EarthCARE/CPR Level 1b
Product Definition Document

Feb 2017

Japan Aerospace Exploration Agency
(JAXA)

Change Record

Issue	Date	Sheet	Description of Change
draft 1	Jun, 2011	All	First issue
draft 2	Jun, 2012	1.2 3.2 4.1 4.3	Update the documents. Update unit of products. Update EarthCARE CPR Level 1b Product file name. Update EarthCARE/CPR L1b Product File Format.
Draft 3	Nov, 2012	3.2 4.1 4.2	Update the “unit of product” in Product List. Update the File Naming Convention. Update the “ScienceDataBlock“
draft 4	Mar, 2013	3.3 3.4 3.5 3.6 3.7 4	Add the sections described about the product. Update corresponding to baseline documents (1).
draft 5	Sep, 2013	1.2. 2.1. 3. Table 4.1-1 4.3.	Update the baseline document. Add the description about operation mode. Reconstruct this chapter. Update the naming convention Add the new parameters and change “Name” in some parameters.
draft 6	Dec, 2013	3.4. 3.3. 4.2 4.3.	Add the quality definition. Update the definition of frame start/end in L1b product. Update the HDF library’s version. Add the new parameters and change “Name” in some parameters. -- ・”CPRParameterVersion” in “L1SpecificProductHeader” is merged in “rayHeaderCalVers” in “Data”. ・” procResult” in “L1SpecificProductHeader” is merged in “dataQuality” in “Data”.

Issue	Date	Sheet	Description of Change
draft 7	Aug, 2014	Title	Update the title.
		1.2	Update the baseline document.
		3.2	Update compressed rule and Table3.2-2 additional information.
		3.3.1	Update the definition of frame start/end in L1b product.
		3.3.2	Add the new section “Location information”.
		3.4.1	Update the name of flags.
		4.2	Update version of HDF5.
		4.3	Add the definition of dimension. Update the Table 4.3-2.
draft 8	Oct, 2014	3.3.2.	Add the figure of ray center position
		3.4.1	Update the flag definition.
		4.3.1	Update the definition of profile time.
draft 9	Dec, 2014	3.2	Add “Valid observed height range” in Table3.2-2.
		4.3.1.	Add “solar elevation angle” and “solar azimuth angle”.
NC	Jan, 2015	All	Establish the document
A draft1	Mar, 2015	1.3	Add “Term Definition”.
		Table 3.3-1	Update the orbit image.
		Table 3.3-2	Update the description of overlaps.
		4.2	Update the HDF library’s version.
		Table4.3-2	Update the description of “File_Name” and “inputFileName”. Update the examples of “File_Description” and “File_Class”. Update the description of “calibrationParametersQuality”. Update the description of “firstLineFirstSampleCoord” to “lastLineLastSampleCoord”. Remove “mdsDescriptionVector” group. Update the description of “navigationLandSeaFlg”.
A	Dec, 2015	1.2	Update “Baseline Documents.”
		1.3	Update “Term Definition”.
		4.1	Update “File Naming Convention”.
		4.2, 4.3	Update the data structure.
		Table4.3-2	Add “binHeight” Swap array order from “nbin,nray” to “nray,nbin”.
		Appendix	Add ”Appendix”

Issue	Date	Sheet	Description of Change
B draft1	Mar 2016	1.2 4.2, 4.3 Table4.3-2	Update “Baseline Documents.” Update the data structure. Update the name and value of “validrange” attribute.
B	Feb 2017	Figure 2.1-1 Table2.1-1 Table 3.2-2 Table4.2-1 Table4.3-2 Appendix	Update the observation window. Update the observation window. Update the name of “ScienceDataBlock” and “L1SpecificProductHeader” to “ScienceData” and “SpecificProductHeader”. Add open points by finding the inconsistency with File Format Standard.

Contents

1. Introduction

1.1. Outline

The purpose of this document is to specify the format and content of the L1 products for EarthCARE/CPR. The targets of this document are the L1 product released in public.

JAXA EarthCARE/CPR data processing system processes CPR Level 0 data into Level 1b products.

1.2. Baseline Documents

Following documents give the baseline for the design of products.

(1) EarthCARE Products Definitions Volume 1 - Common Products Definitions (EC.ICD.ASD.SY.00005 issue 8)

(2) EarthCARE Cloud Profiling Radar (CPR) Level 1b Algorithm Theoretical Basis Document (L1b ATBD)(SEC-140039)

(3) Earth Observation Mission CFI Software GENERAL SOFTWARE USER MANUAL(EO-MA-DMS-GS-0003 Issue4.7)

(4) EarthCARE Cloud Profiling Radar (CPR) Science Telemetry Source Packet Definition (SEC-080015G)

1.3. Term Definition

No	Term	Definition
1	pps	Pulse Per Second; This is the timing signal from the spacecraft to the CPR used for on-board time synchronization.
2	control cycle	This is the unit of controlling and processing cycle of CPR which is one second and contains 14 rays of observation data.

2. EarthCARE/CPR Overview

2.1. Cloud Profiling Radar (CPR) Overview

The CPR which will be the first space-borne millimeter radar with Doppler velocity measurement capability and will be the most sensitive cloud profiling radar in orbit has been developed by Japanese agencies (JAXA and NICT). The CPR implements a 2.5 mφ large reflector and high power transmitter and will be able to detect -35 dBZ cloud.

Figure 2.1-1 shows the operation image of the CPR nominal operation. The CPR will change the observation window (basically 16 km in high latitude area and 20 km in middle and low latitude area) and change the PRF to make effective cloud observation. The vertical resolution of product is 500 m. The footprint is less than 1 km, and its horizontal resolution (integration length) is 500 m. The horizontal resolution of product is 765 m (cross-track), 840 m (along-track).

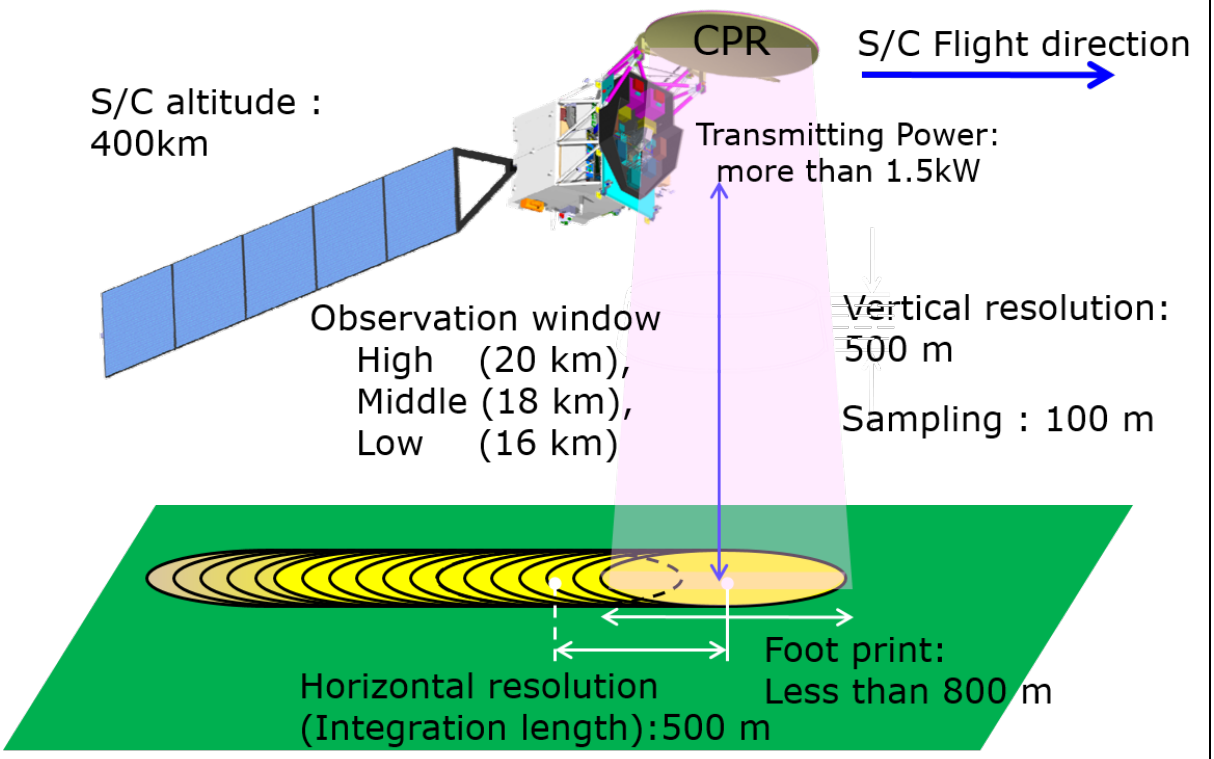

Figure 2.1-1 CPR observation overview

There are three calibrations considered for the CPR. The first one is the internal calibration for signal processing unit which will be processed electrically and this calibration needs to stop the observations. The second one is the sea surface calibration which will be performed to calibrate RF performance and to get normalized radar cross section. This calibration shall be performed wide sea area like those shown in Figure 2.1-2. The third one is the external calibration which will be performed using ground based radar calibrator. Antenna pattern measurement, RF performance measurement and Doppler velocity measurement will be verified by this calibration. This calibration is currently planned when the EarthCARE spacecraft flies over Japan.

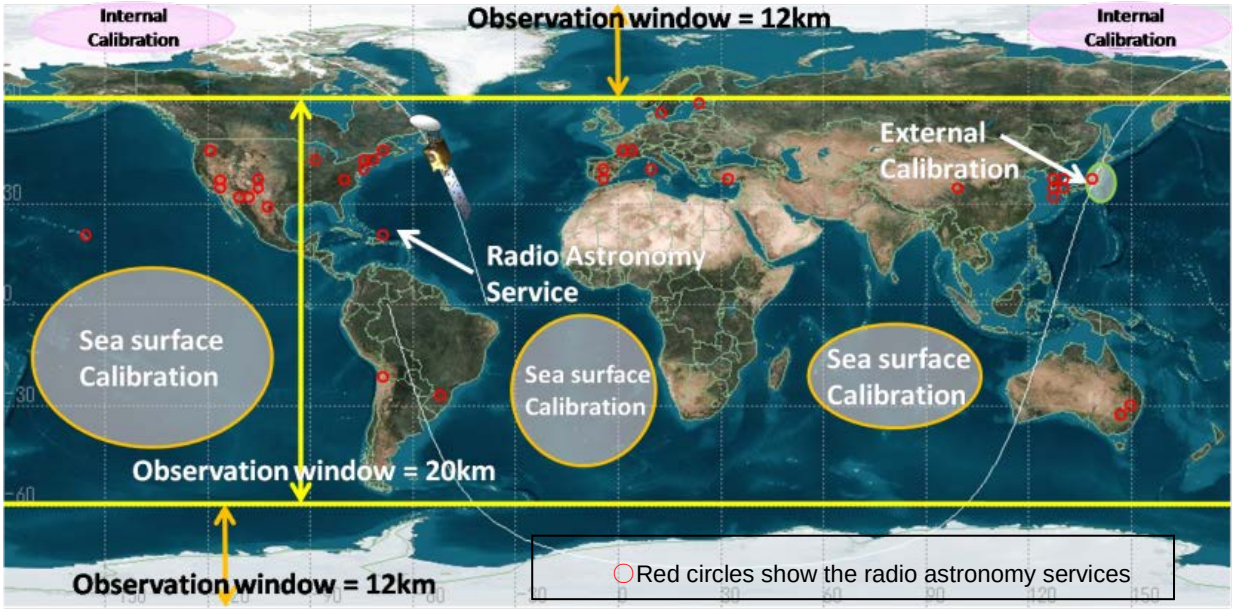

Figure 2.1-2 CPR calibration area image

A part of the external calibration data is released with the nominal observation data as the EarthCARE/CPR Level 1 Product. However, the internal calibration data and the sea surface calibration data aren't released.

