHeader contains metadata of general interest. Table 2.2-1 shows each metadata elements in FileHeader.

**Table 2.2-1 FileHeader Group**

Metadata Element	Estimated Size (bytes)	Description
DOI	256	Digital Object Identifier
AlgorithmID	50	The algorithm that generated this product, e.g., 2A12.
AlgorithmVersion	50	The version of the algorithm that generated this product.
FileName	50	The file name of this granule.
SatelliteName	10	Values are: TRMM GPM MULTI F10 ... F18 AQUA GCOMW1 CORIOLIS MT1 NOAA15 ... NOAA19 METOPANPP. More values will be added as they are known.
InstrumentName	10	Values are: PR TMI VIRS PRTMI KU KA DPR GMI DPRGMI MERGED SSMI SSMIS AMSRE AMSR2 WIND-SAT MADRAS AMSUA AMSUB SAPHIR MHS ATMS. More values will be added as they are known.
GenerationDateTime	50	The date and time this granule was generated. The format is YYYY-MM-DDTHH:MM:SS.sssZ, where YYYY is 4-digit year, MM is month number, DD is day of month, T is "T", HH is hour, MM is minute, SS is second, sss is millisecond, and Z is "Z". All fields are zero-filled. The missing value is constructed by replacing all digits with 9, i.e., 9999-99-99T99:99:99.999Z
StartGranuleDateTime	50	The start time defining this granule. The format is the same as GenerationDateTime. DETAILS: An orbital granule starts when the satellite is at the position defined by GranuleStart. Thus the start time is not the first scan time. Some algorithms have overlap scans in the file before the start time as defined in SwathHeader. A monthly granule starts on the first ms of the month, for example March 1998 would be 1998-03-01T00:00:00.000Z
StopGranuleDateTime	50	The stop time defining this granule. The format is the same as GenerationDateTime. DETAILS: An orbital granule stops when the satellite is at the position defined by GranuleStart. Thus the stop time is not the last scan time. Some algorithms have overlap scans in the file after the stop time as defined in SwathHeader. A monthly granule stops on the last ms of the month, for example March 1998 would be 1998-03-31T23:59:59.999Z
GranuleNumber	50	The number of this granule, which starts as in GranuleStart. If the GranuleStart is identical to the orbit start, then the GranuleNumber will be the same as the orbit number. The GranuleNumber will have 6 digits, including leading zeroes, for example 001234.
NumberOfSwaths	50	The number of swaths in this granule.
NumberOfGrids	50	The number of grid structures in this granule.
GranuleStart	50	The starting place in the orbit of this granule. Currently defined values are "SOUTHERNMOST LATITUDE" and "NORTHBOUND EQUATOR CROSSING".
TimeInterval	50	The time interval covered by this granule. Values are "ORBIT", "HALF ORBIT", "HALF HOUR", "HOUR", "3 HOUR", "DAY", "MONTH", "CONTACT".
ProcessingSystem	50	The name of the processing system, e.g., "PPS", "JAXA".
ProductVersion	50	The data version assigned by the processing system.
EmptyGranule	50	Whether a granule is empty. Values are "EMPTY" or "NOT EMPTY".
MissingData	50	The number of missing scans.



### 2.2.1.2 InputRecord

InputRecord contains a record of input files for this granule. Table 2.2-2 shows each metadata elements in InputRecord.

**Table 2.2-2 InputRecord Group**

Metadata Element	Estimated Size (bytes)	Description
InputFileName	1000	A list of input file names for this granule.
InputAlgorithmVersions	1000	A list of algorithm versions of the input files for this granule.
InputGenerationDateTimes	1000	A list of generation date times of the input files for this granule. The format is the same as GenerationDateTime.

### 2.2.1.3 InputAlgorithmVersions

InputAlgorithmVersions contains a list of input algorithm versions for this granule. Since some algorithms may have 2000 input files, this group is a "Long Metadata Group", which has no elements.

### 2.2.1.4 InputGenerationDataTimes

InputGenerationDateTimes contains a list of input generation datetimes for this granule. Since some algorithms may have 2000 input files, this group is a "Long Metadata Group", which has no elements.

### 2.2.1.5 FileInfo

FileInfo contains metadata used by the PPS I/O Toolkit. Table 2.2-3 shows each metadata elements in FileInfo.

**Table 2.2-3 FileInfo Group**

Metadata Element	Estimated Size (bytes)	Description
DataFormatVersion	50	The version of the data format used to write this file. This version is separate for each AlgorithmID. The order is: "a" "b" ... "z" "aa" "ab" ... "az" "ba" "bb" ...
TKCodeBuildVersion	50	Usually TK CodeBuildVersion is "1". If the I/O routines built by TKIO change even though the DataFormatVersion is unchanged, then TK CodeBuildVersion increments to "2", "3", ... If subsequently DataFormatVersion changes, TKCodeBuildVersion becomes "1" again.
MetadataVersion	50	The version of metadata used to write this file. This version is separate for each AlgorithmID. The order is: "a" "b" ... "z" "aa" "ab" ... "az" "ba" "bb" ...
FormatPackage	50	The underlying format of this granule. Values are "HDF4", "HDF5", "NETCDF", "TKBINARY"
BlueprintFilename	50	The filename of the primary blueprint file that defined the format used to write this file.
BlueprintVersion	10	The BlueprintVersion of the format definition
TKIOVersion	50	The version of TKIO used to create I/O routines to write this file. TKIOVersion does not define the format used to write this file.
MetadataStyle	50	The style in which the metadata was written, e.g., "PVL". "PVL" means < parameter >=< value >;
EndianType	50	The endian type of the system that wrote this file. Values are "BIG ENDIAN" and "LITTLE ENDIAN".

## 2.2.2. Data Group

Elements of data group are explained in detail in this section.

### 2.2.2.1 G1 (Group)

#### (1) G1\_GridHeader (Metadata)

G1\_GridHeader contains metadata defining the grids in the grid structure.

**Table 2.2-4 G1\_GridHeader Group**

Metadata Element	Estimated Size (bytes)	Description
BinMethod	50	Method used to obtain the value in each grid box. The only defined value is "ARITHMEAN".
Registration	50	Representative location within the grid box. The only defined value is "CENTER".
LatitudeResolution	50	North-south size of a bin (degrees latitude).
LongitudeResolution	50	East-west size of a bin (degrees longitude).
NorthBoundingCoordinate	50	Northern-most latitude (degrees) covered by the grid.
SouthBoundingCoordinate	50	Southern-most latitude (degrees) covered by the grid.
EastBoundingCoordinate	50	Eastern-most longitude (degrees) covered by the grid.
WestBoundingCoordinate	50	Western-most longitude (degrees) covered by the grid.
Origin	50	Origin of the grid indices, e.g., "SOUTHWEST".

