SAM-2018016-0F
(MAS-110009K)

EarthCARE/CPR Level 1b Product Definition Document

Sep 2024

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.
C	Jul 2017	2.1 Figure2.1-1 Table4.3-2	Update the name of the observation window. Change the figure to the latest version. Update the name of “surfaceElevation”. Update the description of “subOperationalMode”.
	Jan 2018	1.3 3.1 3.3 Figure3.3-2 Table4.3-2	Add an item in “Term Definition”. Modify the description of “frame ID”. Modify the description of the relationship between “ray”, “frame” and “granule”. Add the description of “processing frame”. Modify the figure of the relationship between “ray”, “frame” and “granule”. Update the value and description of “File_Class”. Update the description of “processingFrameNo”. Update the value of “frameStartMargin” and “frameStopMargin”.
	Mar 2018	Table4.3-2	Modify the description of rayNumber.

Issue	Date	Sheet	Description of Change
D (SAM-2018016NC)	Mar 2019	3.4.1 Table3.4-1 3.4.1(2) 4.3.1 Table4.3-2	Correct the range of spare bits for “Ray Status Flag”. (10-15 --> 10-31) Change the definition of “Surface Estimation Flag”. Rename the following attribute names: - “longName” --> “long_name” - “unit” --> “units” - “validRange” --> “valid_range” Change the following units of HeaderData and ScienceData: - “deg.” --> “degree_north” (for latitude) - “deg.” --> “degree_east” (for longitude) - “deg.” --> “degree” (for others) - “second” --> “seconds since 2000-1-1 00:00:00.0 0:00”” Rename “navigateLandSeaFlg" to "navigateLandWaterFlg" and modify its description. Modify the description of “pitchAngle”, “rollAngle”, and “yawAngle”.
	Apr 2019	Front page 3.3 Figure3.3-1	Add a new document number. (SAM-2018016-0A) Correct the figure caption. (“Product unit” --> “Product frame”)
E draft1 (SAM-2018016A)	Oct. 2020	ALL 1.3. Table2.1-1 Table3.2-2 Figure3.3-3 3.3.1. Figure3.3-4 Figure3.3-5 3.4.2. Table4.3-2	Proofread the document. Update “Term Definition”. Update “Frequency/Area” and “Duration Time”. Update “observed height range” and add “valid data height range”. Update the explanation of observation height range and valid/invalid data Change the word “pps” to “control cycle” Update figures. Update figures. Update quality definition. Add descriptions of “binHeight”, “solarElevationAngle”, and “solarAzimuthAngle”. Add a note of caution about the Units” column. Remove “Units”, “Size of each element”, “Number of elements”, and “Total size” for the Groups. Delete the “valid_range” attribute with no specific values. Add “Datatype” column in the HeaderData table Add a description of the HeaderData group.

Issue	Date	Sheet	Description of Change
F (SAM- 2018016B)	Mar. 2022	3.4.1 Table4.3-2	Add a new quality flag (Ray Quality Flag). Change description of No.9 bit of RayStatusFlag. Add the following header data: “frameStartMarginCount” “frameStopMarginCount” Add the following science data: “rayQualityFlag” “dopplerVelocityAtSurfaceBin” “satelliteVelocityContaminationInLOS” Change datatype of the following science data (H5T_IEEE_F32LE -> H5T_IEEE_F64LE): “xPosition” “yPosition” “zPosition” “satelliteVelocityX” “satelliteVelocityY” “satelliteVelocityZ”

Issue	Date	Sheet	Description of Change
G (SAM-2018016C)	Jan. 2023	2.1 2.2 3.2 Table4.3-2	Add a description to refer to Table 3.2-2. Newly add the section 2.2 to explain the calibration overview. Add a description as to where in the data users can find out what the observation mode is. Modify the description and unit of the following header data: "frameStartMarginCount" "frameStopMarginCount" Fix the wrong time format in the description of the following header group and data: "Validity_Period" "Creation_Date" "sensingStartTime" "sensingStopTime" "processingStartTime" "processingStopTme" "frameStartTime" "frameStopTime" Correct the datatype of _FillValue of the following data. "dopplerVelocityAtSurfaceBin" "satellietVelocityContaminationInLOS" Correct the length of the string for the following header data (60 -> 56). "File_Name" "productName" "originalProductName"
H (SAM-2018016D)	Mar. 2023	Table4.3-2	Modify the description of the following science data "pitchAngle" "rollAngle" "yawAngle" and add the figure to explain the rotation of the satellite orbit frame.
J (SAM-2018016E)	Jul. 2023	Table3.4-1 3.4.1.(1) 3.4.1.(5)	Add a description of "Ray_Status_Altitude_Range_Over_Warning". Add a description of Ray_Status_Altitude_Over_Warning. Add a description of the RCV TEMP to Rx_gain_Warning

Issue	Date	Sheet	Description of Change
	Jul. 2023	1.2.(3) Table3.2-1 Table3.4-2 3.4.2 Table4.3-2	Modify the version. Modify the File size. Modify the description of Bit No.2. Modify the description of product quality. Modify the description of No.25
	Sep. 2023	Table4.3-2	Modify the Name of No.98 from inputFileName to InputFileList.
K (SAM-2018016F)	Dec. 2023	Table4.3-2	Modify the description of No.137 from "Calibration table version" to "L1b version control file version".
	Mar. 2024	Table 3.4-4 Table 3.4-5 Table 3.4-6	Modify the description of No.1 and No.2. Modify the description of No.1. Modify the description of No.8. Delete the description of No.1~7.
	Sep. 2024	1.1 Table4.3-2	Add the description of formatVersion defined in this document. Modify the Datatyepe of the following data: No.36 "formatMajorVersion" No.37 "formatMinorVersion" No.43 "orbitNumber" No.97 "MDSCount" No.159 "dopplerVelocityAtSurfaceBin" No.160 "satelliteVelocityContaminationInLOS" Modify the FillValue's Datatype of the following data: No.122~124 "x/y/zPosition" No.125~127 "satelliteVelocityX/Y/Z" No.159 "dopplerVelocityAtSurfaceBin" No.160 "satelliteVelocityContaminationInLOS"

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.