Table 2.1-1 shows CPR operational mode to output ISP.

Table 2.1-1 CPR operational mode

Operational Mode	Description	Frequency/ Area	Duration Time
Nominal Observation	Nominal observation mode. Variable PRF. Observation window changes 16 km, 18 km and 20 km in accordance with the latitude.	–	–
External Calibration	External calibration mode. ARC measurement is performed in this mode	[TBD]	[TBD]
Sea Surface Calibration	Sea surface calibration with satellite roll maneuver	[TBD]	[TBD]
Internal Calibration	Internal calibration mode without RF transmission	[TBD]	[TBD]
Contingency Observation	Operation mode with fixed PRF when S/C navigation data is not available or poor accuracy	–	–

3. Product Overview

3.1. Processing Overview

CPR L1b products include received echo power, radar reflectivity factor, normalized surface scattering cross section, Doppler velocity, spectral width, ancillary data, and data flag.

In processing for received echo power, calibrated received power is produced by using temperature data. And the radar reflectivity factor is processed from the received echo power and other input parameters. Normalized surface scattering cross section is calculated after dividing the radar reflectivity by the real cross section. Doppler velocity is calculated from phase angle which is converted from the ratio of the real and imaginary parts of covariance coefficients of the pulse-pair processing in level 0 data. The spectral width is figured from the two covariance coefficients and radar reflectivity of the pulse-pair in level 0 data. Figure 3.1-1 gives an input/output for level 1b data processing.

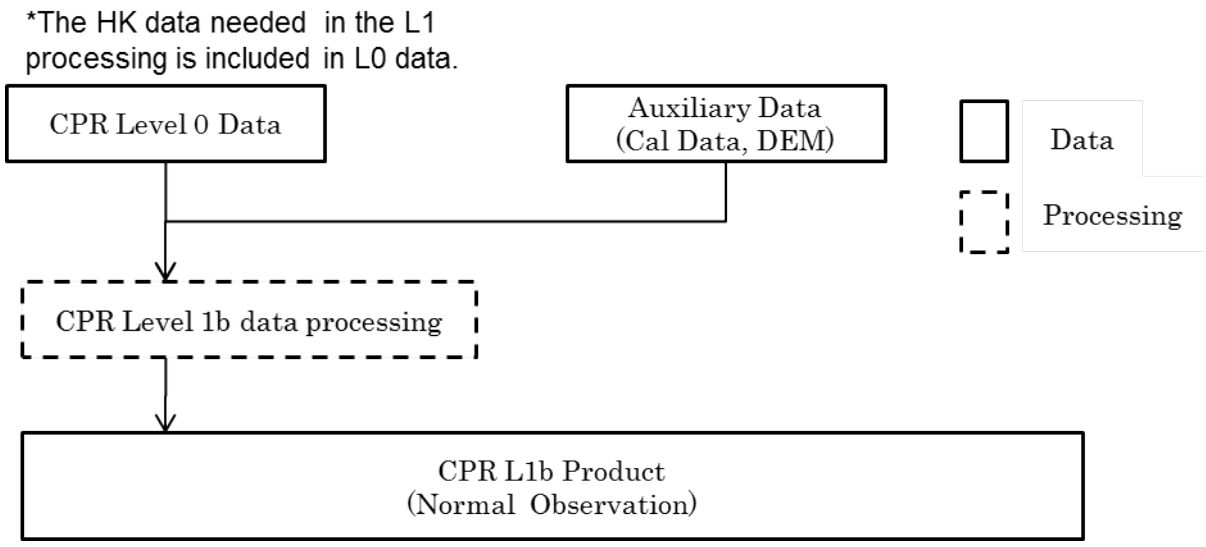

Figure 3.1-1 Input/output data for level 1b data processing

3.2. Definition of Level 1b Product

Table3.2-1 shows EarthCARE/CPR level 1b product.

Table 3.2-1 EarthCARE/CPR level 1b product

Processing Level	Unit	Pixel Size	Observation Mode	File Size (*1)	Note
1b	1/8 orbit	Horizontal 500m Vertical 100m	Nominal Observation (containing the external calibration data)	70.0MB [TBD]	

(*1) The file size is estimated as un-compressed data. All of the L1b products are compressed by gzip internal compression.

Table 3.2-2 shows the operational mode stored in the L1b product. In case of the nominal observation mode and contingency observation mode, either nominal (RF on) data or silent state (RF off) data is stored in L1b product. In case of the external calibration mode, nominal (RF on) data is stored only for the altitude less than the specific one (17 km). The silent state data in external calibration mode is not stored. The nominal data in the sea surface calibration mode or the internal calibration mode is not stored either. These calibration modes are supposed to give no data.

Table 3.2-2 the operational mode stored in the L1b product

operational mode	nominal (RF on)	silent state (RF off)	valid observed height range
Nominal Observation	✓(*2)	✓ (noise) (*2)	-1 to 16 km -1 to 18 km -1 to 20 km
External Calibration	✓ (less than the specific altitude (<=17 km)) (*3)	missing	-3 to 18 km
Sea Surface Calibration	missing	N/A	N/A
Internal Calibration	missing	N/A	N/A
Contingency Observation	✓	✓ (noise)	Fixed PRF

(*2) Invalid values are stored under the effective observation altitude.

(*3) Invalid values are stored over the specific altitude (>17 km).

3.3. Product Outline

EarthCARE/CPR Level 1b product contains a frame data. The frame is defined as 1/8 orbit. The interval between two frames is overlapped. The eight frames in one orbit are called in “A“, “B”, “C”, ”D”, “E”, “F”, “G” and “H” in order. The orbit and frames are shown in Figure 3.3-1. The detailed definition of frames are shown in Table 3.3-2.

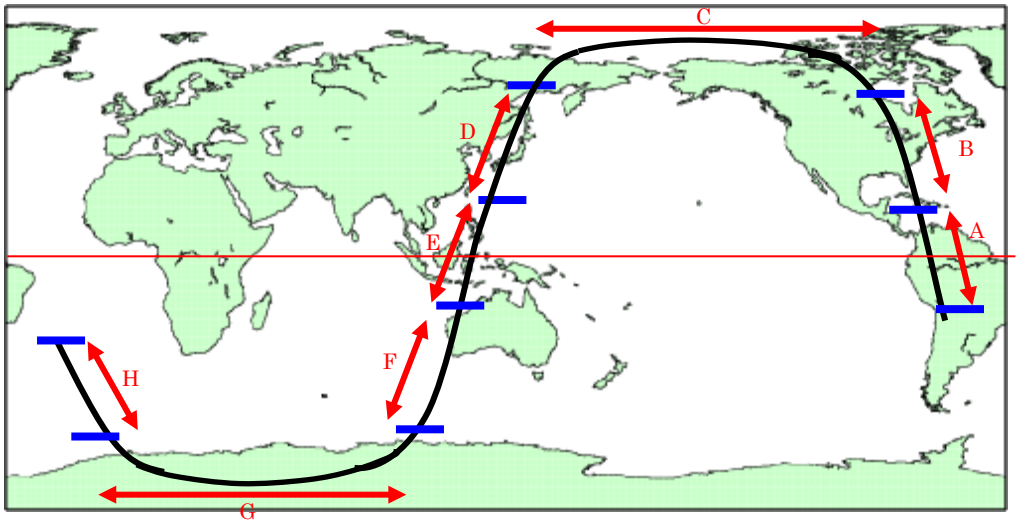

Figure 3.3-1 Product unit on a world map

The footprint and granule size are showed in Figure 3.3-2. In the EarthCARE/CPR Level 1b product, a granule is 1 frame (= 1/8 orbit) and 28 ray. 28ray is overlap with the previous or next frame. There are approximately 9718 rays per granule and 218 bins (or 544 bins / contingency observation) per ray. The number of the ray and bin per granule depends on the observation mode included in a granule.

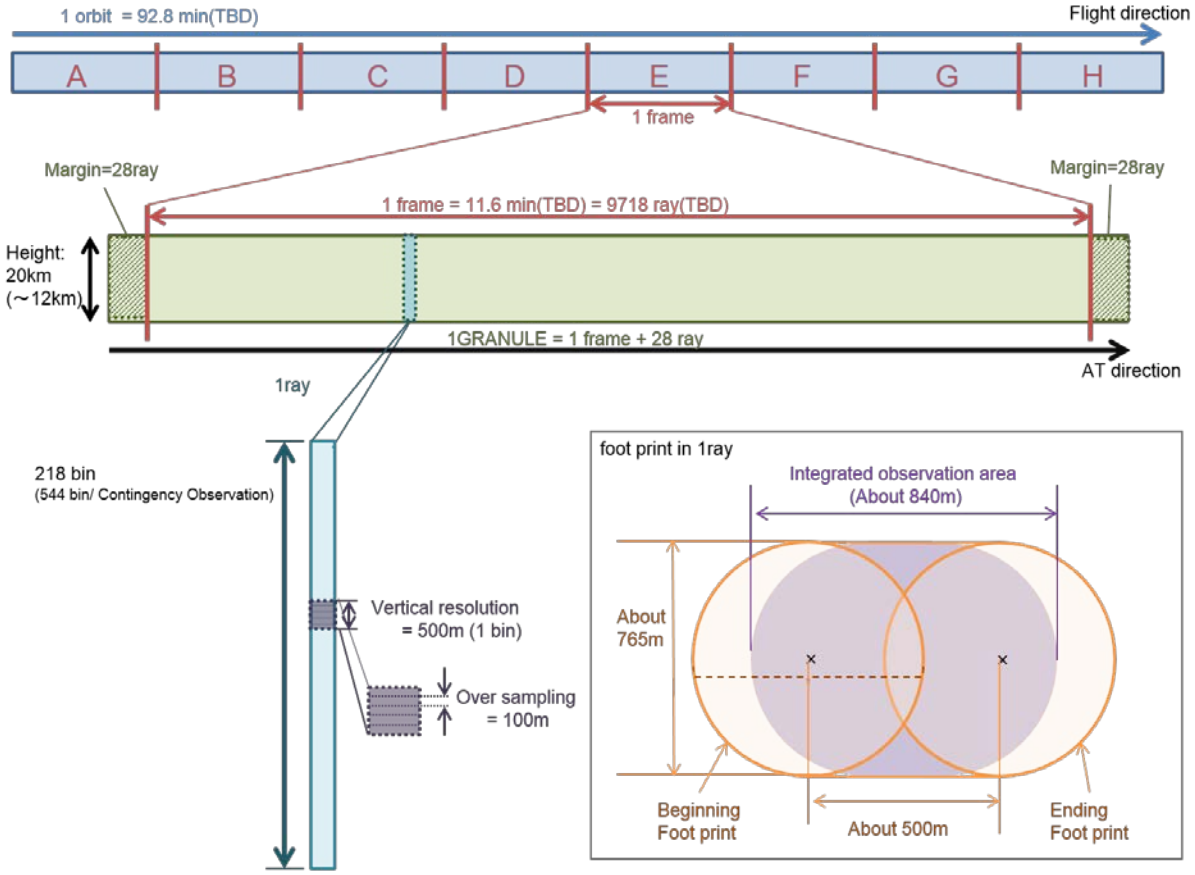

Figure 3.3-2 footprint and granule size

The treatment of calibration data is showed in Figure 3.3-3. The “frame start” and “frame end” in Figure 3.3-3 are the date time defined with satellite latitude in L1b processing. However, in case of missing in the “Frame start” or “Frame end” part of L0 data, the “frame start” and “frame end” in L0 data are referred.