#### (2) 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

Type	Array	Unit
4-byte integer	ltL x lnL x ns x hgt x rt x st	N/A

Count. Special values are defined as:

-9999                      Missing value

##### mean

Type	Array	Unit
4-byte float	ltL x lnL x ns x hgt x rt x st	N/A

mean. Special values are defined as:

-9999.9                      Missing value

**stdev**

Type	Array	Unit
4-byte float	ltL x lnL x ns x hgt x rt x st	N/A

Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:

-9999.9      Missing value

**hist**

Type	Array	Unit
4-byte integer	ltL x lnL x ns x hgt x rt x st x bin	N/A

Histogram. Special values are defined as:

-9999      Missing value

**(3) 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**

Type	Array	Unit
4-byte integer	ltL x lnL x ns x hgt x rt x st	N/A

Count. Special values are defined as:

-9999      Missing value

**mean**

Type	Array	Unit
4-byte float	ltL x lnL x ns x hgt x rt x st	N/A

mean. Special values are defined as:

-9999.9      Missing value

**stdev**

Type	Array	Unit
4-byte integerfloat	ltL x lnL x ns x hgt x rt x st	N/A

Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:

-9999.9 Missing value

**hist**

Type	Array	Unit
4-byte integer	ltL x lnL x ns x hgt x rt x st x bin	N/A

Histogram. Special values are defined as:

-9999 Missing value

**(4) precipTotWaterContent (Group in G1)**

Equivalent water content of both liquid-phase and ice-phase precipitating water ( $\text{g/m}^3$ ). (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**

Type	Array	Unit
4-byte integer	ltL x lnL x ns x hgt x rt x st	N/A

Count. Special values are defined as:

-9999 Missing value

**mean**

Type	Array	Unit
4-byte float	ltL x lnL x ns x hgt x rt x st	N/A

mean. Special values are defined as:

-9999.9 Missing value

**stdev**

Type	Array	Unit
4-byte float	ltL x lnL x ns x hgt x rt x st	N/A

Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:

-9999.9 Missing value

**hist**

Type	Array	Unit
4-byte integer	ltL x lnL x ns x hgt x rt x st x bin	N/A

Histogram. Special values are defined as:

-9999            Missing value

**(5) precipLiqWaterContent (Group in G1)**

Equivalent water content of liquid-phase precipitating water ( $\text{g/m}^3$ ). (Note: liquid can be in the form of rain or liquid water in mixed-phase particles.)

**count**

Type	Array	Unit
4-byte integer	ltL x lnL x ns x hgt x rt x st	N/A

Count. Special values are defined as:

-9999            Missing value

**mean**

Type	Array	Unit
4-byte float	ltL x lnL x ns x hgt x rt x st	N/A

mean. Special values are defined as:

-9999.9        Missing value

**stdev**

Type	Array	Unit
4-byte float	ltL x lnL x ns x hgt x rt x st	N/A

Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:

-9999.9        Missing value

**hist**

Type	Array	Unit
4-byte integer	ltL x lnL x ns x hgt x rt x st x bin	N/A

Histogram. Special values are defined as:

-9999 Missing value

**(6) precipTotDm (Group in G1)**

Volume-weighted mean of the liquid-equivalent precipitation particle diameter (mm).

**count**

Type	Array	Unit
4-byte integer	ltL x lnL x ns x hgt x rt x st	N/A

Count. Special values are defined as:

-9999 Missing value

**mean**

Type	Array	Unit
4-byte float	ltL x lnL x ns x hgt x rt x st	N/A

mean. Special values are defined as:

-9999.9 Missing value

**stdev**

Type	Array	Unit
4-byte float	ltL x lnL x ns x hgt x rt x st	N/A

Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:

-9999.9 Missing value

**hist**

Type	Array	Unit
4-byte integer	ltL x lnL x ns x hgt x rt x st x bin	N/A

Histogram. Special values are defined as:

-9999 Missing value

**(7) precipTotLogNw (Group in G1)**

Common logarithm of the intercept of the normalized gamma distribution representing the liquid-equivalent precipitation particle size distribution ( $\log_{10}(m-4)$ ).

**count**

Type	Array	Unit
4-byte integer	ltL x lnL x ns x hgt x rt x st	N/A

Count. Special values are defined as:

-9999 Missing value

**mean**

Type	Array	Unit
4-byte float	ltL x lnL x ns x hgt x rt x st	N/A

mean. Special values are defined as:

-9999.9 Missing value

**stdev**

Type	Array	Unit
4-byte float	ltL x lnL x ns x hgt x rt x st	N/A

Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:

-9999.9 Missing value

**hist**

Type	Array	Unit
4-byte integer	ltL x lnL x ns x hgt x rt x st x bin	N/A

Histogram. Special values are defined as:

-9999 Missing value

**(8) precipAllObs**

Type	Array	Unit
4-byte integer	ltL x lnL x ns x hgt x st	N/A

Number of total observations, whether precipitating or not. Special values are defined as:

-9999 Missing value

**(9) 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**

Type	Array	Unit
4-byte integer	ltL x lnL x ns x st x tim	N/A

Count. Special values are defined as:

-9999 Missing value

**mean**

Type	Array	Unit
4-byte float	ltL x lnL x ns x st x tim	N/A

mean. Special values are defined as:

-9999.9 Missing value

**stdev**

Type	Array	Unit
4-byte float	ltL x lnL x ns x st x tim	N/A

Standard deviation for the monthly product. Mean of squares for the daily product.

Special values are defined as:

-9999.9 Missing value

**(10) surfPrecipTotRateDiurnalAllObs**

Type	Array	Unit
4-byte integer	ltL x lnL x ns x st x tim	N/A

Number of total diurnal observations, whether precipitating or not. Special values are defined as:

-9999 Missing value

**(11) surfPrecipTotRateUn**

Type	Array	Unit
4-byte float	ltL x lnL x ns	N/A

Surface total precipitation rate unconditioned. To obtain rate conditioned on precipitation, divide by the probability. Special values are defined as:

-9999.9 Missing value



**(12) surfPrecipLiqRateUn**

Type	Array	Unit
4-byte float	ltL x lnL x ns	N/A

Surface liquid precipitation rate unconditioned. To obtain rate conditioned on precipitation, divide by the probability. Special values are defined as:

-9999.9 Missing value

**(13) surfPrecipTotRateProb**

Type	Array	Unit
4-byte float	ltL x lnL x ns	N/A

Probability of total surface precipitation. Special values are defined as:

-9999.9 Missing value

**(14) surfPrecipLiqRateProb**

Type	Array	Unit
4-byte float	ltL x lnL x ns	N/A

Probability of liquid surface precipitation. Special values are defined as:

-9999.9 Missing value

**2.2.2.2 G2 (Group)****(1) G2\_GridHeader (Metadata)**

G2\_GridHeader contains metadata defining the grids in the grid structure.

**Table 2.2-5 G2\_GridHeader Group**

Metadata Element	Estimated Size (bytes)	Description
BinMethod	50	Method used to obtain the value in each grid box. The only defined value is "ARITHMEAN".
Registration	50	Representative location within the grid box. The only defined value is "CENTER".
LatitudeResolution	50	North-south size of a bin (degrees latitude).
LongitudeResolution	50	East-west size of a bin (degrees longitude).
NorthBoundingCoordinate	50	Northern-most latitude (degrees) covered by the grid.
SouthBoundingCoordinate	50	Southern-most latitude (degrees) covered by the grid.
EastBoundingCoordinate	50	Eastern-most longitude (degrees) covered by the grid.
WestBoundingCoordinate	50	Western-most longitude (degrees) covered by the grid.
Origin	50	Origin of the grid indices, e.g., "SOUTHWEST".