The version of the product formats defined in this document is 0.11 and must be reflected in the “formatMajorVersion” and “formatMinorVersion” of the MainProductHeader.

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 11)

(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 Issue4.20)

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

1.3. **Term Definition**

No	Term	Definition
1	frame	One orbit data is divided to 8 frames by latitudes of 67.5, 22.5, -22.5, -67.5 degrees, and each frame is assigned individual ID from A to H.
2	control cycle	Control cycle is a cycle of Radar operation and data processing of CPR. The time duration of a control cycle is one second.
3	ray	Ray refers to a single vertical data set of a profile and it is also used as the unit for counting the number of data toward the along-track direction. CPR produces 14 rays in every control cycle during observation.
4	bin	The word of “bin” generally means to convert continuous data into discrete groups. The radars operate by "binning" the received signals, which are sorted into a set of bins by time of arrival.
5	RF	RF stands for Radio Frequency. “RF on” and “RF off” mean that the RF pulse is transmitting to the earth or not from CPR.
6	processing frame	Processing frame refers to a ray in a control cycle.
7	processing frame number	This is the sequential number of rays in a control cycle. It is expressed by the number from 1 to 14.

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 image of the CPR nominal operation. The CPR will change the observation window (basically "middle" in high latitude area and "high" 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).

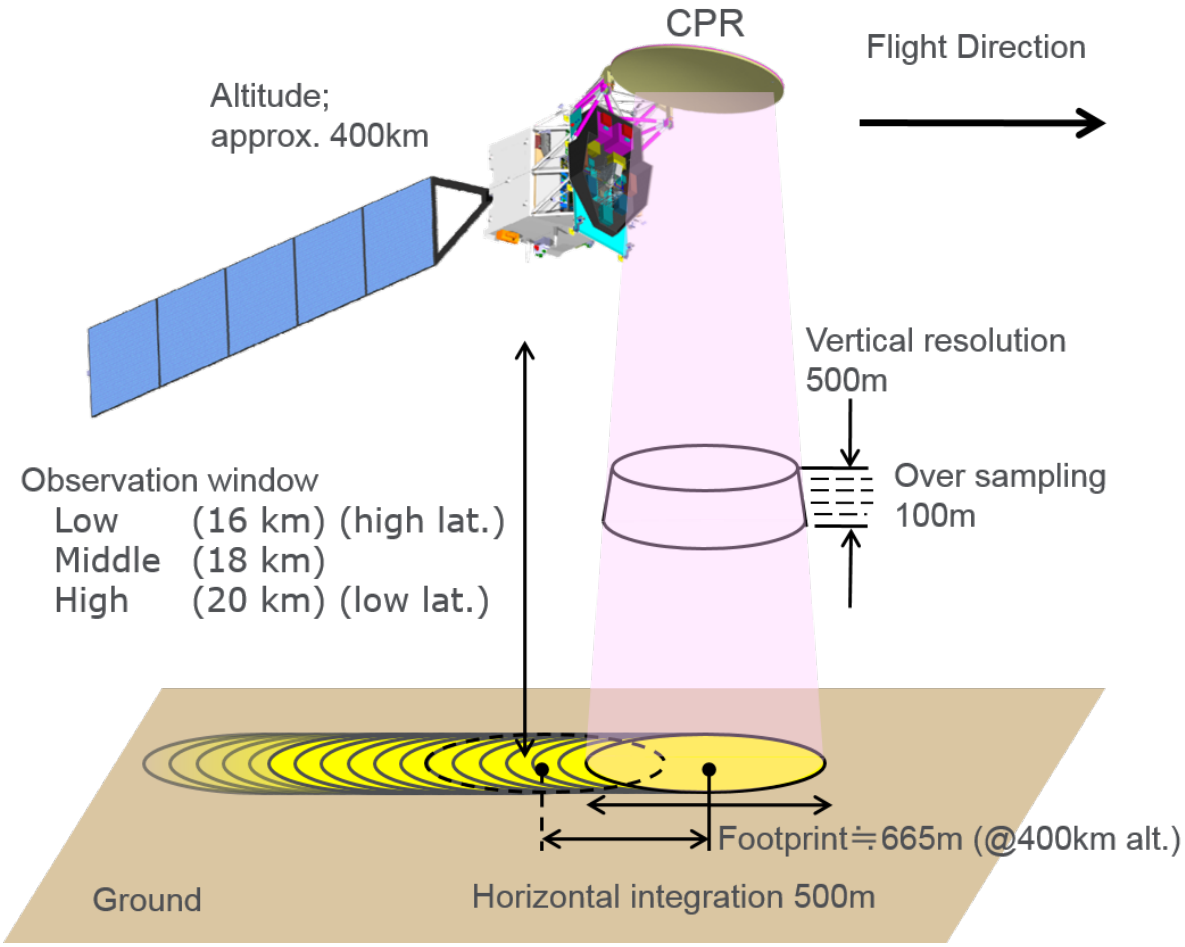


Figure 2.1-1 CPR observation overview

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 when the spacecraft flies over 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.