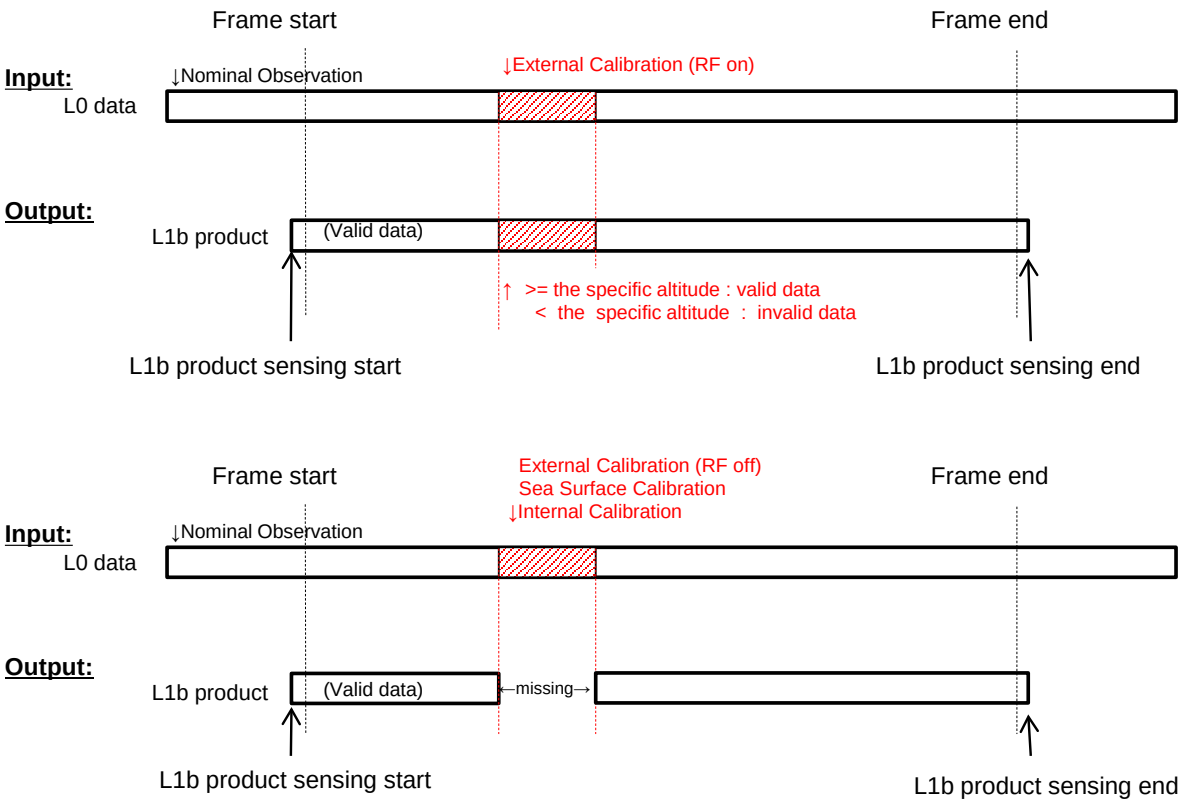

Figure 3.3-3 Calibration data in L1b product

The number of missing ray is stored in L1b product. Missing ray is defined as Table 3.3-1.

Table 3.3-1 the number of missing ray

missing type	detail
missing ray	The number of missing ray from L1b product frame start to L1b product frame end. (Figure 3.3-3)

3.3.1. Definition Of Frame

The frame is defined based on the satellite latitude calculated in L1b processing. The boundary latitude is showed in Table 3.3-2.

Table 3.3-2 boundary latitude

frame number	start latitude	(middle)	end latitude
A	-22.5	0	22.5
B	22.5	45	67.5

frame number	start latitude	(middle)	end latitude
C	67.5	northern edge	67.5
D	67.5	45	22.5
E	22.5	0	-22.5
F	-22.5	-45	-67.5
G	-67.5	southern edge	-67.5
H	-67.5	-45	-22.5

Therefore, L2 processing needs to be executed per two rays ("1 and 2", "3 and 4", …, "13 and 14"). The ray number (processing frame) of start position needs to be odd numbers. In case that the first ray number is even number, the next odd number is used as a start position. In the bottom in Figure 3.3-4 and Figure 3.3-5, start position is 9 ray in 3 pps (not 8 ray in 3 pps) and end position is 10 ray in 101 pps (not 9 ray in 101 pps). The margin is 28 ray.

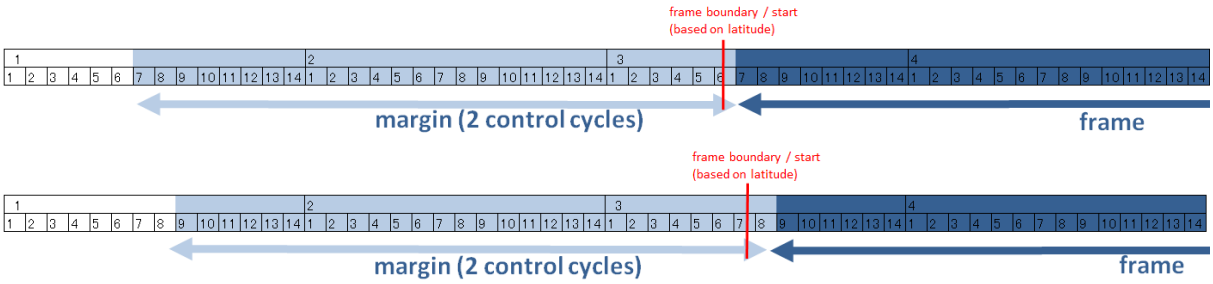

Figure 3.3-4 Definition of frame as the start position

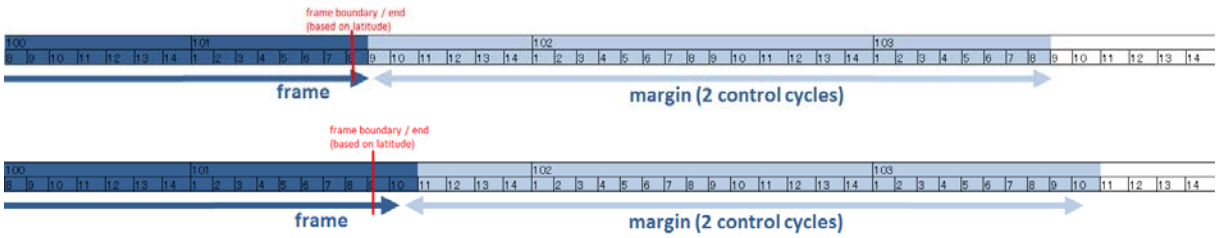

Figure 3.3-5 Definition of frame as the end position

The sensing start and end time is defined as follows.

- sensing start time
  "profile time" of the first ray in L1b product
  (9 ray/1 pps in the bottom in Figure 3.3-4)
- sensing end time
  "profile time" of the last ray in L1b product
  (10 ray/103 pps in the bottom in Figure 3.3-5)

3.3.2. Location information

All geolocation information in the L1 products (e.g. latitude and longitude fields) is given in a geodetic reference frame (Earth Fixed reference frame ITRF).

Observation altitude (h_{obs}) is given with the following formula and Figure 3.3-6.

$h_{obs} = h_{sat} - d_{obs}$

h_{sat} [m] : altitude of satellite

d_{obs}[m] : r*cosθ
r [m] : distance from satellite to bin
θ [deg.] : incident angle

r is the function of bin number (n) and defined in distance from satellite to the first bin (r0) and interval of range bins (Δr) as below.L1b product includes r0.

$r(n) = r0 + \Delta r * n$

n : bin number
0 to 217 (nominal observation mode) or
0 to 543 (contingency observation mode)
r0 [m] : distance from satellite to the first bin
Δr[m] : $\Delta r = (c * \Delta t)/2$
c [m/s] : light speed
Δt[s] : sampling interval