**(2) 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**

Type	Array	Unit
4-byte integer	ltH x lnH x ns x hgt x rt	N/A

Count. Special values are defined as:

-9999 Missing value

**mean**

Type	Array	Unit
4-byte float	ltH x lnH x ns x hgt x rt	N/A

mean. Special values are defined as:

-9999.9 Missing value

**stdev**

Type	Array	Unit
4-byte float	ltH x lnH x ns x hgt x rt	N/A

Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:

-9999.9 Missing value

**(3) 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**

Type	Array	Unit
4-byte integer	ltH x lnH x ns x hgt x rt	N/A

Count. Special values are defined as:

-9999 Missing value

**mean**

Type	Array	Unit
4-byte float	ltH x lnH x ns x hgt x rt	N/A

mean. Special values are defined as:

-9999.9 Missing value

**stdev**

Type	Array	Unit
4-byte float	ltH x lnH x ns x hgt x rt	N/A

Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:

-9999.9          Missing value

**(4) precipTotWaterContent (Group in G2)**

Equivalent water content of both liquid-phase and ice-phase precipitating water ( $\text{g/m}^3$ ). (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**

Type	Array	Unit
4-byte integer	ltH x lnH x ns x hgt x rt	N/A

Count. Special values are defined as:

-9999          Missing value

**mean**

Type	Array	Unit
4-byte float	ltH x lnH x ns x hgt x rt	N/A

mean. Special values are defined as:

-9999.9          Missing value

**stdev**

Type	Array	Unit
4-byte float	ltH x lnH x ns x hgt x rt	N/A

Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:

-9999.9          Missing value

**(5) precipLiqWaterContent (Group in G2)**

Equivalent water content of liquid-phase precipitating water ( $\text{g/m}^3$ ). (Note: liquid can be in the form of rain or liquid water in mixed-phase particles.)

**count**

Type	Array	Unit
4-byte integer	ltH x lnH x ns x hgt x rt	N/A

Count. Special values are defined as:

-9999            Missing value

**mean**

Type	Array	Unit
4-byte float	ltH x lnH x ns x hgt x rt	N/A

mean. Special values are defined as:

-9999.9        Missing value

**stdev**

Type	Array	Unit
4-byte float	ltH x lnH x ns x hgt x rt	N/A

Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:

-9999.9        Missing value

**(6) precipTotDm (Group in G2)**

Volume-weighted mean of the liquid-equivalent precipitation particle diameter (mm).

**count**

Type	Array	Unit
4-byte integer	ltH x lnH x ns x hgt x rt	N/A

Count. Special values are defined as:

-9999            Missing value

**mean**

Type	Array	Unit
4-byte float	ltH x lnH x ns x hgt x rt	N/A

mean. Special values are defined as:

-9999.9        Missing value

**stdev**

Type	Array	Unit
4-byte float	ltH x lnH x ns x hgt x rt	N/A

Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:

-9999.9          Missing value

**(7) precipTotLogNw (Group in G2)**

Common logarithm of the intercept of the normalized gamma distribution representing the liquid-equivalent precipitation particle size distribution ( $\log_{10}(m-4)$ ).

**count**

Type	Array	Unit
4-byte integer	ltH x lnH x ns x hgt x rt	N/A

Count. Special values are defined as:

-9999          Missing value

**mean**

Type	Array	Unit
4-byte float	ltH x lnH x ns x hgt x rt	N/A

mean. Special values are defined as:

-9999.9          Missing value

**stdev**

Type	Array	Unit
4-byte float	ltH x lnH x ns x hgt x rt	N/A

Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:

-9999.9          Missing value

**(8) precipAllObs**

Type	Array	Unit
4-byte integer	ltH x lnH x ns x hgt	N/A

Number of total observations, whether precipitating or not. Special values are defined as:

-9999 Missing value

### (9) 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

Type	Array	Unit
4-byte integer	ltH x lnH x ns x tim	N/A

Count. Special values are defined as:

-9999 Missing value

#### mean

Type	Array	Unit
4-byte float	ltH x lnH x ns x tim	N/A

mean. Special values are defined as:

-9999.9 Missing value

#### stdev

Type	Array	Unit
4-byte float	ltH x lnH x ns x tim	N/A

Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:

-9999.9 Missing value

### (10) surfPrecipTotRateDiurnalAllObs

Type	Array	Unit
4-byte integer	ltH x lnH x ns x tim	N/A

Number of total diurnal observations, whether precipitating or not. Special values are defined as:

-9999 Missing value

**(11) surfPrecipTotRateUn**

Type	Array	Unit
4-byte float	ltH x lnH x ns	N/A

Surface total precipitation rate unconditioned. To obtain rate conditioned on precipitation, divide by the probability. Special values are defined as:

-9999.9 Missing value

**(12) surfPrecipLiqRateUn**

Type	Array	Unit
4-byte float	ltH x lnH x ns	N/A

Surface liquid precipitation rate unconditioned. To obtain rate conditioned on precipitation, divide by the probability. Special values are defined as:

-9999.9 Missing value

**(13) surfPrecipTotRateProb**

Type	Array	Unit
4-byte float	ltH x lnH x ns	N/A

Probability of total surface precipitation. Special values are defined as:

-9999.9 Missing value

**(14) surfPrecipLiqRateProb**

Type	Array	Unit
4-byte float	ltH x lnH x ns	N/A

Probability of liquid surface precipitation. Special values are defined as:

-9999.9 Missing value

### **3. 3GCSH–Gridded Orbital Convective Stratiform Heating from Combined**



## 3.1. Data Format Structure

### 3.1.1. Dimension definition

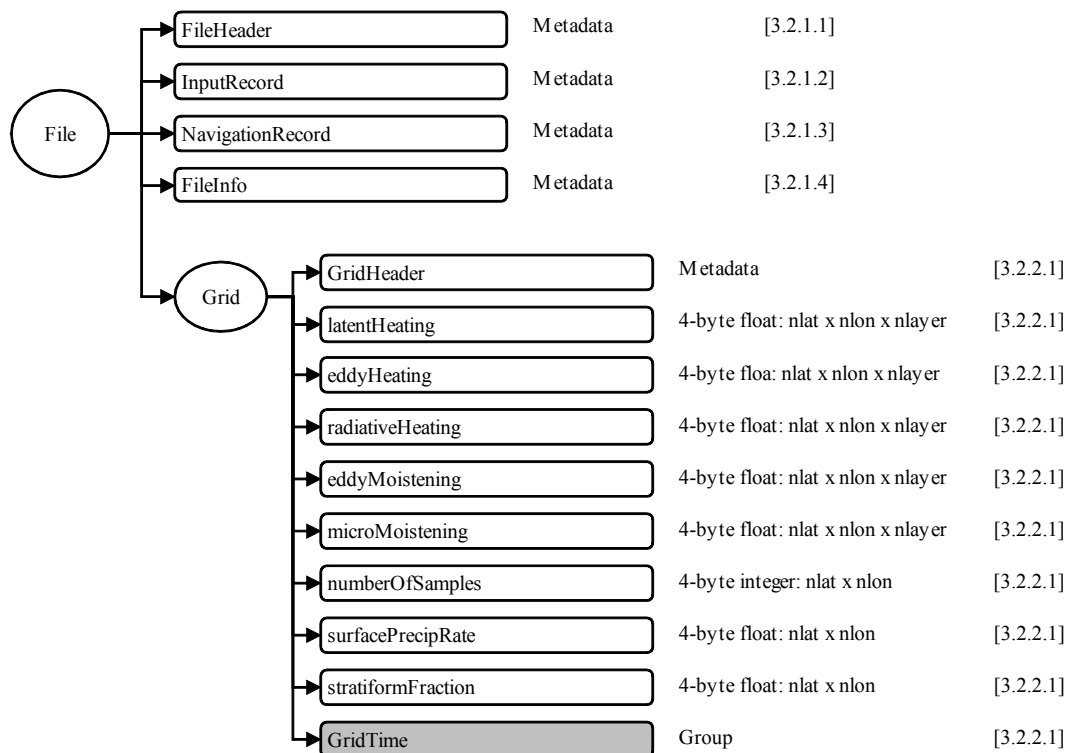
Dimension definitions:

- nlat
  - 536 Number of 0.25° grid intervals of latitude from 67°N to 67°S
- nlon
  - 1440 Number of 0.25° grid intervals of longitude from 180°W to 180°E
- nlayer
  - 19 Number of layers at the fixed heights of 0.0-0.5km, 0.5-1km, 1-2km, ..., 17-18km

### 3.1.2. Data format Structure for 3GCSH - Gridded Orbital Convective Stratiform Heating from Combined

3GCSH “Gridded Orbital Convective Stratiform Heating from Combined”, produces 0.25°x0.25°orbital apparent heating profiles from surface convective rainfall rate and surface stratiform rainfall rate. Thr PI is Dr. Wei-Kuo Tao. The granule size is one orbit.

The following sections describe the structure and contents of the format.

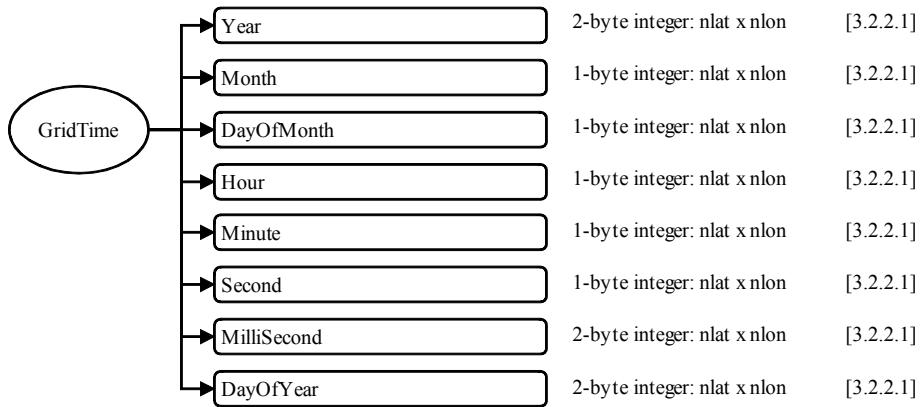


**Figure 3.1-1 Data Format Structure for 3GCSH, Gridded Orbital Convective Stratiform Heating from Combined**

### 3.1.3. Data Format Structure for each Group

#### 3.1.3.1 Data Format Structure for GridTime

GridTime is shown in this section.



**Figure 3.1-2 Data Format Structure 3GCSH GridTime**

## 3.2. Contents of objectives in each Group

### 3.2.1. Metadata

#### 3.2.1.1 FileHeader

FileHeader contains metadata of general interest. Table 3.2-1 shows each metadata element in FileHeader.

**Table 3.2-1 FileHeader Group**

Metadata Element	Estimated Size (bytes)	Description
DOI	256	Digital Object Identifier
AlgorithmID	50	The algorithm that generated this product, e.g., 2A12.
AlgorithmVersion	50	The version of the algorithm that generated this product.
FileName	50	The file name of this granule.
SatelliteName	10	Values are: TRMM GPM MULTI F10 ... F18 AQUA GCOMW1 CORIOLIS MT1 NOAA15 ... NOAA19 METOPANPP. More values will be added as they are known.
InstrumentName	10	Values are: PR TMI VIRS PRTMI KU KA DPR GMI DPRGMI MERGED SSMI SSMIS AMSRE AMSR2 WIND-SAT MADRAS AMSUA AMSUB SAPHIR MHS ATMS. More values will be added as they are known.
GenerationDateTime	50	The date and time this granule was generated. The format is YYYY-MM-DDTHH:MM:SS.sssZ, where YYYY is 4-digit year, MM is month number, DD is day of month, T is "T", HH is hour, MM is minute, SS is second, sss is millisecond, and Z is "Z". All fields are zero-filled. The missing value is constructed by replacing all digits with 9, i.e., 9999-99-99T99:99:99.999Z
StartGranuleDateTime	50	The start time defining this granule. The format is the same as GenerationDateTime. DETAILS: An orbital granule starts when the satellite is at the position defined by GranuleStart. Thus the start time is not the first scan time. Some algorithms have overlap scans in the file before the start time as defined in SwathHeader. A monthly granule starts on the first ms of the month, for example March 1998 would be 1998-03-01T00:00:00.000Z
StopGranuleDateTime	50	The stop time defining this granule. The format is the same as GenerationDateTime. DETAILS: An orbital granule stops when the satellite is at the position defined by GranuleStart. Thus the stop time is not the last scan time. Some algorithms have overlap scans in the file after the stop time as defined in SwathHeader. A monthly granule stops on the last ms of the month, for example March 1998 would be 1998-03-31T23:59:59.999Z
GranuleNumber	50	The number of this granule, which starts as in GranuleStart. If the GranuleStart is identical to the orbit start, then the GranuleNumber will be the same as the orbit number. The GranuleNumber will have 6 digits, including leading zeroes, for example 001234.
NumberOfSwaths	50	The number of swaths in this granule.
NumberOfGrids	50	The number of grid structures in this granule.
GranuleStart	50	The starting place in the orbit of this granule. Currently defined values are "SOUTHERNMOST LATITUDE" and "NORTHBOUND EQUATOR CROSSING".
TimeInterval	50	The time interval covered by this granule. Values are "ORBIT", "HALF ORBIT", "HALF HOUR", "HOUR", "3 HOUR", "DAY", "MONTH", "CONTACT".
ProcessingSystem	50	The name of the processing system, e.g., "PPS", "JAXA".
ProductVersion	50	The data version assigned by the processing system.
EmptyGranule	50	Whether a granule is empty. Values are "EMPTY" or "NOT EMPTY".
MissingData	50	The number of missing scans.

### 3.2.1.2 InputRecord

InputRecord contains a record of input files for this granule. Table 3.2-2 shows each metadata elements in InputRecord.

**Table 3.2-2 InputRecord Group**

Metadata Element	Estimated Size (bytes)	Description
InputFileName	1000	A list of input file names for this granule.
InputAlgorithmVersions	1000	A list of algorithm versions of the input files for this granule.
InputGenerationDateTimes	1000	A list of generation date times of the input files for this granule. The format is the same as GenerationDateTime.

### 3.2.1.3 NavigationRecord

NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for detail. Table 2.2-3 shows each metadata elements in NavigationRecord.