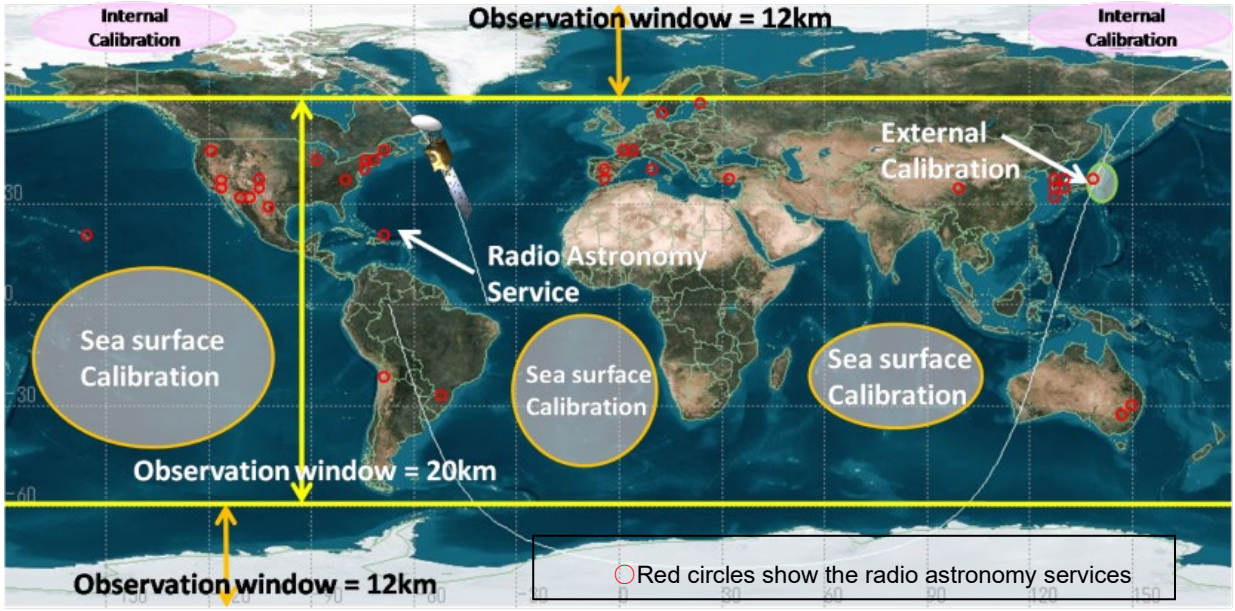


Figure 2.1-2 CPR calibration area image

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 (Refer to Table 3.2-2).

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 "low", "middle" and "high" in accordance with the latitude.	_	_
External Calibration	External calibration mode. ARC measurement is performed in this mode	Up to 1 or 2 per repeat cycle/ Kanto area in Japan	A few seconds
Sea Surface Calibration	Sea surface calibration with satellite roll maneuver	Up to 1 per repeat cycle	Less than 400 seconds

Operational Mode	Description	Frequency/ Area	Duration Time
Internal Calibration	Internal calibration mode without RF transmission	1/month (short time) 4/year (long time)	90 seconds (short time) One orbit (long time)
Contingency Observation	Operation mode with fixed PRF when S/C navigation data is not available or poor accuracy	–	–

2.2. Calibration Overview

There are three objectives for three CPR calibrations as below.

- Sensitivity
- Doppler Velocity
- Antenna Beam Pointing

To assure these performances, CPR obtains various calibration data. There are two types of calibration data. One is acquired with observation data on the Observation Mode. This type of calibration data is used for L1b processing to calibrate the observed data. The other one is acquired on the Calibration Mode such as External Calibration Mode, Sea Surface Calibration Mode, and External Calibration Mode. This type of calibration data is analyzed by the JAXA CPR Integrated Team, which investigates the need to update the calibration tables of the L1b processor. The L1b processor works with multiple calibration tables, which are labeled with single version number, noted in the "rayHeaderCalVers" attribute in the ScienceData/Data group of the L1b product. (Refer to Table 4.3-2 EathCARE/CPR L1b Product File Format). When the calibration table is updated, the "rayHeaderCalVers" will be incremented and which parameters of calibration tables are updated will be described in the release note of the L1 processor [TBC]

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.

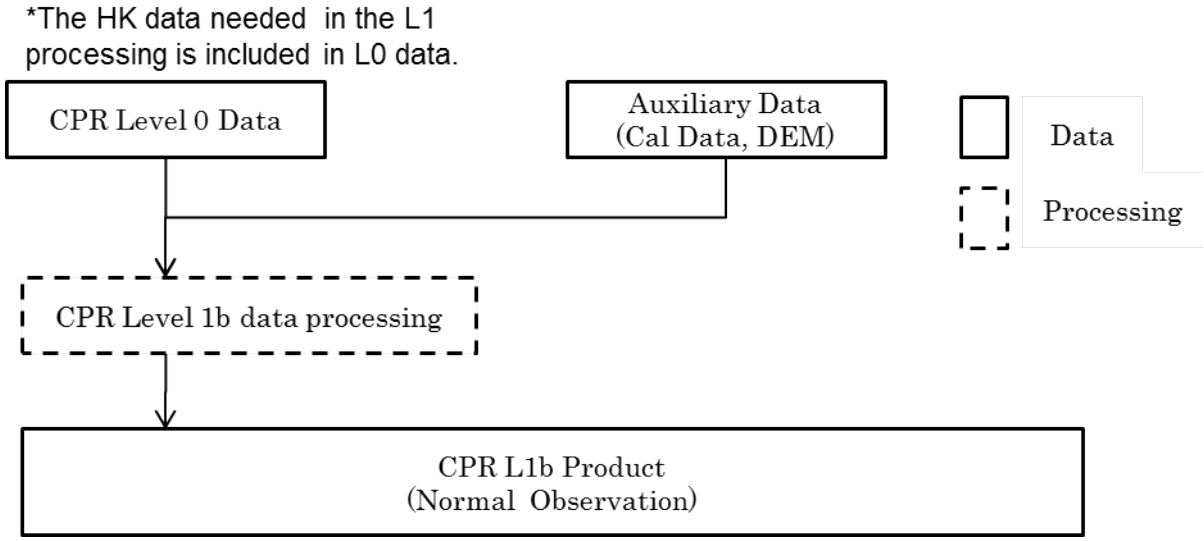


Figure 3.1-1 Input/output data for level 1b data processing

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	60.0MB	

(*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 data stored in the L1b product for each operational mode. 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 the external calibration mode, nominal (RF on) data is stored only for the bins higher than the specific altitude. The silent state data in external calibration mode is not stored. The nominal data in the sea surface calibration mode and the internal calibration mode are not stored either. These calibration modes are supposed to give no data.