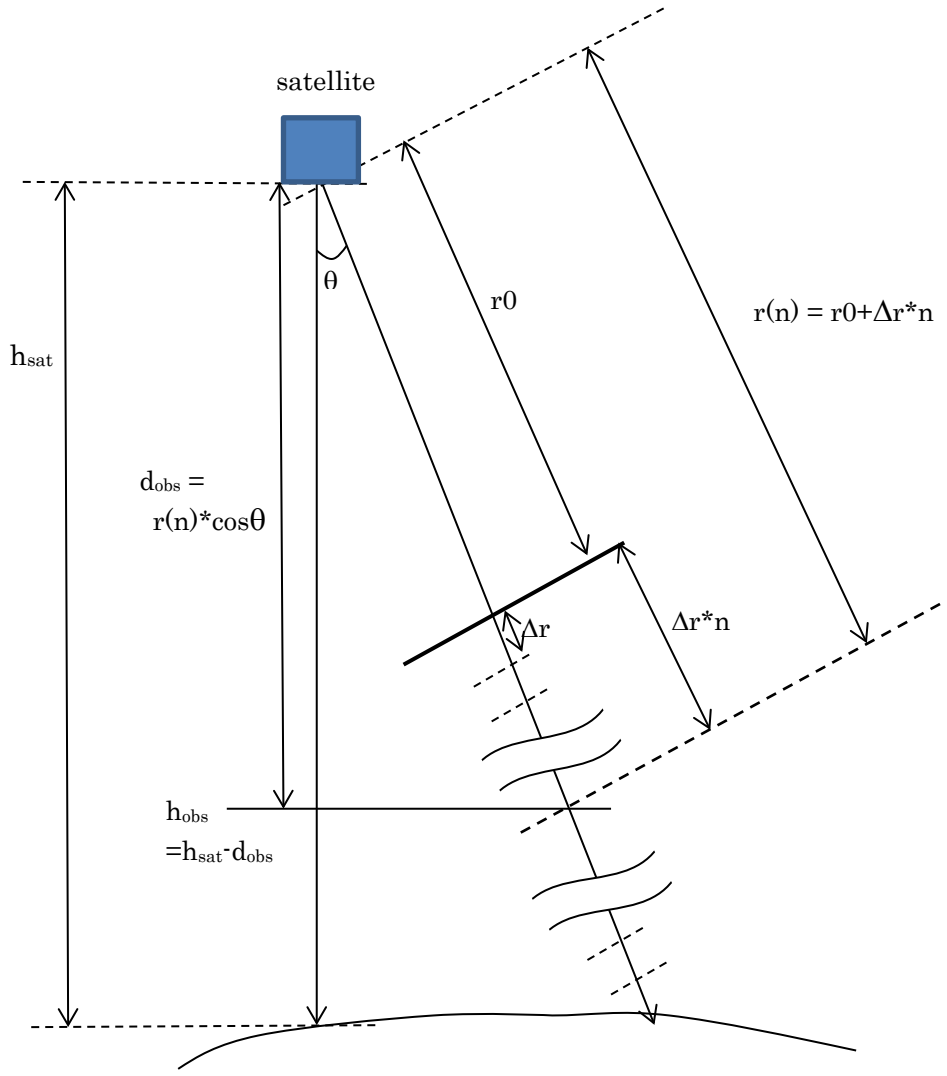

Figure 3.3–6 Observation altitude

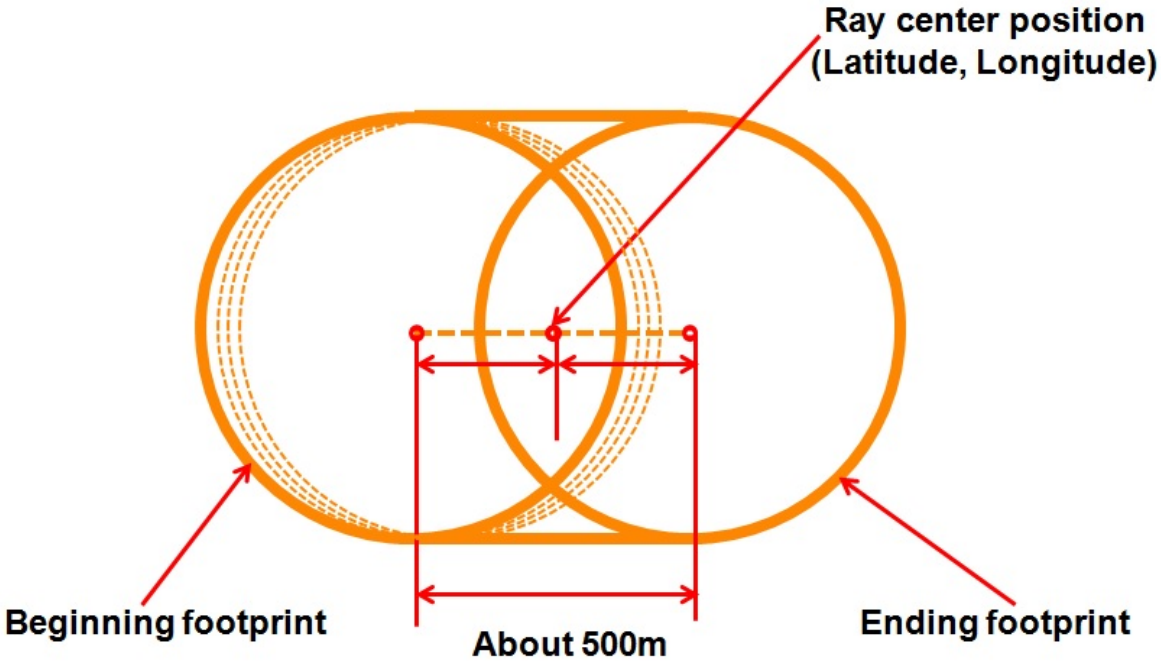

Figure 3.3-7 Ray center position

3.4. Quality Information

3.4.1. Flag Definition

The following flags are included in L1b product to inform the quality.

- Ray Status Flag (in "ray")
- Surface Estimation Flag (in "ray")
- Pulse Shape Warning Flag (in "ray")
- Doppler Status Flag (in "ray")
- Tx Rx Status Flag (in "ray")
- Bin Flag (in "bin")

(1)Ray Status Flag

This flag shows status of data communication between satellite and CPR, and error information on CPR data processing and ground processing. Instrument_Error affect all CPR products because of stopping CPR observation. Clock_Quality_Waning shows status of time synchronization between CPR and satellite. Orbit_Qualty_Warning, Orbit_Qulity_Error and Orbit_Information affect reliability of satellite position and attitude. They also affect reliability of **dopplerVelocity** and **sigmaZero**. Three ECC2_Bit_Error show errors of onboard data processing. Data_Conversion_Warning and Ground_Processing_Error shows errors at ground L1 data processing. Both data processing errors affect reliability of various CPR products.

Table 3.4-1 Ray status flag definition

Bit No (MSB)	Name	Description
0	Ray_Status_Instrument_Error	CPR stops observation
1	Ray_Status_Clock_Quality_Warning	Satellite clock information is not utilized
2	Ray_Status_Orbit_Quality_Warning	Reliability of S/C navigation data is poor
3	Ray_Status_Orbit_Quality_Error	S/C navigation data stop
4	Ray_Status_Data_Conversion_Warning	Various CPR science data have conversion error in L1 processing
5	Ray_Status_Orbit_Information_(not_GPS_raw_data)	The GPS orbit file is not utilized
6	Ray_Status_Log_Detection_Processing_ECC2_Bit_Error	Log data processing is invalid
7	Ray_Status_Pulse_Pair_Processing_ECC2_Bit_Error	IQ data processing is invalid
8	Ray_Status_Tx_Power_Monitor_Processing_ECC2_Bit_Error	Tx monitor data processing is invalid
9	Ray_Status_Ground_Processing_Error	Various fatal data processing error occur in L1 processing.

Bit No (MSB)	Name	Description
10-15	(Spare)	

(2) Surface Estimation Flag

This flag shows reliability of **surfaceBinNumber**, **surfaceBinFraction**, **sigmaZero** products. The ten's digit of this flag shows a flag relating to estimated **sigmaZero** level. If this is not zero, estimated **sigmaZero** level is out of normal range. The one's digit of this flag shows a flag relating to rain attenuation. If this flag is not zero, range integrated reflectivity is above some threshold.

(3) Pulse Shape Warning Flag

This flag shows reliability of estimated **transmitPower** using power monitor or Doppler reference signal. This flag also affect reliability of **radarReflectivityFactor** and **sigmaZero**. Explanation of each bit is shown in following table.

Table 3.4-2 Pulse shape warning flag definition

Bit No (MSB)	Name	Description
0	Pulse_Shape_Pulse_Width_Warning	Estimated pulse width is poor reliability
1	Pulse_Shape_Tx_Power_Warning	Estimated transmitted power is poor reliability
2	Pulse_Shape_Calc_Warning	[TBD]
3-15	(Spare)	

(4) Doppler Status Flag

This flag shows reliability of estimated **dopplerVelocity** and **covarianceCoeff** judged from CPR and satellite information. Explanation of each bit is shown in following table.

Table 3.4-3 Doppler status flag definition

Bit No (MSB)	Name	Description
0	Doppler_Status_IQ_Detector_Warning	Data of IQ detector is poor reliability because of temperature change
1	Doppler_Status_Txphase_Warning	Phase change of transmitted pulses is above threshold
2	Doppler_Status_Stellite_Velocity_Correction_Warning	Radial satellite velocity for Doppler correction is above threshold
3 - 15	(Spare)	

(5)Tx Rx Status Flag

This flag shows status of transmitter and receiver of CPR. Rx_gain bit flag affects reliability of **noiseFloorPower**, **receivedEchoPower**, **radarReflectivityFactor**, **spectrumWidth** and **sigmaZero**. PLO_warning and Tx_warmup bit flag affects reliability of dopplerVelocity and covarianceCoeff. Explanation of each bit is shown in following **dopplerVelocity** and **covarianceCoeff**.

Table 3.4-4 Tx Rx status flag definition

Bit No (MSB)	Name	Description
0	TxRx_Status_Tx_Off	No pulse transmission
1	TxRx_Status_Rx_Gain_Warning	Estimated receiver gain is out of normal range
2	TxRx_Status_PLO_Warning	Phase coherency of transmitter and receiver is poor reliability
3	TxRx_Status_Tx_Warmup_Warning	Transmit phase may be unstable because of warming up
4 - 15	(Spare)	

(6)Bin Status Flag

This flag shows status of each bin's echo reliability considering Log and IQ detector range. If Log_detector_High or Log_detector_Low bit flag is not zero, **receivedEchoPower** and **radarReflectivityFactor** in this bin is poor reliability. If IQ_detector_High or IQ_detector_Low bit flag is not zero, **dopplerVelocity** and **covarianceCoeff** in this bin is poor reliability. Explanation of each bit is shown in following table.

Table 3.4-5 Bin status flag definition

Bit No (MSB)	Name	Description
0	Bin_Status_Log_Detector_High_Warning	Log detector output is too high.
1	Bin_Status_Log_Detector_Low_Warning	Log detector output is too low.
2	Bin_Status_IQ_Detector_High_Warning	IQ detector output is too high.
3	Bin_Status_IQ_Detector_Low_Warning	IQ detector output is too low.
4 - 7	(Spare)	

3.4.2. Quality Definition

The quality in L1b product is defined based on “missing ratio” as follows. “missing ratio” means that the ratio of missing and invalid rays. “invalid ray” indicates that the ray that any flags defined in 3.4.1.1(1), 3.4.1.1(2), 3.4.1.1(3), 3.4.1.1(4) and 3.4.1.1(5) (except in 3.4.1.1(6)) are 1.

GOOD	: “missing ratio” >= specified value [TBD]
FAIR	: ”missing ratio” < specified value [TBD]

4. Product Format

4.1. File Naming Convention

Following is the naming convention of a file name.

EarthCARE CPR Level 1b Product file name

```
1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9
E C A _ J _ C P R _ A A A _ 1 B S _ Y Y Y Y M M D D T h h m m _ Y Y Y Y M M D D T h h m m _ x x x x x f _ v V v . h 5
①       ②  ③       ④       ⑤       ⑥                                ⑦                              ⑧             ⑨    ⑩
```

Table 4.1-1 EarthCARE CPR Level 1b Product File Naming Convention

	Name	Num	Value
①	Mission ID	3	「ECA」【Fixed】
	Separator	1	「_」(Underscore)【Fixed】
②	Processing agency	1	「J」【Fixed】
	Separator	1	「_」(Underscore)【Fixed】
③	Sensor ID	3	「CPR」【Fixed】
	Separator	1	「_」(Underscore)【Fixed】
④	instrument file identifier	3	「NOM」【Fixed】
	Separator	1	「_」(Underscore)【Fixed】
⑤	Process level, Product type	3	「1BS」or「1BT」(「S」:Standard product,「T」:Test product for JAXA internal use)
	Separator	1	「_」(Underscore)【Fixed】

	Name	Num	Value
⑥	Frame start time	13	UTC YYYY: Year MM:Month DD:Day of a Month 「T」:【Fixed】 hh:Hour 0-23 mm:Minute 0-59
	Separator	1	「_」(Underscore)【Fixed】
⑦	Frame end time	13	UTC YYYY: Year MM:Month DD:Day of a Month 「T」:【Fixed】 hh:Hour 0-23 mm:Minute 0-59
	Separator	1	「_」(Underscore)【Fixed】
⑧	Frame ID	6	Orbit number (5 digits) 00001-99999 + frame number (1 digit)
	Separator	1	「_」(Underscore)【Fixed】
⑨	Product version	3	「v」【Fixed】 V:product major version (A-Z) v:product minor version (a-z) The major version is incremented with reprocessing from mission beginning in principle.
⑩	Extension	3	「.h5」【Fixed】 HDF5 file format

4.2. Data Structure Outline

Table 4.2-1 gives data structures of EarthCARE/CPR level 1b product whose format is HDF5 which version is 1.8.13.