**Table 3.2-3 NavigationRecord Group**

Metadata Element	Estimated Size (bytes)	Description
LongitudeOnEquator	50	The longitude where the satellite crosses the equator going from south to north.
UTCDateTimeOnEquator	50	The UTC time when the satellite crosses the equator going from south to north. The format is the same as GenerationDate Time.
MeanSolarBetaAngle	50	The average solar beta angle in this granule.
EphemerisFileName	50	Name of the ephemeris file input for processing.
AttitudeFileName	50	Name of the attitude file input for processing.
GeoControlFileName	50	Name of the GeoTK Control Parameters File input for processing.
EphemerisSource	50	Values are "0 CONSTANT INPUT TEST VALUE", "1 GROUND ESTIMATED STATE (GES)", "2 GPS FILTERED SOLUTION (GEONS)", "3 GPS POINT SOLUTION (PVT)", "4 ON BOARD PROPAGATED (OBP)", "5 OEM GROUND EPHEMERIS FILE", "6 GEONS WITH FALLBACK AS FLAGGED", "7 PVT WITH FALLBACK AS FLAGGED", "8 OBP WITH FALLBACK AS FLAGGED", "9 GES WITH FALLBACK AS FLAGGED"
AttitudeSource	50	Values are "0 CONSTANT INPUTS FOR TESTING", "1 ON BOARD CALCULATED PITCH ROLL YAW"
GeoToolkitVersion	50	Version of the GeoToolkit
SensorAlignmentFirstRotationAngle	50	Alignment angle, first rotation, in degrees. Rotation adjustment from sensor coordinates to the Attitude Control System Flight Coordinates.
SensorAlignmentSecondRotationAngle	50	Alignment angle, second rotation, in degrees.
SensorAlignmentThirdRotationAngle	50	Alignment angle, third rotation, in degrees.
SensorAlignmentFirstRotationAxis	50	Euler rotation sequence, first rotation axis. Values are "1", "2", "3" (representing X, Y, Z).
SensorAlignmentSecondRotationAxis	50	Euler rotation sequence, second rotation axis. Values are "1", "2", "3" (representing X, Y, Z).
SensorAlignmentThirdRotationAxis	50	Euler rotation sequence, third rotation axis. Values are "1", "2", "3" (representing X, Y, Z).

### 3.2.1.4 FileInfo

FileInfo contains metadata used by the PPS I/O Toolkit. Table 3.2-4 shows each metadata elements in FileInfo.

**Table 3.2-4 FileInfo Group**

Metadata Element	Estimated Size (bytes)	Description
DataFormatVersion	50	The version of the data format used to write this file. This version is separate for each AlgorithmID. The order is: "a" "b" ... "z" "aa" "ab" ... "az" "ba" "bb" ...
TKCodeBuildVersion	50	Usually TK CodeBuildVersion is "1". If the I/O routines built by TKIO change even though the DataFormatVersion is unchanged, then TK CodeBuildVersion increments to "2", "3", ... If subsequently DataFormatVersion changes, TKCodeBuildVersion becomes "1" again.
MetadataVersion	50	The version of metadata used to write this file. This version is separate for each AlgorithmID. The order is: "a" "b" ... "z" "aa" "ab" ... "az" "ba" "bb" ...
FormatPackage	50	The underlying format of this granule. Values are "HDF4", "HDF5", "NETCDF", "TKBINARY"
BlueprintFilename	50	The filename of the primary blueprint file that defined the format used to write this file.
BlueprintVersion	10	The BlueprintVersion of the format definition
TKIOVersion	50	The version of TKIO used to create I/O routines to write this file. TKIOVersion does not define the format used to write this file.
MetadataStyle	50	The style in which the metadata was written, e.g., "PVL". "PVL" means < parameter >=< value >;
EndianType	50	The endian type of the system that wrote this file. Values are "BIG ENDIAN" and "LITTLE ENDIAN".

### 3.2.2. Data Group

Elements of data group are explained in detail in this section.

From March 2016, 3GCSH - Gridded Orbital Convective Stratiform Heating from Combined data is released. The elements of data format of 3GCSH is shown in the Table below are explained in 3.2.2.1 Grid (Group), (2)~(10).

#### 3GSLH - Gridded Orbital Convective Stratiform Heating from Combined Data Format Group Name 1: Grid

Group Name 2	Element [array]	Missing	Min	Max	unit	type
N/A	latenHeating [19][1440][536]	-9999.9	-50	100	K/hr	4-byte float
	eddyHeating [19][1440][536]	-9999.9	-50	100	K/hr	4-byte float
	radiativeHeating [19][1440][536]	-9999.9	-50	100	K/hr	4-byte float
	eddyMoistening	-9999.9	-50	100	K/hr	4-byte

Group Name 2	Element [array]	Missing	Min	Max	unit	type
	[19][1440][536]					float
	microMoistening [19][1440][536]	-9999.9	-50	100	K/hr	4-byte float
	numberOfSamples [1440][536]	-9999	0	500000		4-byte integer
	surfacePrecipRate [1440][536]	-9999.9	0	3000	mm/hr	4-byte float
	stratiformFraction [1440][536]	-9999.9	0	1		4-byte float
Gridtime	Year [720][268]	-9999	1950	2100	years	2-byte integer
	Month [720][268]	-99	1	12	months	1-byte integer
	DayOfMonth [720][268]	-99	1	31	days	1-byte integer
	Hour [720][268]	-99	0	23	hours	1-byte integer
	Minute [720][268]	-99	0	59	minutes	1-byte integer
	Second [720][268]	-99	0	60	s	1-byte integer
	MilliSecond [720][268]	-9999	0	999	ms	2-byte integer
	DayOfYear [720][268]	-9999	1	366	days	2-byte integer

### 3.2.2.1 Grid (Group)

#### (1) GridHeader (Metadata)

GridHeader contains metadata defining the grids in the grid structure.

**Table 3.2-5 GridHeader Group**

Metadata Element	Estimated Size (bytes)	Description
BinMethod	50	Method used to obtain the value in each grid box. The only defined value is "ARITHMEAN".
Registration	50	Representative location within the grid box. The only defined value is "CENTER".
LatitudeResolution	50	North-south size of a bin (degrees latitude).
LongitudeResolution	50	East-west size of a bin (degrees longitude).
NorthBoundingCoordinate	50	Northern-most latitude (degrees) covered by the grid.
SouthBoundingCoordinate	50	Southern-most latitude (degrees) covered by the grid.
EastBoundingCoordinate	50	Eastern-most longitude (degrees) covered by the grid.
WestBoundingCoordinate	50	Western-most longitude (degrees) covered by the grid.
Origin	50	Origin of the grid indices, e.g., "SOUTHWEST".

**(2) latentHeating**

Type	Array	Unit
4-byte float	nlat x nlon x nlayer	K/hr

Latent heating. Values range from -50 to 100 K/hr.

-9999.9: Missing value

**(3) eddyHeating**

Type	Array	Unit
4-byte float	nlat x nlon x nlayer	K/hr

Eddy flux heating. Values range from -50 to 100 K/hr.

-9999.9: Missing value

**(4) radiativeHeating**

Type	Array	Unit
4-byte float	nlat x nlon x nlayer	K/hr

Radiative heating. Values range from -50 to 100 K/hr.

-9999.9: Missing value

**(5) eddyMoistening**

Type	Array	Unit
4-byte float	nlat x nlon x nlayer	K/hr

Apparent moistening due to eddy processes. Values range from -50 to 100 K/hr.