Table 3.2-2 the stored data in L1b product for each operation mode

operational mode	nominal (RF on)	silent state (RF off)	observed height range	valid data height range
Nominal Observation	✓	✓ (noise)	-1 to 16 km (Low) -1 to 18 km (Middle) -1 to 20 km (High)	-1 to 16 km -1 to 18 km -1 to 20 km
External Calibration	✓	missing	-3 to 18 km	-1 to 18 km
Sea Surface Calibration	missing	N/A	N/A	missing
Internal Calibration	missing	N/A	N/A	missing
Contingency Observation	✓	✓ (noise)	Depends on satellite height	-1 to 20 km (*2)

(*2) Doppler data is not included.

Users of L1b product can confirm the operational mode by looking at the attributes “operationalMode” and “subOperationalMode” in the ScienceData/Data group of the L1b product (Refer to Table 4.3-2 EarthCARE/CPR L1b Product File Format)

3.3. Product Outline

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

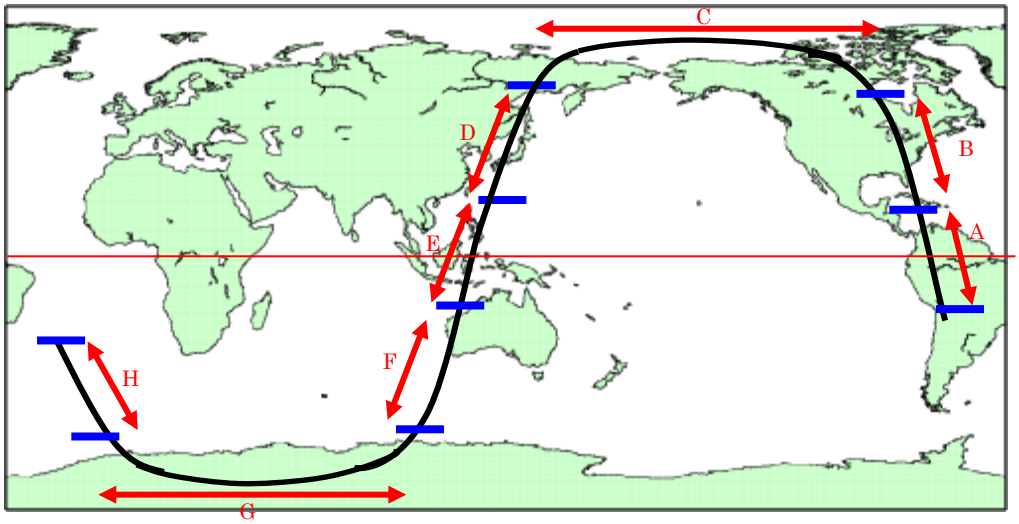


Figure 3.3-1 Product frame on a world map

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 56 rays. 56 rays are the overlap with the previous frame (28 rays) and next frame (28 rays). There are approximately 9718 rays per frame and 218 bins (or 544 bins / contingency observation) per ray. The number of the rays and the bins per granule depends on the observation mode included in a granule.

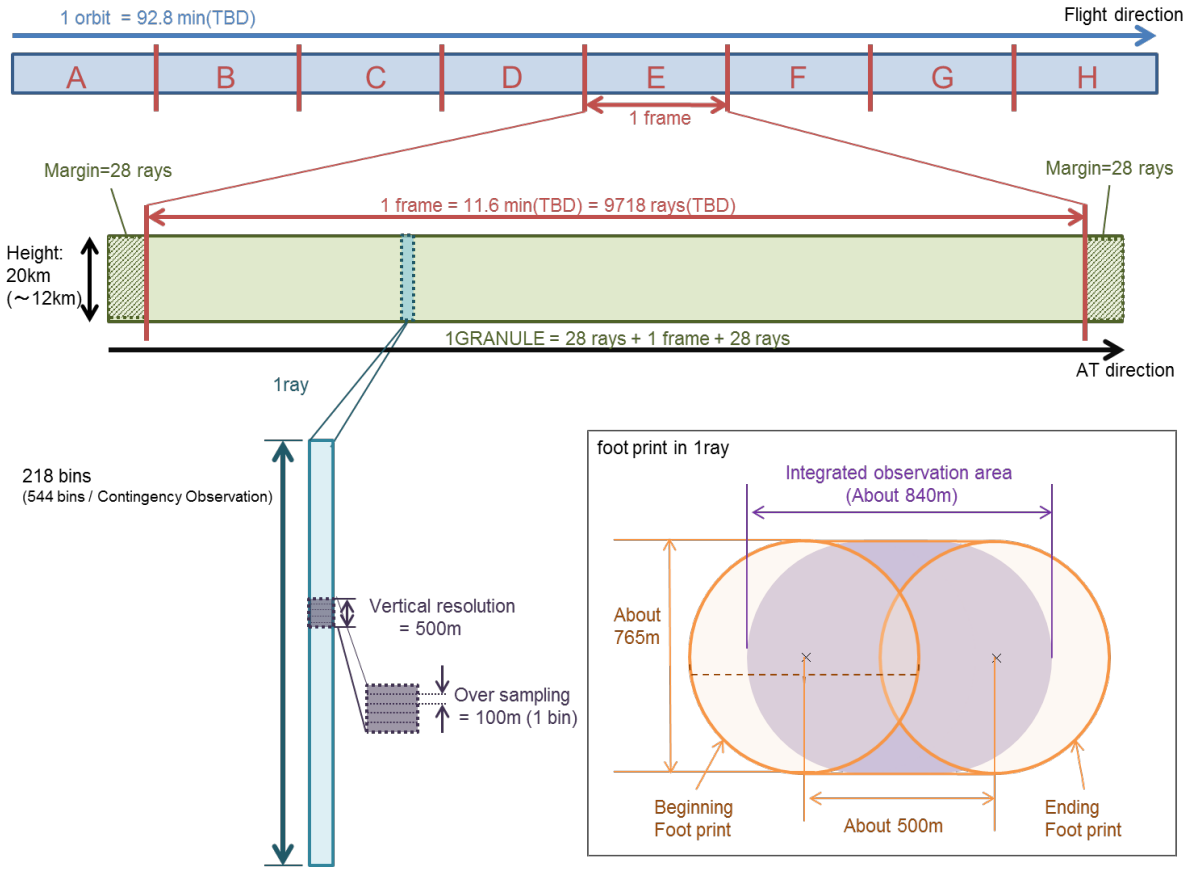


Figure 3.3-2 footprint and granule size

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 time when the satellite crosses the frame border, which is defined by specific latitudes in L1b processing. However, if the data which corresponds to the start or the end of the frame is missed in L0 data, the “frame start” and “frame end” in L0 data are referred.