Table 4.2-1 General data structures of EarthCARE level 1b product

Name			Outline
HeaderData			
	FixedProductHeader		Following contents are stored as a description of a product which conforms to baseline document (1). ・Product file name ・Mission name ・Validity period
	VariableProductHeader		
		MainProductHeader	Following contents are stored as a description of a product which conforms to baseline document (1). ・Sensor name ・Product level ・Processor name and version ・Sensing start/end time ・Orbital information
		SpecificProductHeader	・MDS information ・Quality information ・Reference data information
ScienceData			Following contents are mainly stored as results of L1b process. ・Received echo power profile ・Radar reflectivity factor profile ・Normalized surface cross section ・Doppler velocity profile ・Spectral width profile ・Covariance coefficient profile

4.3. Data Structure Detail

4.3.1. Standard Product

- EarthCARE/CPR level 1b product

  See Table 4.3-2.

Table 4.3-1 Definition of dimensions

Dimension	Description	Number of elements	Sort order
nray	Number of ray , see section 3.3 and Figure 3.3.2.	-	Time progress
nbin	Number of bin , see section 3.3 and Figure 3.3.2	218 (Nominal observation mode) 544 (Contingency observation mode)	From top to bottom

Table 4.3-2 (draft) EarthCARE/CPR L1b Product File Format

No.	group	Group / Name / Role Name	Units	Size of each element	Number of elements	Total size	Description	Remarks	Remarks	Example
1	G	**HeaderData**								
2	G	**FixedProductHeader**								
3		File_Name	unitless	60	1	60	This is the logical file name of the product. The format must follow the rules set forth in 4.1.			
4		File_Description	unitless	2000	1	2000	This is a one-line description of the File Type. Allowed descriptions are pre-defined for each project for each File Type defined. See "Earth Explorer Ground Segment - File Format Standard" - PE-TN-ESA-GS-0001 for details.			TBD
5		Notes	unitless	2000	1	2000	This is a textual description of the product/file. There are no prescriptions on its format provided it fits into the maximum allowed size. See "Earth Explorer Ground Segment - File Format Standard" - PE-TN-ESA-GS-0001 for details.			
6		Mission	unitless	9	1	9	The Mission field must be set to the applicable value for the project. For EarthCARE the value is shown in the table.			EarthCARE
7		File_Class	unitless	4	1	4	This describes the agency generating the product (ESA/JAXA), its latency (NRT/offline/not applicable), the environment (operational, test, simulator, system verification), and the product baseline. See "Earth Explorer Ground Segment - File Format Standard" - PE-TN-ESA-GS-0001 for details. For EarthCARE each letter of the File Class has a specific meaning as follows: CCCC = ABCD where: A = Agency generating the file E ESA J JAXA B = Latency N Near-real time (placeholder only, currently not used) O Offline X Not applicable C = Environment O Operational (Only these files will be distributed to users) T Test S Simulator (formerly SIMU) V System Verification Test (formerly SVTx) D = Product baseline			JXOA
8		File_Type	unitless	10	1	10	This defines the file/product structure. All file/products of the same File Type share same structure. See "Earth Explorer Ground Segment - File Format Standard" - PE-TN-ESA-GS-0001 for details. The 10 character File Type can be subdivided into two sub-fields as follows: TTTTTTTTTT = FFFFDDDDDD where: FFFF = File Category DDDDDD = Semantic Descriptor			

No.	group	Group / Name / Role Name	Units	Size of each element	Number of elements	Total size	Description	Remarks	Remarks	Example
9		Validity_Period	unitless	47	1	47	For products, the Validity Period equals the time span between the time stamps of the frame start and frame stop.The format of a Validity Period is <Validity Start>_<Validity Stop>, whereby Validity Start (Stop) is the UTC time of the frame start(stop),i.e.,Validity Period is <frameStartTime> <frameStopTime>,with frameStartTime and frameStopTime as defined below..For files, the Validity Period defines the time span during which the content of the file should be used in the processing. Again, the format of a Validity Period is <Validity Start>_<Validity Stop>. For the purposes of the Fixed Product Header time stamps are in CCSDS time format: YYYY-MM-DDThh:mm:ss.sss. See "Earth Explorer Ground Segment - File Format Standard" - PE-TN-ESA-GS-0001 for details. The default value for the start of a Validity Period is 0000-00-00T00:00:00, for the end of a Validity Period is 9999-99-99T99:99:99.			
10		File_Version	unitless	4	1	4	This field is retained for compatibility with "Earth Explorer Ground Segment - File Format Standard" - PE-TNESA- GS-0001. It was used to distinguish between different instances of files with the same validity. For EarthCARE products it has no meaning as the processing time is used to distinguish between product instances. It is therefore always set to “0001”.			
11	G	**Source**	unitless	47	1	47	the (sub)system that generated the product/file.			
12		System	unitless	10	1	10	[UndefCreat/ESSSxxxxxx/ECGPxxxxxx/PDGSxxxxxx/JAXAxxxxxx/MLSEABBR10]	—		JAXAxxxxxx
13		Creator	unitless	10	1	10	[UndefCreat/ESSSxxxxxx/ECGPxxxxxx/PDGSxxxxxx/JAXAxxxxxx/MLSEABBR10]	—		JAXAxxxxxx
14		Creator_Version	unitless	4	1	4	This is the version of the system that generated the product/file which is always set to "0001".	—		0001
15		Creation_Date	unitless	23	1	23	This is the creation date of the product/file. "YYYY-MM-DDThh:mm:ss.sss"	—		
16	G	**VariableProductHeader**								
17	G	**MainProductHeader**								
18		productName	unitless	60	1	60	The productName field in the Main Product Header is identical to the File_Name field in the Fixed Product Header.	—		
19		originalProductName	unitless	60	1	60	This field should be left empty when the product is created. When renaming the product (which is necessary, e.g., for JAXA products received at the ESA PDGS) the (logical) file name before renaming should be reported here.	—		
20		missionID	unitless	3	1	3	This is a project-specific field which is always set to 'ECA'.	—		ECA

No.	group	Group / Name / Role Name	Units	Size of each element	Number of elements	Total size	Description	Remarks	Remarks	Example
21		fileClass	unitless	4	1	4	This is a repetition of the file class element of the product file name. See "Tailoring of the Earth Explorer File Format Standard for the EarthCARE Ground Segment" - EC-TN-ESA-GS-0218. for details. For EarthCARE each letter of the File Class has a specific meaning as follows: CCCC = ABCD where: A = Agency generating the file E ESA J JAXA B = Latency N Near-real time (placeholder only, currently not used) O Offline X Not applicable C = Environment O Operational (Only these files will be distributed to users) T Test S Simulator (formerly SIMU) V System Verification Test (formerly SVTx) D = Product baseline	—		
22		fileCategory	unitless	4	1	4	This is a repetition of the file category element of the product file name. See "Tailoring of the Earth Explorer File Format Standard for the EarthCARE Ground Segment" - EC-TN-ESA-GS-0218. for details. [xxxx_/MPL_/TLM_/GEO_/AUX_/REP_/LOG_/MTD_/ATL_/BBR_/CPR_/MSI_/AC__/AM__/BM__/ACM_/ALL_]	—		CPR_
23		productType	unitless	3	1	3	This is a repetition of the file product type element of the product file name. See "Tailoring of the Earth Explorer File Format Standard for the EarthCARE Ground Segment" - EC-TN-ESA-GS-0218. for details.	—		NOM
24		productLevel	unitless	2	1	2	This is a repetition of the file product type element of the product file name. See "Tailoring of the Earth Explorer File Format Standard for the EarthCARE Ground Segment" - EC-TN-ESA-GS-0218. for details. the processing level of the product [0_/1A/1B/1C/1D/2A/2B]	—		1B
25		sensingStartTime	unitless	23	1	23	The sensing start is the time stamp of the least recent sample in the product. "YYYY-MM-DDThh:mm:ss.sss"	—		
26		sensingStopTime	unitless	23	1	23	The sensing stop is the time stamp of the most recent sample in the product. "YYYY-MM-DDThh:mm:ss.sss"	—		
27		degradedProductQualityFlag	unitless	1	1	1	Boolean flag to assess the overall product quality identifying the presence of significant errors within the product. [0/1]	—		1
28		description	unitless	2000	1	2000	A comment relevant to the product/file can be written here.There are no format constraints as long as the text fits into the maximum allowed size.	—		TBD
29		processorName	unitless	2000	1	2000	The name of the processor that generated the product, used the file etc. is provided here. For instance, this field could be set to "BBR PDGS L0 Processor". There are no format constraints as long as the text fits into the maximum allowed size.	—		JAXA CPR L1 Processor

No.	group	Group / Name / Role Name	Units	Size of each element	Number of elements	Total size	Description	Remarks	Remarks	Example
30		processorMajorVersion	unitless	2	1	2	This is the major version of the overall processor that generates the product/file, comprising not only the executable(s) but also its configuration (e.g., selection of algorithm options, thresholds, static auxiliary inputs etc.). It is assumed that this overall processor configuration be uniquely identified through a "Major Version.Minor Version" for Configuration Control. At least a major version must be defined and be stored in this field.	—		1
31		processorMinorVersion	unitless	2	1	2	This is the minor version of the overall processor that generates the product/file, comprising not only the executable(s) but also its configuration (e.g., selection of algorithm options, thresholds, static auxiliary inputs etc.). It is assumed that this overall processor configuration be uniquely identified through a "Major Version.Minor Version" for Configuration Control. If a Minor Version is not used, this field must be set to 0.	—		0
32		executableMajorVersion	unitless	2	1	2	This is the major version of the executable (or combination of executables) that generates the product/file. It is assumed that any software generating files/products be uniquely identified through a "Major Version.Minor Version" for Configuration Control. At least a major version must be defined and be stored in this field.	—		1
33		executableMinorVersion	unitless	2	1	2	This is the minor version of the executable (or combination of executables) that generates the product/file. It is assumed that any software generating files/products be uniquely identified through a "Major Version.Minor Version" for Configuration Control. If a Minor Version is not used, this field must be set to 0.	—		0
34		formatMajorVersion	unitless	2	1	2	This is the major version of the format of the product/file. At least a major version must be defined and be stored in this field. Product definition documents must specify this format version for each product/file they are defining. The format version is updated only when the format actually changes, not when the Product definition document is updated for another reason.	—		1
35		formatMinorVersion	unitless	2	1	2	This is the minor version of the format of the product/file. If a Minor Version is not used, this field must be set to 0. Product definition documents must specify this format version for each product/file they are defining. The format version is updated only when the format actually changes, not when the Product definition document is updated for another reason.	—		0
36		subsettedProduct	unitless	1	1	1	This is used to mark products extracted from a base product without further processing, [0/1]	—		
37		acquisitionStation	unitless	10	1	10	This is the Acquisition Station (e.g., Kiruna) where the downlink occurred. [XXXXXXXXX]	—		XXXXXXXXXX
38		processingCentre	unitless	4	1	4	This is the Processing Centre where the product was generated. This is identical to the field Source.System in the fixed product header,see No11.	—		JAXAxxxxxx
39		processingStartTime	unitless	23	1	23	This is the processing start time of the product, i.e. when the first product sample was processed on ground. This is the actual sensing time, so it is affected by data gaps and instrument sampling. For synergistic products, the least recent start sensing time (from the set of start sensing times for the various instruments) has to be used. "YYYY-MM-DDThh:mm:ss.sss"	—		