-9999.9: Missing value

**(6) microMoistening**

Type	Array	Unit
4-byte float	nlat x nlon x nlayer	K/hr

Apparent moistening due to eddy processes. Values range from -50 to 100 K/hr.

-9999.9: Missing value

**(7) numberOfSamples**

Type	Array	Unit
4-byte integer	nlat x nlon	N/A

Number of samples in  $0.25^\circ \times 0.25^\circ$  boxes. Values range from 0 to 500000.



-9999: Missing value

**(8) surfacePrecipRate**

Type	Array	Unit
4-byte integer float	nlat x nlon	mm/hr

Mean estimated surface precipitation rate from Level 2 Combined. Values range from 0 to 3000 mm/hr.

-9999.9: Missing value

**(9) stratiformFraction**

Type	Array	Unit
4-byte float	nlat x nlon	N/A

Ratio of stratiform to total surface rain rate from Level 2 PR. Values range from 0 to 1.

-9999.9: Missing value

**(10) GridTime (Group)**

**Year**

Type	Array	Unit
2-byte integer	nscan	year

4-digit year (e.g., 1998). Values range from 1950 to 2100 years.

-9999: Missing value

**Month**

Type	Array	Unit
1-byte integer	nscan	months

Month of the year. Values range from 1 to 12 months.

-99: Missing value

**DayOfMonth**

Type	Array	Unit
1-byte integer	nscan	days

Day of the month. Values range from 1 to 31 days.

-99: Missing value

**Hour**

Type	Array	Unit
1-byte integer	nscan	hours

UTC hour of the day. Values range from 0 to 23 hours.

-99: Missing value

### Minute

Type	Array	Unit
1-byte integer	nscan	minuits

Minute of the hour. Values range from 0 to 59 Minuits.

-99: Missing value

### Second

Type	Array	Unit
1-byte integer	nscan	s

Second of the minuite. Values range from 0 to 60 s.

-99: Missing value

### MilliSecond

Type	Array	Unit
2-byte integer	nscan	ms

Thousandths of the second. Values range from 0 to 999 ms.

-99: Missing value

### DayOfYear

Type	Array	Unit
2-byte integer	nscan	day

Day of the year. Values range from 1 to 366 days.

-99: Missing value

### SecondOfDay

Type	Array	Unit
8-byte float	nscan	s

A time associated with the scan. scanTime sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s.

-9999.9: Missing value

## **4. 3HCSH – Monthly Convective Stratiform Heating from Combined**

## 4.1. Data Format Structure

### 4.1.1. Dimension definition

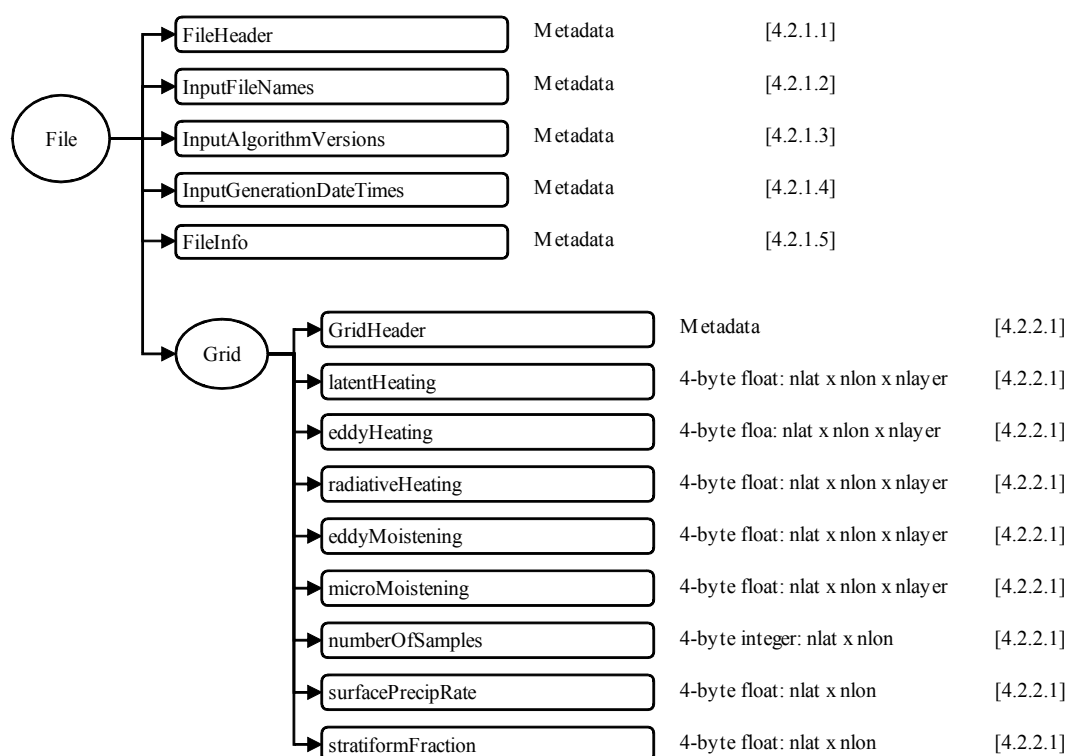
Dimension definitions:

- nlat
  - 536 Number of 0.25° grid intervals of latitude from 67°N to 67°S.
- nlon
  - 1440 Number of 0.25° grid intervals of longitude from 180°W to 180°S.
- nlayer
  - 19 Number of layers at 0.0-0.5km, 0.5-1km, 1-2km, ..., 17-18km.

### 4.1.2. Data Format Structure of 3HCSH – Monthly Convective Stratiform Heating from Combined

3HCSH, “Monthly Convective Stratiform Heating from Combined”, produces  $0.25^\circ \times 0.25^\circ$  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.



**Figure 4.1-1 Data Format Structure of  
3HCSH - Monthly Convective Stratiform Heating from Combined**

## 4.2. Contents of objectives in each Group

### 4.2.1. Metadata

#### 4.2.1.1 FileHeader

FileHeader contains metadata of general interest. This group appears in all data products. Table 4.2-1 shows each metadata elements in FileHeader.