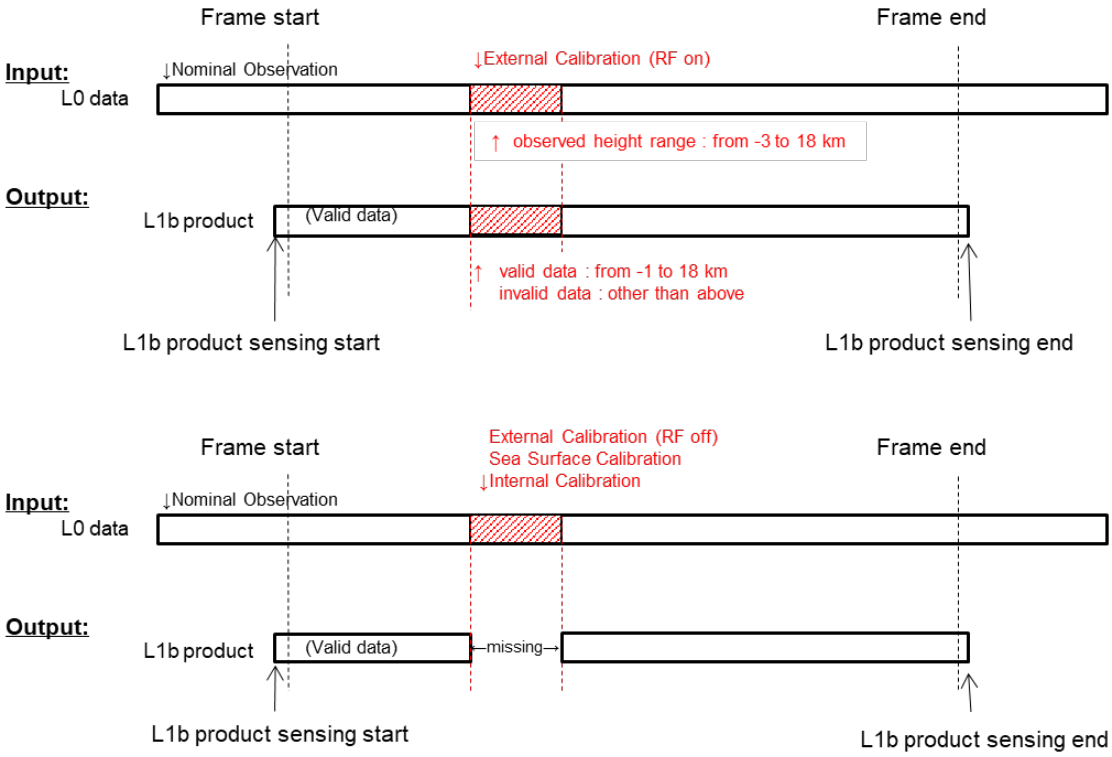


Figure 3.3-3 Calibration data in L1b product

The number of missing rays 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 rays from frame start to frame end in a L1b product. (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 latitudes are showed in Table 3.3-2.

Table 3.3-2 boundary latitude

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

frame ID	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

Each ray in a control cycle is called “processing frame”. Because L2 processing needs to be executed per two rays ("1st and 2nd", "3rd and 4th", …, "13th and 14th"), the ray (processing frame) number of start position in the frame needs to be an odd number. In case that the first ray just after the frame boundary is an even number, L1 processing sets the next odd number as a start position. In the bottom in **Figure 3.3-4** and **Figure 3.3-5**, start position is 9th ray in 3rd control cycle (not 8th ray in 3rd control cycle) and end position is 10th ray in 101th control cycle (not 9th ray in 101th control cycle). The margin is 28 rays before and after the frame.

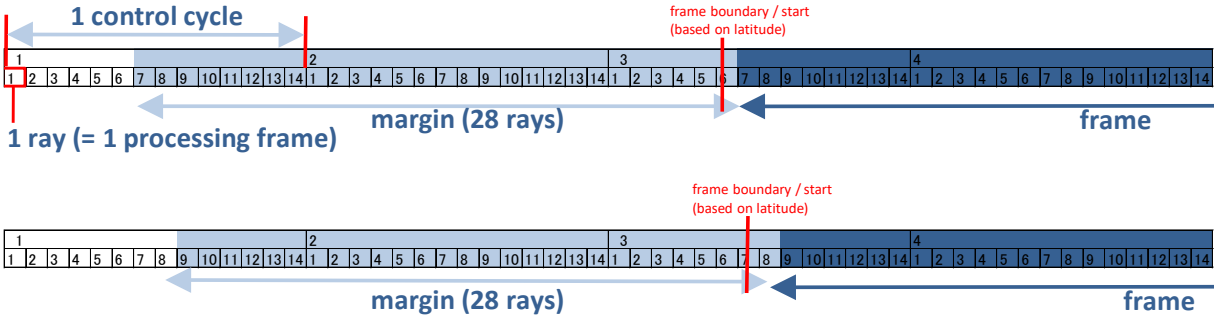


Figure 3.3-4 Definition of frame start position

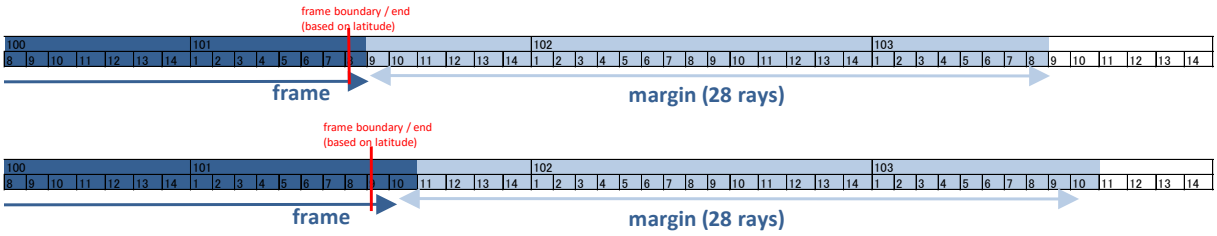


Figure 3.3-5 Definition of frame end position

The sensing start and end time is defined as follows.