No.	group	Group / Name / Role Name	Units	Size of each element	Number of elements	Total size	Description	Remarks	Remarks	Example
40		processingStopTime	unitless	23	1	23	This is the processing stop time of the product, i.e. when the last product sample was processed on ground. This is the actual sensing time, so it is affected by data gaps and instrument sampling. For synergistic products, the most recent start sensing time (from the set of stop sensing times for the various instruments) has to be used. "YYYY-MM-DDThh:mm:ss.sss"	—		
41		orbitNumber	unitless	4	1	4	This is the orbit number for the current product (excluding margins added for overlap between products). It is the same number as used in the file instance ID of the file name, see "Tailoring of the Earth Explorer File Format Standard for the EarthCARE Ground Segment" - EC-TN-ESA-GS-0218. for details.	—		
42		frameID	unitless	1	1	1	This is the frame identifier for the current product (A, B, C, D, …). It is the same letter as used in the file instance ID of the file name, see "Tailoring of the Earth Explorer File Format Standard for the EarthCARE Ground Segment" - EC-TN-ESA-GS-0218. for details.	—		
43		ANXTime	unitless	26	1	26	This is the UTC date/time of the ANX at the start of the current orbit (given by orbitNumber), in CCSDS time format: YYYY-MM-DDThh:mm:ss.ssssss. This means, all frames within the given orbit will have the same ANXTime, i.e. the ones at the start of the first frame.	—		
44		ANXLongitude	deg.	8	1	8	This is the longitude of the ANX at the start of the current orbit (given by orbitNumber), i.e., the longitude at ANXTime. This means, all frames within the given orbit will have the same ANXLongitude, i.e. the ones at the start of the first frame.	—		
45		stateVectorSource	unitless	15	1	15	This field describes where the State Vector used for generating the product comes from [UndefinedSource/GENERATEDxxxxxx/FOS_PREDICTEDxx/FOS_RESTITUTEDx/ONBOARD_GPSxxxx]	—		ONBOARD_GPSxxxx
46		stateVectorTime	unitless	26	1	26	UTC Time, in CCSDS time format: YYYY-MM-DDThh:mm:ss.ssssss, associated to the satellite state vector given in Cartesian form in the following six fields position ([xyz]Position) and velocity ([xyz]Velocity), and as Kepler elements in the six fields after that (orbitSemiMajorAxis to meanAnomaly). The state vector given is close to ANX at the start of the orbit indicated by orbitNumber. It is the state vector closest to ANX from the orbit file used on input, independently whether it is slightly before are slightly after ANX.	—		
47		xPosition	m	8	1	8	the position (in meters) on ground along the x-axis in the WGS84 Reference System of the least recent sample in the product.	—		
48		yPosition	m	8	1	8	the position (in meters) on ground along the y-axis in the WGS84 Reference System of the least recent sample in the product.	—		
49		zPosition	m	8	1	8	the position (in meters) on ground along the z-axis in the WGS84 Reference System of the least recent sample in the product.	—		
50		xVelocity	m/s	8	1	8	the velocity (in meters/second) on ground along the x-axis in the WGS84 Reference System of the least recent sample in the product.	—		
51		yVelocity	m/s	8	1	8	the velocity (in meters/second) on ground along the y-axis in the WGS84 Reference System of the least recent sample in the product.	—		

No.	group	Group / Name / Role Name	Units	Size of each element	Number of elements	Total size	Description	Remarks	Remarks	Example
52		zVelocity	m/s	8	1	8	the velocity (in meters/second) on ground along the z-axis in the WGS84 Reference System of the least recent sample in the product.	—		
53		orbitSemiMajorAxis	m	8	1	8	This is the semi major axis (in meters) of the first orbit covered in the product (field orbitStart).	—		
54		orbitEccentricity	unitless	8	1	8	This is the eccentricity of the first orbit covered in the product (field orbitStart).	—		
55		orbitInclination	deg.	8	1	8	This is the inclination (in 10-3 decimal degrees, i.e. decimal millidegrees) of the first orbit covered in the product (field orbitStart).	—		
56		perigeeArgument	deg.	8	1	8	This is the argument of perigee (in 10-3 decimal degrees, i.e. decimal millidegrees) for the first orbit covered in the product (field orbitStart).	—		
57		rightAscension	deg.	8	1	8	This is the right ascension (in 10-3 decimal degrees, i.e. decimal millidegrees) for the first orbit covered in the product (field orbitStart).	—		
58		meanAnomaly	deg.	8	1	8	This is the mean anomaly (in 10-3 decimal degrees, i.e. decimal millidegrees) of the satellite at the acquisition of the first sample contained in the product.	—		
59	G	**frameStartCoordinates**	unitless	45	1	45	These are the geographic coordinates (latitude and longitude) of the subsatellite point at the frame start. The frame start latitude is determined by the number of frames per orbit and the latitude offset of the start of the first frame in an orbit (frame A).			
60		geographicLatitude	deg.	4	1	4	Geodetic latitude in decimal degrees.	—		
61		geographicLongitude	deg.	4	1	4	Geocentric longitude in decimal degrees.	—		
62	G	**frameStopCoordinates**	unitless	45	1	45	These are the geographic coordinates (latitude and longitude) of the subsatellite point at the frame end. The frame stop latitude is determined by the number of frames per orbit and the latitude offset of the start of the first frame in an orbit (frame A).			
63		geographicLatitude	deg.	4	1	4	Geodetic latitude in decimal degrees.	—		
64		geographicLongitude	deg.	4	1	4	Geocentric longitude in decimal degrees.	—		
65		frameStartTime	unitless	23	1	23	This is the UTC time when the subsatellite track crosses the frame start latitude, in CCSDS time format: YYYY-MM-DDThh:mm:ss.sss. Frame boundary times are solely determined by the satellite orbit, i.e. instrument viewing directions or instrument sampling do not affect this field.	—		
66		frameStopTime	unitless	23	1	23	This is the UTC time when the subsatellite track crosses the frame stop latitude, in CCSDS time format: YYYY-MM-DDThh:mm:ss.sss. Frame boundary times are solely determined by the satellite orbit, i.e. instrument viewing directions or instrument sampling do not affect this field.	—		
67		frameStartMargin	km	8	1	8	This is the length along-track of the data which have been added to the product before the frame start, in km. This is an approximate value only, so it should be given in full km (no fractional part). This is because the actual margin is derived using a fixed time offset from frame start while the satellite ground speed varies slightly along the orbit, and because of the finite instrument sampling. Set to zero (0.0) if no margin is added.	—		0.5

No.	group	Group / Name / Role Name	Units	Size of each element	Number of elements	Total size	Description	Remarks	Remarks	Example
68		frameStopMargin	km	8	1	8	This is the length along-track of the data which have been added to the product after the frame end, in km. This is an approximate value only, so it should be given in full km (no fractional part). This is because the actual margin is derived using a fixed time offset from frame start while the satellite ground speed varies slightly along the orbit, and because of the finite instrument sampling. Set to zero (0.0) if no margin is added.	—		0.5
69	G	SpecificProductHeader					The L1 Specific Product Header provides instrument-dependent information specific to the L1 products of a given instrument.			
70		calibrationParametersQuality	unitless	4	1	4	Should the L1 product contain calibration parameters, this field provides their quality status. Indeed a L1 product may be used in closed loop to process the next L1 product, if the former includes updated calibration information. [UNDEFINED_QUALITY/NOT_APPLICABLE/RECENT/STALE] This parameter is always set to "UNDEFINED_QUALITY" in L1b products.	—		UNDEFINED_QUALITY
71		dataQuality	unitless	5	1	5	Data Quality Flag for Available Data in Total Frame (Good: inadequate data rate is less than standard inadequate data rate Fair: inadequate data rate is larger than standard inadequate data rate)	—		
72	G	**firstLineFirstSampleCoord**	unitless	45	1	45	These are the geographic coordinates (in decimal degrees) of the first sample of the first line in the product.			
73		geographicLatitude	deg.	4	1	4	Geodetic latitude in decimal degrees.	—		
74		geographicLongitude	deg.	4	1	4	Geocentric longitude in decimal degrees.	—		
75	G	**firstLineMiddleSampleCoord**	unitless	45	1	45	These are the geographic coordinates (in decimal degrees) of the middle sample of the first line in the product.			
76		geographicLatitude	deg.	4	1	4	Geodetic latitude in decimal degrees.	—		
77		geographicLongitude	deg.	4	1	4	Geocentric longitude in decimal degrees.	—		
78	G	**firstLineLastSampleCoord**	unitless	45	1	45	These are the geographic coordinates (in decimal degrees) of the last sample of the first line in the product.			
79		geographicLatitude	deg.	4	1	4	Geodetic latitude in decimal degrees.	—		
80		geographicLongitude	deg.	4	1	4	Geocentric longitude in decimal degrees.	—		
81	G	**lastLineFirstSampleCoord**	unitless	45	1	45	These are the geographic coordinates (in decimal degrees) of the fisrt sample of the last line in the product.			
82		geographicLatitude	deg.	4	1	4	Geodetic latitude in decimal degrees.	—		
83		geographicLongitude	deg.	4	1	4	Geocentric longitude in decimal degrees.	—		
84	G	**lastLineMiddleSampleCoord**	unitless	45	1	45	These are the geographic coordinates (in decimal degrees) of the middle sample of the last line in the product.			
85		geographicLatitude	deg.	4	1	4	Geodetic latitude in decimal degrees.	—		
86		geographicLongitude	deg.	4	1	4	Geocentric longitude in decimal degrees.	—		
87	G	**lastLineLastSampleCoord**	unitless	45	1	45	These are the Geographic coordinates (in decimal degrees) of the last sample of the last line in the product.			