**Table 4.2-1 FileHeader Group**

Element	Data size (bytes)	Description
DOI	256	Digital Object Identifier with DOIauthority and DOIshortName.
AlgorithmID	50	The algorithm that generated this product, e.g., 2A12.
AlgorithmVersion	50	The version of the algorithm that generated this product.
FileName	50	The file name of this granule.
SatelliteName	10	Values are: TRMM GPM MULTI F10 ... F18 AQUAGCOMW1 CORIOLIS MT1 NOAA15 ... NOAA19 METOPANPP. More values will be added as they are known.
InstrumentName	10	Values are: PR TMI VIRS PRTMI KU KA DPR GMIDPRGMI MERGED SSMI SSMIS AMSRE AMSR2 WINDSATMADRAS AMSUA AMSUB SAPHIR MHS ATMS. More values will be added as they are known.
GenerationDateTime	50	The date and time this granule was generated. The format is YYYY-MM-DDTHH:MM:SS.sssZ, where YYYY is 4-digit year, MM is month number, DD is day of month, T is "T", HH is hour, MM is minute, SS is second, sss is millisecond, and Z is "Z". All fields are zero-filled. The missing value is constructed by replacing all digits with 9, i.e., 9999-99-99T99:99:99.999Z.
StartGranuleDateTime	50	The start time defining this granule. The format is the same as GenerationDateTime. DETAILS: An orbital granule starts when the satellite is at the position defined by GranuleStart. Thus the start time is not the first scan time. Some algorithms have overlap scans in the file before the start time as defined in SwathHeader. A monthly granule starts on the first ms of the month, for example March 1998 would be 1998-03-01T00:00:00.000Z.
StopGranuleDateTime	50	The stop time defining this granule. The format is the same as GenerationDateTime. DETAILS: An orbital granule stops when the satellite is at the position defined by GranuleStart. Thus the stop time is not the last scan time. Some algorithms have overlap scans in the file after the stop time as defined in SwathHeader. A monthly granule stops on the last ms of the month, for example March 1998 would be 1998-03-31T23:59:59.999Z.
GranuleNumber	50	The number of this granule, which starts as in GranuleStart. If the GranuleStart is identical to the orbit start, then the GranuleNumber will be the same as the orbit number. The GranuleNumber will have 6 digits, including leading zeroes, for example 001234.
NumberOfSwaths	50	The number of swaths in this granule.
NumberOfGrids	50	The number of grid structures in this granule.
GranuleStart	50	The starting place in the orbit of this granule. Currently defined values are "SOUTHERNMOST LATITUDE" and "NORTHBOUND EQUATOR CROSSING".
TimeInterval	50	The time interval covered by this granule. Values are "ORBIT", "HALF ORBIT", "HALF HOUR", "HOUR", "3 HOUR", "DAY", "DAY ASC", "DAY DES", "MONTH", "CONTACT".
ProcessingSystem	50	The name of the processing system, e.g., "PPS", "JAXA".
ProductVersion	50	The data version assigned by the processing system.
EmptyGranule	50	Whether a granule is empty. Values are "EMPTY" or "NOT EMPTY".
MissingData	50	The number of missing scans.

### 4.2.1.2 InputFileNames

InputFileNames contains a list of input file names for this granule. Since some algorithms may have 2000 input files, this group is a “Long Metadata Group”, which has no elements. This group appears in Level 3 time averaged products.

### 4.2.1.3 InputAlgorithmVersions

InputAlgorithmVersions contains a list of input algorithm versions for this granule. Since some algorithms may have 2000 input files, this group is a “Long Metadata Group”, which has no elements. This group appears in Level 3 time averaged products.

### 4.2.1.4 InputGenerationDateTimes

InputGenerationDateTimes contains a list of input generation datetimes for this granule. Since some algorithms may have 2000 input files, this group is a “Long Metadata Group”, which has no elements. This group appears in Level 3 time averaged products.

### 4.2.1.5 FileInfo

FileInfo contains metadata used by the PPS I/O Toolkit. This group appears in all data products. Table 4.2-2 shows each metadata elements in FileInfo.

**Table 4.2-2 FileInfo Group**

Element	Data size (bytes)	Description
DataFormatVersion	50	The version of the data format used to write this file. This version is separate for each AlgorithmID. The order is: "a" "b" ... "z" "aa" "ab" ... "az" "ba" "bb".
TKCodeBuildVersion	50	Usually TK CodeBuildVersion is "1". If the I/O routines built by TKIO change even though the DataFormatVersion is unchanged, then TK CodeBuildVersion increments to "2", "3", ... If subsequently DataFormatVersion changes, TKCodeBuildVersion becomes "1" again.
MetadataVersion	50	The version of metadata used to write this file. This version is separate for each AlgorithmID. The order is: "a" "b" ... "z" "aa" "ab" ... "az" "ba" "bb" ...
FormatPackage	50	The underlying format of this granule. Values are "HDF4", "HDF5", "NETCDF", "TKBINARY".
BlueprintFilename	50	The filename of the primary blueprint file that defined the format used to write this file.
BlueprintVersion	10	The BlueprintVersion of the format definition.
TKIOVersion	50	The version of TKIO used to create I/O routines to write this file. TKIOVersion does not define the format used to write this file.
MetadataStyle	50	The style in which the metadata was written, e.g., "PVL". "PVL" means < parameter >=< value >.
EndianType	50	The endian type of the system that wrote this file. Values are "BIG ENDIAN" and "LITTLE ENDIAN".

## 4.2.2. Data Group

Elements of data group are explained in detail in this section.

From March 2016, new product of 3HCSH “Monthly Convective Stratiform Heating from Combined” is available for users. Data format structure is introduced in following table, as the Group Name 1: Grid. 8 elements are introduced in 4.2.2.1 Grid (Group) (2)~(9).

### 3HCSH Gridded Orbital Convective Stratiform Heating from Combined

#### Group Name 1: Grid

Group Name 2	Elements [array]	Missing Value	Min	Max	unit	type
N/A	latentHeating [19][1440][536]	-9999.9	-50	100	K/hr	4-byte float
	eddyHeating [19][1440][536]	-9999.9	-50	100	K/hr	4-byte float
	radiativeHeating [19][1440][536]	-9999.9	-50	100	K/hr	4-byte float
	eddyMoistening [19][1440][536]	-9999.9	-50	100	H/hr	4-byte float
	microMoistening [19][1440][536]	-9999.9	-50	100	K/hr	4-byte float
	numberOfSamples [1440][536]	-9999.9	0	500000		4-byte integer
	surfacePrecipRate [1440][536]	-9999.9	0	3000	mm/hr	4-byte float
	stratiformFraction [1440][536]	-9999.9	0	1		4-byte float

### 4.2.2.1 Grid (Group)

#### (1) GridHeader (Metadata)

GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

**Table 4.2-3 GridHeader Elements**

No	Element	Description	Data size (bytes)
1	BinMethod	Method used to obtain the value in each grid box. The only defined value is "ARITHMEAN".	50
2	Registration	Representative location within the grid box. The only defined value is "CENTER".	50
3	LatitudeResolution	North-south size of a bin (degrees latitude).	50



4.2. Contents of objectives in each Group

4.2.2. Data Group

4.2.2.1. Grid (Group)

No	Element	Description	Data size (bytes)
4	LongitudeResolution	East-west size of a bin (degrees longitude).	50
5	NorthBoundingCoordinate	Northern-most latitude (degrees) covered by the grid.	50
6	SouthBoundingCoordinate	Southern-most latitude (degrees) covered by the grid.	50
7	EastBoundingCoordinate	Eastern-most longitude (degrees) covered by the grid.	50
8	WestBoundingCoordinate	Western-most longitude (degrees) covered by the grid.	50
9	Origin	Origin of the grid indices, e.g., "SOUTHWEST".	50

(2) **latentHeating**

Type	Array	Unit
4-byte float	nlat x nlon x nlayer	K/hr

Latent heating. Values range from -50 to 100 K/hr.

-9999.9: Missing value

(3) **eddyHeating**

Type	Array	Unit
4-byte float	nlat x nlon x nlayer	K/h

Eddy flux heating. Values range from -50 to 100 K/h.

-9999.9: Missing value

(4) **radiativeHeating**

Type	Array	Unit
4-byte float	nlat x nlon x nlayer	K/hr

Radiative heating. Value range from -50 to 100 K/hr.