- sensing start time

  “profile time” of the first ray in L1b product

  (9th ray/1st control cycle in the bottom in **Figure 3.3-4**)

- sensing end time

  “profile time” of the last ray in L1b product

  (10th ray/103rd control cycle 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 by 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 by 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

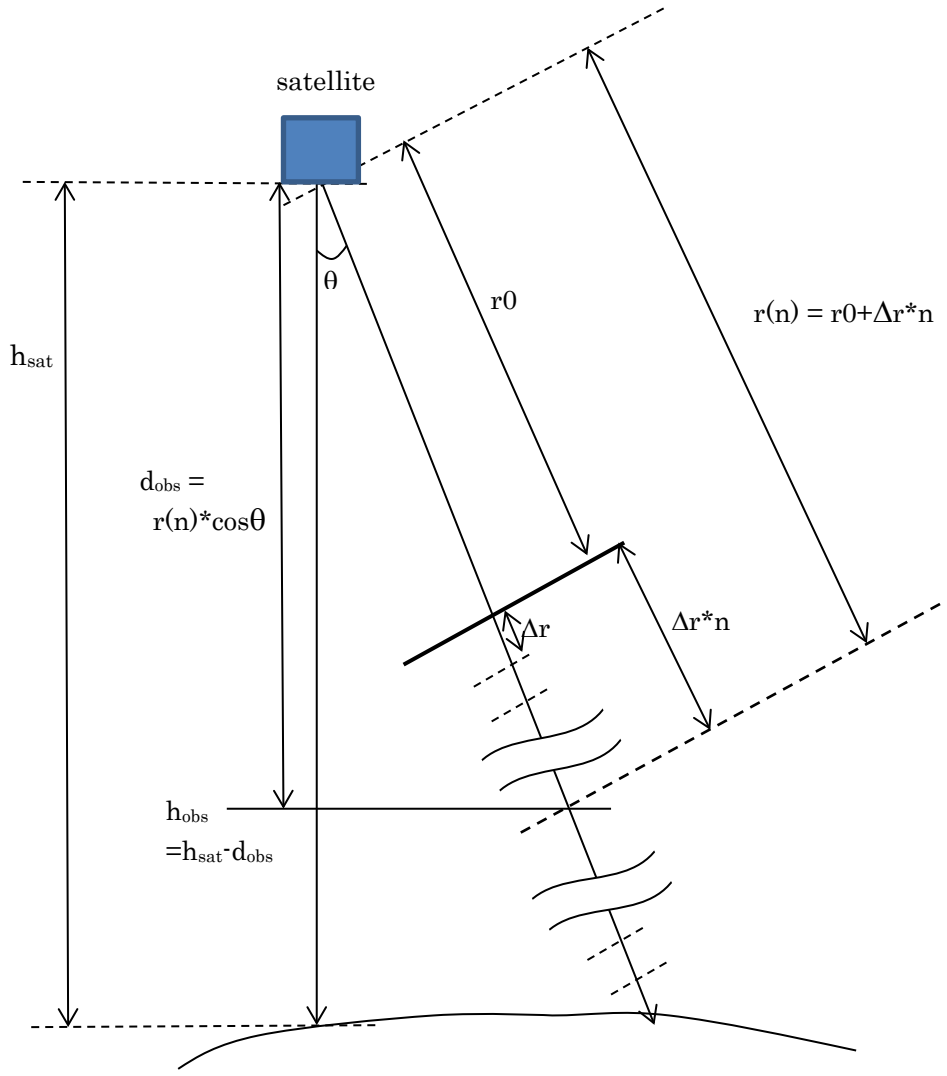


Figure 3.3–6 Observation altitude

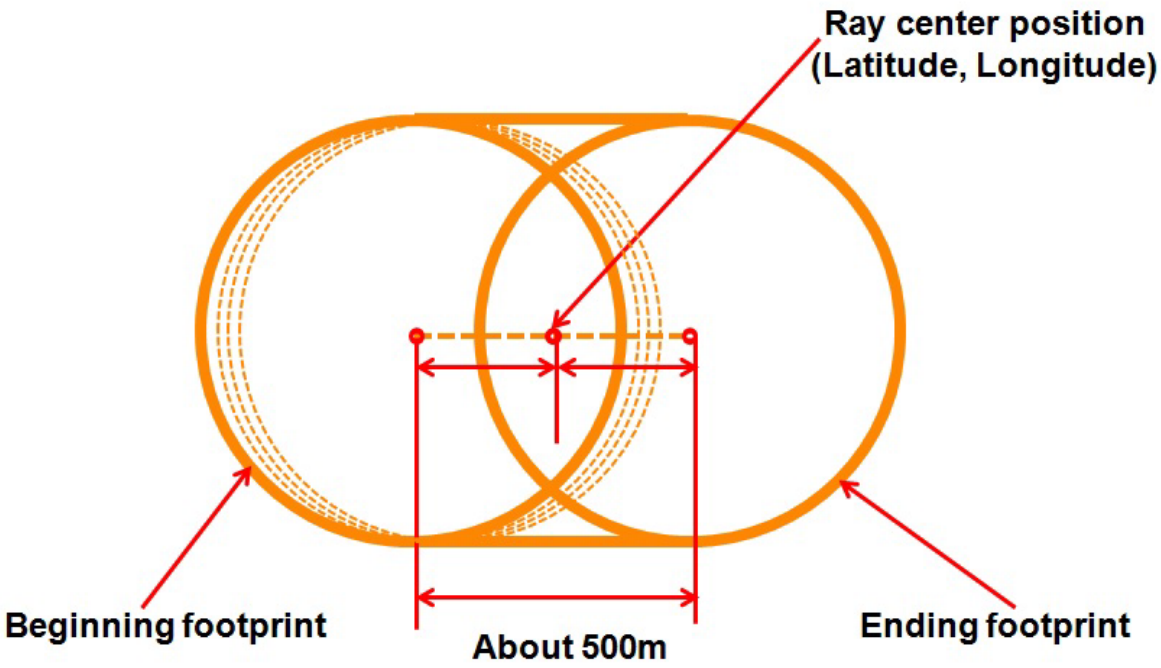


Figure 3.3-7 Ray center position

3.4. Quality Information

3.4.1. Flag Definition

The following flags are included in L1b product for the information of product 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")
- Ray Quality 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 which occur in the ground L1 data processing. Altitude_Range_Over_Warning shows that satellite altitude has exceeded the altitude range shown in the PRF table. 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