No.	group	Group / Name / Role Name	Units	Size of each element	Number of elements	Total size	Description	Remarks	Remarks	Example
88		geographicLatitude	deg.	4	1	4	Geodetic latitude in decimal degrees.	—		
89		geographicLongitude	deg.	4	1	4	Geocentric longitude in decimal degrees.	—		
90		RDSCount	unitless	8	1	8	the number of Reference Data Sets included in the product.	—		0 (fixed)
91		QDSCount	unitless	8	1	8	the number of Quality Data Sets included in the product.	—		0 (fixed)
92		ADSCount	unitless	8	1	8	This is the number of Annotation Data Sets included in the product.	—		0 (fixed)
93		MDSCount	unitless	8	1	8	This is the number of Measurement Data Sets included in the product.	—		1
94		inputFileName	unitless	2000	1	2000	The input files used to generate the L1b product. ・L1a data ・orbit/attitude information files	—		
95		orbitFileFlag	unitless	1	1	1	This is the orbit file flag. 0:PDGS Reconstructed Orbit File 1:FOS Reconstituted Orbit File 2:FOS Predicted Orbit File -- The PDGS reconstructed orbit data is postprocessed by velocity and time obtained from on-board GPS data and reformatted to standard EarthExplorer CFI format. The FOS orbit reconstitution data is derived from either GPS or RF doppler/ranging. The instrument ground processing software uses the CFI orbit propagator software module and an orbit state vector (OSV) as input to calculate the satellite position all along the orbit. The FOS predicted orbit is a high accuracy orbit prediction generated closer to the time of the overpass. The file contains OSV. It is generated every day, and contains one OSV per orbit, located at (or very near to) the Ascending node. This means that predicted OSVs for a given day are updated 30 times, with increasing accuracy.	—		
96		missingRayNumber	unitless	2	1	2	The number of missing ray except the calibration data.	—		
97		beamwidthAT	deg.	4	1	4	The beamwidth for along track direction. [deg.]	—		0.095
98		beamwidthCT	deg.	4	1	4	The beamwidth for corss track direction. [deg.]	—		0.095

No	group	Group / Name / Role Name	Dataspace		Attribute					Datatype	Description	Remarks	Example
			Rank	Size	Name	Num	Datatype	Description	Example				
99	G	ScienceData											
100	G	Geo											
101		rayNumber	1	1	longName	10	H5T_STRING	long name	ray number	H5T_STD_I16LE	Number of Ray within L1B Product (One Frame + 28(Margin ray))		
					unit	8	H5T_STRING	unit	unitless				
					validRange	2	H5T_STD_I16LE	valid range	0 to 32767				
					_FillValue	1	H5T_STD_I16LE	fill value	-32767				
102		rangeBinMaxNumber	1	1	longName	10	H5T_STRING	long name	bin number	H5T_STD_I16LE	Maximum Range Bin Size for this L1B product (218 for Normal Observation or 544 for Contingency Observation)		218 or 544
					unit	8	H5T_STRING	unit	unitless				
					validRange	2	H5T_STD_I16LE	valid range	218 to 544				
					_FillValue	1	H5T_STD_I16LE	fill value	-32767				
103		profileTime	1	nray	longName	12	H5T_STRING	long name	profile time	H5T_IEEE_F64LE	Representative Time of each ray Sequential seconds counted from 1/1/2000.		
					unit	7	H5T_STRING	unit	seconds				
					validRange	2	H5T_IEEE_F64LE	valid range	0 to 1.79e+308				
					_FillValue	1	H5T_IEEE_F64LE	fill value	9.9692099683868690e+36				
104		timeFlag	1	nray	longName	9	H5T_STRING	long name	time flag	H5T_STD_U16LE	Synchronization Flag between CPR time and Satellite time (1: Synchronized 0: Unsynchronized)		
					unit	8	H5T_STRING	unit	unitless				
					validRange	2	H5T_STD_U16LE	valid range	0 to 1				
					_FillValue	1	H5T_STD_U16LE	fill value	65535				
105		latitude	1	nray	longName	8	H5T_STRING	long name	latitude	H5T_IEEE_F64LE	Latitude (degree) of ray center position given in geodetic reference frame. See Figure 3.3-7		
					unit	4	H5T_STRING	unit	deg.				
					validRange	2	H5T_IEEE_F64LE	valid range	-90 to +90				
					_FillValue	1	H5T_IEEE_F64LE	fill value	9.9692099683868690e+36				
106		longitude	1	nray	longName	10	H5T_STRING	long name	longtitude	H5T_IEEE_F64LE	Longitude (degree) of ray center position given in geodetic reference frame. See Figure 3.3-7		
					unit	4	H5T_STRING	unit	deg.				
					validRange	2	H5T_IEEE_F64LE	valid range	-180 to 180				
					_FillValue	1	H5T_IEEE_F64LE	fill value	9.9692099683868690e+36				
107		rayHeaderSpatAvg	1	nray	longName	26	H5T_STRING	long name	ray header spatial average	H5T_IEEE_F32LE	Horizontal Satellite-Track Length for one Ray		
					unit	1	H5T_STRING	unit	m				
					validRange	2	H5T_IEEE_F32LE	valid range	0 to 3.4e+38				
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
108		processingFrameNo	1	nray	longName	23	H5T_STRING	long name	processing frame number	H5T_STD_I16LE	Sequential Ray Number after 1 second break		
					unit	8	H5T_STRING	unit	unitless				
					validRange	2	H5T_STD_I16LE	valid range	1 to 14				
					_FillValue	1	H5T_STD_I16LE	fill value	-32767				
109		rangeToIntercept	1	nray	longName	18	H5T_STRING	long name	range to intercept	H5T_IEEE_F32LE	Range(m) from Satellite to the geoid surface at each ray		
					unit	1	H5T_STRING	unit	m				
					validRange	2	H5T_IEEE_F32LE	valid range					
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
110		DEMElevation	1	nray	longName	13	H5T_STRING	long name	DEM elevation	H5T_IEEE_F32LE	Representative surface elevation (m) from the geoid surface at each ray		
					unit	1	H5T_STRING	unit	m				
					validRange	2	H5T_IEEE_F32LE	valid range					
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
111		binHeight	2	nray,nbin	longName	10	H5T_STRING	long name	bin height	H5T_IEEE_F32LE			
					unit	1	H5T_STRING	unit	m				
					validRange	2	H5T_IEEE_F32LE	valid range					
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
112		navigationLandSeaFlg	1	nray	longName	24	H5T_STRING	long name	navigation land sea flag	H5T_STD_U16LE	Land-Sea Flag (0:sea 1:land 65535:invalid) The land/water mask derived from Globcover is used.		
					unit	8	H5T_STRING	unit	unitless				
					validRange	2	H5T_STD_U16LE	valid range	0 to 1				
					_FillValue	1	H5T_STD_U16LE	fill value	65535				
113		rangeToFirstBin	1	nray	longName	18	H5T_STRING	long name	range to first bin	H5T_IEEE_F32LE	Distance (m) from Satellite to the first sampling bin in L1b data at each ray		
					unit	1	H5T_STRING	unit	m				
					validRange	2	H5T_IEEE_F32LE	valid range					
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
114		rayHeaderRangeBinSize	1	1	longName	25	H5T_STRING	long name	ray header range bin size	H5T_IEEE_F32LE	One Sample Bin Range (m) (Fixed value from L1specific file)		100
					unit	1	H5T_STRING	unit	m				
					validRange	2	H5T_IEEE_F32LE	valid range					
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
115		pitchAngle	1	nray	longName	11	H5T_STRING	long name	pitch angle	H5T_IEEE_F32LE	Satellite Pitch Angle (degree) calculated by CFI tool at each ray		
					unit	4	H5T_STRING	unit	deg.				
					validRange	2	H5T_IEEE_F32LE	valid range	-180.0 to 180.0				
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				

No	group	Group / Name / Role Name	Dataspace		Attribute					Datatype	Description	Remarks	Example
			Rank	Size	Name	Num	Datatype	Description	Example				
116		rollAngle	1	nray	longName	10	H5T_STRING	long name	roll angle	H5T_IEEE_F32LE	Satellite Roll Angle (degree) calculated by CFI tool at each ray		
					unit	4	H5T_STRING	unit	deg.				
					validRange	2	H5T_IEEE_F32LE	valid range	-180.0 to 180.0				
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
117		yawAngle	1	nray	longName	9	H5T_STRING	long name	yaw angle	H5T_IEEE_F32LE	Satellite Yaw Angle (degree) calculated by CFI tool at each ray		
					unit	4	H5T_STRING	unit	deg.				
					validRange	2	H5T_IEEE_F32LE	valid range	-180.0 to 180.0				
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
118		xPosition	1	nray	longName	20	H5T_STRING	long name	satellite position X	H5T_IEEE_F32LE	X Position of Satellite (m) with Earth Centered Earth Fixed (ECEF) coordinate		
					unit	1	H5T_STRING	unit	m				
					validRange	2	H5T_IEEE_F32LE	valid range					
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
119		yPosition	1	nray	longName	20	H5T_STRING	long name	satellite position Y	H5T_IEEE_F32LE	Y Position of Satellite (m) with Earth Centered Earth Fixed (ECEF) coordinate		
					unit	1	H5T_STRING	unit	m				
					validRange	2	H5T_IEEE_F32LE	valid range					
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
120		zPosition	1	nray	longName	20	H5T_STRING	long name	satellite position Z	H5T_IEEE_F32LE	Z Position of Satellite (m) with Earth Centered Earth Fixed (ECEF) coordinate		
					unit	1	H5T_STRING	unit	m				
					validRange	2	H5T_IEEE_F32LE	valid range					
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
121		satelliteVelocityX	1	nray	longName	20	H5T_STRING	long name	satellite velocity X	H5T_IEEE_F32LE	X Component of Satellite Velocity (m/s) with Earth Centered Earth Fixed (ECEF) coordinate		
					unit	3	H5T_STRING	unit	m/s				
					validRange	2	H5T_IEEE_F32LE	valid range					
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
122		satelliteVelocityY	1	nray	longName	20	H5T_STRING	long name	satellite velocity Y	H5T_IEEE_F32LE	Y Component of Satellite Velocity (m/s) with Earth Centered Earth Fixed (ECEF) coordinate		
					unit	3	H5T_STRING	unit	m/s				
					validRange	2	H5T_IEEE_F32LE	valid range					
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
123		satelliteVelocityZ	1	nray	longName	20	H5T_STRING	long name	satellite velocity Z	H5T_IEEE_F32LE	Z Component of Satellite Velocity (m/s) with Earth Centered Earth Fixed (ECEF) coordinate		
					unit	3	H5T_STRING	unit	m/s				
					validRange	2	H5T_IEEE_F32LE	valid range					
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
124		solarElevationAngle	1	nray	longName	21	H5T_STRING	long name	solar elevation angle	H5T_IEEE_F32LE			
					unit	4	H5T_STRING	unit	deg.				
					validRange	2	H5T_IEEE_F32LE	valid range	0.0 to 180.0				
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
125		solarAzimuthAngle	1	nray	longName	19	H5T_STRING	long name	solar azimuth angle	H5T_IEEE_F32LE			
					unit	4	H5T_STRING	unit	deg.				
					validRange	2	H5T_IEEE_F32LE	valid range	0.0 to 360.0				
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
126	G	Data											
127		operationalMode	1	nray	longName	16	H5T_STRING	long name	operational mode	H5T_STD_U16LE	Observation Mode (4:Normal Observation 5:Sea-Surface Calibration 6:External Calibration 8: Contingency Observation)		
					unit	8	H5T_STRING	unit	unitless				
					validRange	2	H5T_STD_U16LE	valid range	4 to 8				
					_FillValue	1	H5T_STD_U16LE	fill value	65535				
128		subOperationalMode	1	nray	longName	20	H5T_STRING	long name	sub operational mode	H5T_STD_U16LE	Sub Observation Mode (dataMode=4 1: 12 km Obs 2: 16 km Obs 3: 20 km Obs 5: MIX Obs(12 km) 6; MIX obs(16 km) 7:MIX obs(20 km)) (dataMode=8 1:Contingency Obs 2:External Cal 3:Sea-Surface Cal) (dataMode=5,6,other 0)		
					unit	8	H5T_STRING	unit	unitless				
					validRange	2	H5T_STD_U16LE	valid range	0 to 7				
					_FillValue	1	H5T_STD_U16LE	fill value	65535				
129		rangeBinValidNumber	1	nray	longName	16	H5T_STRING	long name	valid bin number	H5T_STD_I16LE	Number of Valid Range Bin with Observation mode (20,16,12 km)		
					unit	8	H5T_STRING	unit	unitless				
					validRange	2	H5T_STD_I16LE	valid range					
					_FillValue	1	H5T_STD_I16LE	fill value	-32767				
130		rayStatusPrf	1	nray	longName	14	H5T_STRING	long name	ray status prf	H5T_IEEE_F32LE	Pulse Repetition Frequency (PRF) at each ray		
					unit	2	H5T_STRING	unit	Hz				
					validRange	2	H5T_IEEE_F32LE	valid range	0 to 10000				
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				