-9999.9: Missing value

(5) **eddyMoistening**

Type	Array	Unit
4-byte float	nlat x nlon x nlayer	K/hr

Apparent moistening due to microphysical processes. Value range from -50 to 100 K/hr.

-9999.9: Missing value

**(6) microMoistening**

Type	Array	Unit
4-byte float	nlat x nlon x nlayer	K/hr

Apparent moistening due to microphysical processes. Value range from -50 to 100 K/hr.

-9999.9: Missing value

**(7) numberOfSamples**

Type	Array	Unit
4-byte integer	nlat x nlon	N/A

Number of samples in  $0.25^\circ \times 0.25^\circ$  boxes. Values range from 0 to 500000.

-9999: Missing value

**(8) surfacePrecipRate**

Type	Array	Unit
4-byte float	nlat x nlon	mm/hr

Mean estimated surface precipitation rate from Level 2 Combined. Value range from 0 to 3000 mm/hr.

-9999.9: Missing value

**(9) stratiformFraction**

Type	Array	Unit
4-byte float	nlat x nlon	N/A

Ratio stratiform to total surface rain rate from Level 2 PR. Values range from 0 to 1.

-9999.9: Missing value

---

# **Index**

---

## **A**

acsModeMidScan .....	20, 39
airPressure .....	29, 48
airTemperature .....	29, 48
AlgorithmRuntimeInfo .....	13

---

## **B**

BinMethod .....	92
-----------------	----

---

## **C**

cloudIceWaterCont .....	29, 49
cloudLiqWaterCont .....	29, 48
correctedReflectFactor .....	33, 52
count62, 63, 64, 65, 66, 67, 68, 70, 71, 72, 73, 74	

---

## **D**

dataQuality .....	17, 36
dataWarning .....	17, 36
DayOfMonth .....	15, 34, 85
DayOfYear .....	16, 35, 86
dprAlt .....	23, 42

---

## **E**

EastBoundingCoordinate .....	93
eddyHeating .....	84, 93
eddyMoistening .....	84, 93
ellipsoidBinOffset .....	26, 45
envParamNode .....	29, 48

---

## **F**

FileHeader .....	12, 60, 80, 90
FileInfo .....	14, 61, 82, 91
FLG .....	33, 52
FractionalGranuleNumber .....	22, 40

---

## **G**

G1 .....	62
G1_GridHeader .....	62
G2 .....	69
G2_GridHeader .....	69
geoError .....	18, 37
geoWarning .....	19, 38
greenHourAng .....	24, 43
Grid .....	83, 92
GridHeader .....	83, 92
GridTime .....	85

---

## **H**

hist .....	63, 64, 65, 66, 67
Hour .....	16, 35, 85

---

## **I**

input .....	44
Input .....	25
InputAlgorithmVersioins .....	61
InputAlgorithmVersions .....	91
InputFileNames .....	91
InputGenerationDataTimes .....	61
InputGenerationDateTimes .....	91
InputRecord .....	13, 61, 81
ioQuality .....	33, 52

---

## **L**

latentHeating .....	84, 93
Latitude .....	17, 35
LatitudeResolution .....	92
limitErrorFlag .....	21, 40
liqMassFracTrans .....	31, 50
liqRateFracTrans .....	31, 51
localZenithAngle .....	26, 44
Longitude .....	36

---

LongitudeResolution.....	93
lowestClutterFreeBin .....	26, 45

---

## *M*

mean62, 63, 64, 65, 66, 67, 68, 70, 71, 72, 73, 74	
microMoistening .....	84, 94
MilliSecond .....	16, 35, 86
Minute .....	16, 35, 86
missing.....	17, 36
modeStatus .....	18, 37
Month .....	15, 34, 85
MS.....	34
MS_SwathHeader.....	34

---

## *N*

navigation.....	22, 41
NavigationRecord.....	13, 81
NorthBoundingCoordinate .....	93
NS .....	15
NS_SwathHeader .....	15
numberOfSamples.....	84, 94

---

## *O*

operationalMode .....	21, 40
Origin .....	93

---

## *P*

phaseBinNodes .....	30, 49
pia .....	32, 52
piaEffective .....	27, 46
piaEffectiveReliabFlag.....	28, 47
piaEffectiveSigma .....	28, 47
pointingStatus .....	20, 39
precipAllObs.....	67, 73
precipitationFlag .....	26, 45
precipitationType .....	27, 46
precipLiqRate .....	63, 70
precipLiqWaterContent .....	65, 71
precipTotDm.....	66, 72

precipTotLogNw.....	66, 73
precipTotPSDparamHigh .....	30, 49
precipTotPSDparamLow .....	49
PrecipTotPSDparamLow .....	30
precipTotRate.....	31, 50, 62, 69
precipTotRateSigma.....	31, 50
precipTotWaterCont .....	30, 50
precipTotWaterContent.....	64, 71
precipTotWaterContSigma.....	31, 50
precipTypeQualityFlag.....	27, 46
PSDparamLowNode .....	30, 49

---

## *R*

radiativeHeating .....	84, 93
Registration.....	92

---

## *S*

scAlt.....	23, 41
scanStatus .....	17, 36
ScanTime .....	15, 34
scAttPitchGeoc .....	23, 42
scAttPitchGeod.....	24, 43
scAttRollGeoc .....	23, 42
scAttRollGeod.....	24, 43
scAttYawGeoc .....	24, 43
scAttYawGeod .....	24, 43
scLat.....	22, 41
scLon.....	22, 41
SCorientation .....	19, 38
scPos .....	22, 41
scVel .....	22, 41
Second.....	16, 35, 86
SecondOfDay .....	16, 35, 86
simulatedBrightTemp .....	32, 52
skinTemperature .....	28, 47
SouthBoundingCoordinate .....	93
stdev.....	63, 64, 65, 66, 67, 68, 70, 71, 72, 73, 74
stormTopAltitude.....	27, 45
stormTopBin .....	26, 45
stratiformFraction .....	85, 94
surfaceAirPressure .....	47

---

SurfaceAirPressure .....	28
surfaceAirTemperature .....	47
surfaceAirTemperture .....	28
surfaceElevation.....	25, 44
surfacePrecipRate.....	85, 94
surfaceRangeBin .....	26, 45
surfaceType .....	25, 44
surfaceVaporDensity.....	28
surfEmissivity .....	32, 51
surfLiqRateFrac .....	32, 51
surfPrecipLiqRateProb.....	69, 75
surfPrecipLiqRateUn .....	69, 75
surfPrecipTotRate.....	32, 51
surfPrecipTotRateDiurnal.....	67, 74
surfPrecipTotRateDiurnalAllObs.....	68, 74
surfPrecipTotRateProb .....	69, 75
surfPrecipTotRateSigma.....	32, 51
surfPrecipTotRateUn .....	68, 75

---

## *T*

targetSelectionMidScan .....	20, 39
------------------------------	--------

tenMeterWindSpeed.....	32, 51
timeMidScan .....	25, 44
timeMidScanOffset .....	25, 44

---

## *V*

vaporDensity .....	29, 48
--------------------	--------

---

## *W*

WestBoundingCoordinate.....	93
-----------------------------	----

---

## *Y*

Year.....	15, 34
-----------	--------

---

## *Z*

zeroDegAltitude .....	27, 46
zeroDegBin .....	27, 46