Bit No (MSB)	Name	Description
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	(Not used)
10	Ray_Status_Altitude_Range_Over_Warning	The satellite altitude is outside the range shown in the PRF table. If it is in Contingency observation mode, don't set up a flag.
11-31	(Spare)	

(2) Surface Estimation Flag

This flag shows failure of surface estimation algorithm in L1 data processing. If this flag is not zero, surface detection is failed, so the error values are set to **surfaceBinNumber**, **surfaceBinFraction** and **sigmaZero**.

Table 3.4-2 Surface estimation flag definition

Bit No (MSB)	Name	Description
0	Surface_estimation	Surface detection failure
1-15	(Spare)	

(3) Pulse Shape Warning Flag

This flag shows reliability of estimated **transmitPower** using power monitor and Doppler reference signal. This flag affects reliability of **radarReflectivityFactor** and **sigmaZero**.

Table 3.4-3 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	It is impossible to calculate. (Not used)
3-15	(Spare)	

(4) Doppler Status Flag

This flag shows reliability of estimated **dopplerVelocity** and **covarianceCoeff** judged from CPR and satellite information.

Table 3.4-4 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 [TBD]. The threshold will be determined after starting in-orbit operation.
2	Doppler_Status_Stellite_Velocity_Correction_Warning	Radial satellite velocity for Doppler correction is above threshold[TBD]. The threshold will be determined after starting in-orbit operation.
3		Offset Function Status is “DIS”.
4		It is impossible to judge the temperature change.
5 -15	(Spare)	

(5) Tx Rx Status Flag

This flag shows status of transmitter and receiver of CPR. Rx_gain_Warning bit flag affects reliability of **noiseFloorPower**, **receivedEchoPower**, **radarReflectivityFactor**, **spectrumWidth**, **sigmaZero**, **RCV-A TEMP** and **RCV-B TEMP**. 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 3.4-5 Tx Rx status flag definition

Bit No (MSB)	Name	Description
0	TxRx_Status_Tx_Off_Warning	No pulse transmission
1	TxRx_Status_Tx_Unstable_Warning	Estimated receiver gain is out of normal range [TBD]. The normal range will be determined after starting in-orbit operation.
2	TxRx_Status_Rx_Gain_Warning	Estimated receiver gain or RCV-A/B TEMP or both are out of normal range
3	TxRx_Status_PLO_Unlock_Warning	There is one or more PLO_lock
4 - 15	(Spare)	

(6) Ray Quality Flag

This flag shows a comprehensive quality information determined by the other quality flags in "ray" (i.e. Ray Status Flag, Surface Estimation Flag, Pulse Shape Warn Flag, Doppler Status Flag, and Tx Rx Status Flag). Each bit of the flag depends on the combination of these five flags masked by the bit masks defined in the L1b process configurations. When all quality flags in “ray” show no errors and no warnings, this flag indicates “0”.

Table 3.4-6 Ray quality flag definition

Bit No (MSB)	Conditions to set the bit to 1
0	This flag is set If any flag is raised in RayStatusFlag, SurfaceEstimationFlag, Pulse ShapeWarnFlag, DopplerStatusFlag, or TxRxStatusFlag.
1-7	(Not used)

(7) 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.

Table 3.4-7 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 CPR L1b product is defined whether product has any valid rays or not. If CPR L1b product has "invalid" ray greater than the standard inadequate data rate, it is defined as "FAIR". Otherwise, it is defined as "GOOD". Standard inadequate data rate is defined in the L1b processing configuration file. If a CPR L1b product has only “invalid” rays, it is defined as “NG”. CPR L1b product defined as “NG” will not be released. A

"valid" ray is defined that all the flags indicated in 3.4.1.(1), 3.4.1.(2), 3.4.1.(3), 3.4.1.(4) and 3.4.1.(5) (except in 3.4.1.(6)) are 0, and an "invalid" ray is defined that at least one flag is not 0.