No	group	Group / Name / Role Name	Dataspace		Attribute					Datatype	Description	Remarks	Example
			Rank	Size	Name	Num	Datatype	Description	Example				
131		integrationNumberEcho	1	nray	longName	30	H5T_STRING	long name	ray status transmission pulses	H5T_STD_I16LE	Pulse Integration Number of the Echo for Each Ray		
					unit	8	H5T_STRING	unit	unitless				
					validRange	2	H5T_STD_I16LE	valid range	0 to 32767				
					_FillValue	1	H5T_STD_I16LE	fill value	-32767				
132		integrationNumberDoppler	1	nray	longName	28	H5T_STRING	long name	ray status pulse-pair number	H5T_STD_I16LE	Integration Number of the Pulse-Pair for Each Ray		
					unit	8	H5T_STRING	unit	unitless				
					validRange	2	H5T_STD_I16LE	valid range	0 to 32767				
					_FillValue	1	H5T_STD_I16LE	fill value	-32767				
133		rayHeaderCalVers	1	1	longName	30	H5T_STRING	long name	ray header calculation version	H5T_STD_U32LE	Calibration table version.(TBD)		
					unit	8	H5T_STRING	unit	unitless				
					validRange	2	H5T_STD_U32LE	valid range					
					_FillValue	1	H5T_STD_U32LE	fill value	4294967295				
134		rayHeaderLambda	1	1	longName	17	H5T_STRING	long name	ray header lambda	H5T_IEEE_F64LE	Radar Wave Length (Fixed Value)		0.003187586
					unit	1	H5T_STRING	unit	m				
					validRange	2	H5T_IEEE_F64LE	valid range					
					_FillValue	1	H5T_IEEE_F64LE	fill value	9.9692099683868690e+36				
135		radarCoefficient	1	nray	longName	17	H5T_STRING	long name	radar coefficient	H5T_IEEE_F32LE	Radar Coefficient for Calculation of Reflectivity		0.032500394
					unit	4	H5T_STRING	unit	$1/m^3$				
					validRange	2	H5T_IEEE_F32LE	valid range					
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
136		pulseWidth	1	nray	longName	11	H5T_STRING	long name	pulse width	H5T_IEEE_F32LE	Estimated Transmit Pulse Length		3.3
					unit	2	H5T_STRING	unit	us				
					validRange	2	H5T_IEEE_F32LE	valid range					
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
137		transmitPower	1	nray	longName	14	H5T_STRING	long name	transmit power	H5T_IEEE_F32LE	Transmit Power of Each Ray		
					unit	1	H5T_STRING	unit	W				
					validRange	2	H5T_IEEE_F32LE	valid range					
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
138		transmitPowerAvg	1	1	longName	22	H5T_STRING	long name	transmit power average	H5T_IEEE_F32LE	Averaged Transmit Power for one Orbital Cycle		
					unit	1	H5T_STRING	unit	W				
					validRange	2	H5T_IEEE_F32LE	valid range					
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
139		pulseShapeWarnFlag	1	nray	longName	21	H5T_STRING	long name	pulse shape warn flag	H5T_STD_U16LE	Quality Flag for Transmit Power Estimation		0
					unit	8	H5T_STRING	unit	unitless				
					validRange	2	H5T_STD_U16LE	valid range					
					_FillValue	1	H5T_STD_U16LE	fill value	65535				
140		receivedEchoPower	2	nray,nbin	longName	19	H5T_STRING	long name	received echo power	H5T_IEEE_F32LE	Received Echo Power before Subtraction of Noise Power		
					unit	1	H5T_STRING	unit	W				
					validRange	2	H5T_IEEE_F32LE	valid range					
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
141		noiseFloorPower	1	nray	longName	17	H5T_STRING	long name	noise floor power	H5T_IEEE_F32LE	Received Noise Level		
					unit	1	H5T_STRING	unit	W				
					validRange	2	H5T_IEEE_F32LE	valid range					
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
142		radarReflectivityFactor	2	nray,nbin	longName	25	H5T_STRING	long name	radar reflectivity factor	H5T_IEEE_F32LE	Radar Reflectivity Factor without Attenuation Correction		
					unit	6	H5T_STRING	unit	mm^6/m^3				
					validRange	2	H5T_IEEE_F32LE	valid range					
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
143		dopplerVelocity	2	nray,nbin	longName	16	H5T_STRING	long name	doppler velocity	H5T_IEEE_F32LE	Radial Doppler Velocity (Corrected with satellite velocity contamination and Doppler reference signal)		
					unit	3	H5T_STRING	unit	m/s				
					validRange	2	H5T_IEEE_F32LE	valid range					
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
144		spectrumWidth	2	nray,nbin	longName	14	H5T_STRING	long name	spectrum width	H5T_IEEE_F32LE	Doppler Spectral Width		
					unit	3	H5T_STRING	unit	m/s				
					validRange	2	H5T_IEEE_F32LE	valid range					
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
145		covarianceCoeff	3	nray,nbin,2	longName	22	H5T_STRING	long name	covariance coefficient	H5T_IEEE_F32LE	Covariance Coefficient of Pulse-Pair with Doppler Reference Correction (Real Part and Imaginary Part)		
					unit	8	H5T_STRING	unit	unitless				
					validRange	2	H5T_IEEE_F32LE	valid range					
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				

No	group	Group / Name / Role Name	Dataspace		Attribute					Datatype	Description	Remarks	Example
			Rank	Size	Name	Num	Datatype	Description	Example				
146		binStatusFlag	1	nray,nbin	longName	15	H5T_STRING	long name	bin status flag	H5T_STD_U8LE	Quality Flag for Received Echo Power and Doppler measurement at each range bin (Echo level at each range bin shows saturation or low level of Log Detector and IQ detector)		0
					unit	8	H5T_STRING	unit	unitless				
					validRange	2	H5T_STD_U8LE	valid range					
					_FillValue	1	H5T_STD_U8LE	fill value	255				
147		txRxStatusFlag	1	nray	longName	16	H5T_STRING	long name	txrx status flag	H5T_STD_U16LE	Quality Flag for Transmitter and Receiver Performance (Transmitter off, Warm-up stage of transmitter, Abnormal Receiver Gain)		
					unit	8	H5T_STRING	unit	unitless				
					validRange	2	H5T_STD_U16LE	valid range					
					_FillValue	1	H5T_STD_U16LE	fill value	65535				
148		dopplerStatusFlag	1	nray	longName	19	H5T_STRING	long name	doppler status flag	H5T_STD_U16LE	Quality Flag for Doppler measurement (Corrections of IQ detector, Doppler Reference signal, Satellite velocity contamination may have larger error)		
					unit	8	H5T_STRING	unit	unitless				
					validRange	2	H5T_STD_U16LE	valid range					
					_FillValue	1	H5T_STD_U16LE	fill value	65535				
149		sigmaZero	1	nray	longName	10	H5T_STRING	long name	sigma zero	H5T_IEEE_F32LE	Normalized Radar Cross Section on Surface		
					unit	2	H5T_STRING	unit	dB				
					validRange	2	H5T_IEEE_F32LE	valid range					
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
150		surfaceBinNumber	1	nray	longName	18	H5T_STRING	long name	surface bin number	H5T_STD_I16LE	Estimated Surface Bin Number (Integer)		
					unit	8	H5T_STRING	unit	unitless				
					validRange	2	H5T_STD_I16LE	valid range					
					_FillValue	1	H5T_STD_I16LE	fill value	-32767				
151		surfaceBinFraction	1	nray	longName	20	H5T_STRING	long name	surface bin fraction	H5T_IEEE_F32LE	Fraction of Surface Bin Number (-0.5 to +0.5)		
					unit	8	H5T_STRING	unit	unitless				
					validRange	2	H5T_IEEE_F32LE	valid range	-0.5 to +0.5				
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36				
152		surfaceEstimationFlag	1	nray	longName	23	H5T_STRING	long name	surface estimation flag	H5T_STD_U16LE	Quality Flag for Surface Bin Estimation		0
					unit	8	H5T_STRING	unit	unitless				
					validRange	2	H5T_STD_U16LE	valid range					
					_FillValue	1	H5T_STD_U16LE	fill value	65535				
153		rayStatusFlag	1	nray	longName	15	H5T_STRING	long name	ray status flag	H5T_STD_U32LE	Quality Flag for onboard Signal Processing and ground L1 processing		0
					unit	8	H5T_STRING	unit	unitless				
					validRange	2	H5T_STD_U32LE	valid range					
					_FillValue	1	H5T_STD_U32LE	fill value	4294967295				

A. Appendix

Table A-1 Open points

No.	Section	Description
1	2.1 Table 2.1-1 CPR operational mode	Frequency/Area and Duration Time of CPR calibration operation will be added after CPR Planning Description is fixed. (by GS-CDR)
2	3.4.1 Flag Definition	The quality information of flag thresholds will be added in section 3.4.1 by MOS-ORR. (MOS-CDR-DL-02)
3	3.4.1 (1) Table 3.4-1 Ray status flag definition	Description of No.10 Ray_Status_Ground_Processing_Error will be added possible ground system error cases by MOS-ORR. (GS-CDR-DL-02)
4	3.4.1 (3) Table 3.4-2 Pulse shape warning flag definition	There is still TBD in the variable description. It will be updated. (by GS-CDR)
5	3.4.2 Quality Definition	The thresholds of "dataQuality" of the product file will be finalized by MOS-ORR.
6	4.3.1 Table 4.3-2 EarthCARE/CPR L1b Product File Format No.9	Validity_Period tag should be modified for compliance to File Format Standard. (by Sep.2017, with v2.3 test data delivery)
7	4.3.1 Table 4.3-2 EarthCARE/CPR L1b Product File Format No.23	The element size of No.23 "productType" should be "4", and example should be "NOM_". This was set corresponding to the PDD Vol.1 (common product definition), but it should be also updated in line with File Format Standard. (by Sep.2017, with v2.3 test data delivery)