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 _ n n n n n f _ v V v . h 5
①       ②  ③       ④       ⑤       ⑥                                ⑦                                ⑧         ⑨  ⑩    ⑪
```

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	File identifier	3	「NOM」【Fixed】
	Separator	1	「_」(Underscore)【Fixed】
⑤	Process level, Process 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	Orbit number	5	nnnnn:00001-99999
⑨	frame ID	1	f: A-H
	Separator	1	「_」(Underscore)【Fixed】
⑩	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.
⑪	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, the format of which is HDF5 of version 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

No	group	Group / Name / Role Name	Dataspace		Attribute					Datatype	Description
			Rank	Size	Name	Num	Datatype	Description	Example		
103	G	**ScienceData**									
104	G	**Geo**									
105		rayNumber	1	1	long_name	10	H5T_STRING	long name	ray number	H5T_STD_I16LE	Number of Ray within L1B Product (28(Frame start margin ray) + One Frame + 28(Frame stop margin ray))
					units	8	H5T_STRING	unit	unitless		
					valid_range	2	H5T_STD_I16LE	valid range	0 to 32767		
					_FillValue	1	H5T_STD_I16LE	fill value	-32767		
106		rangeBinMaxNumber	1	1	long_name	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)
					units	8	H5T_STRING	unit	unitless		
					valid_range	2	H5T_STD_I16LE	valid range	218 to 544		
					_FillValue	1	H5T_STD_I16LE	fill value	-32767		
107		profileTime	1	nray	long_name	12	H5T_STRING	long name	profile time	H5T_IEEE_F64LE	Representative Time of each ray Sequential seconds counted from 1/1/2000.
					units	38	H5T_STRING	unit	seconds since 2000-1-1 00:00:00.0 0:00		
					_FillValue	1	H5T_IEEE_F64LE	fill value	9.9692099683868690e+36		
108		timeFlag	1	nray	long_name	9	H5T_STRING	long name	time flag	H5T_STD_U16LE	Synchronization Flag between CPR time and Satellite time (1: Synchronized 0: Unsynchronized)
					units	8	H5T_STRING	unit	unitless		
					valid_range	2	H5T_STD_U16LE	valid range	0 to 1		
					_FillValue	1	H5T_STD_U16LE	fill value	65535		
109		latitude	1	nray	long_name	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
					units	12	H5T_STRING	unit	degree_north		
					valid_range	2	H5T_IEEE_F64LE	valid range	-90 to +90		
					_FillValue	1	H5T_IEEE_F64LE	fill value	9.9692099683868690e+36		
110		longitude	1	nray	long_name	9	H5T_STRING	long name	longitude	H5T_IEEE_F64LE	Longitude (degree) of ray center position given in geodetic reference frame. See Figure 3.3-7
					units	11	H5T_STRING	unit	degree_east		
					valid_range	2	H5T_IEEE_F64LE	valid range	-180 to 180		
					_FillValue	1	H5T_IEEE_F64LE	fill value	9.9692099683868690e+36		
111		rayHeaderSpatAvg	1	nray	long_name	26	H5T_STRING	long name	ray header spatial average	H5T_IEEE_F32LE	Horizontal Satellite-Track Length for one Ray
					units	1	H5T_STRING	unit	m		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36		
112		processingFrameNo	1	nray	long_name	23	H5T_STRING	long name	processing frame number	H5T_STD_I16LE	Sequential number of rays in each control cycle
					units	8	H5T_STRING	unit	unitless		
					valid_range	2	H5T_STD_I16LE	valid range	1 to 14		
					_FillValue	1	H5T_STD_I16LE	fill value	-32767		
113		rangeToIntercept	1	nray	long_name	18	H5T_STRING	long name	range to intercept	H5T_IEEE_F32LE	Range(m) from Satellite to the geoid surface at each ray
					units	1	H5T_STRING	unit	m		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36		
114		surfaceElevation	1	nray	long_name	25	H5T_STRING	long name	surface elevation (WGS84)	H5T_IEEE_F32LE	Representative surface elevation (m) from the WGS84 surface at each ray
					units	1	H5T_STRING	unit	m		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36		

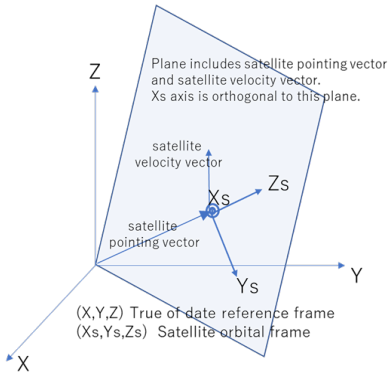
No	group	Group / Name / Role Name	Dataspace		Attribute					Datatype	Description
			Rank	Size	Name	Num	Datatype	Description	Example		
115		binHeight	2	nray,nbin	long_name	10	H5T_STRING	long name	bin height	H5T_IEEE_F32LE	Representative height (m) from the WGS84 surface corresponding to each bin
					units	1	H5T_STRING	unit	m		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36		
116		navigationLandWaterFlg	1	nray	long_name	26	H5T_STRING	long name	navigation land water flag	H5T_STD_U16LE	Land-Water Flag (0:water 1:land 65535:invalid) The land/water mask derived from Globcover is used.
					units	8	H5T_STRING	unit	unitless		
					valid_range	2	H5T_STD_U16LE	valid range	0 to 1		
					_FillValue	1	H5T_STD_U16LE	fill value	65535		
117		rangeToFirstBin	1	nray	long_name	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
					units	1	H5T_STRING	unit	m		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36		
118		rayHeaderRangeBinSize	1	1	long_name	25	H5T_STRING	long name	ray header range bin size	H5T_IEEE_F32LE	One Sample Bin Range (m) (Fixed value from L1specific file)
					units	1	H5T_STRING	unit	m		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36		
119		pitchAngle	1	nray	long_name	11	H5T_STRING	long name	pitch angle	H5T_IEEE_F32LE	Rotation angle around rotated -Xs. See the figure and description of pitch angle(*1). Note that this angle includes the satellite attitude and the CPR antenna's offset angle determined by CPR attachment error and thermal distortion of the antenna.
					units	6	H5T_STRING	unit	degree		
					valid_range	2	H5T_IEEE_F32LE	valid range	-180.0 to 180.0		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36		
120		rollAngle	1	nray	long_name	10	H5T_STRING	long name	roll angle	H5T_IEEE_F32LE	Rotation angle around -Ys (satellite orbit frame). See the figure and description of roll angle(*1). Note that this angle includes the satellite attitude and the antenna's offset angle determined by CPR attachment error and thermal distortion of the antenna.
					units	6	H5T_STRING	unit	degree		
					valid_range	2	H5T_IEEE_F32LE	valid range	-180.0 to 180.0		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36		
121		yawAngle	1	nray	long_name	9	H5T_STRING	long name	yaw angle	H5T_IEEE_F32LE	Rotation angle around rotated $+Z^1$s axis. See the figure and description of yaw angle(*1). Note that this angle includes the satellite attitude and the antenna's offset angle determined by CPR attachment error.
					units	6	H5T_STRING	unit	degree		
					valid_range	2	H5T_IEEE_F32LE	valid range	-180.0 to 180.0		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36		
122		xPosition	1	nray	long_name	20	H5T_STRING	long name	satellite position X	H5T_IEEE_F64LE	X Position of Satellite (m) with Earth Centered Earth Fixed (ECEF) coordinate
					units	1	H5T_STRING	unit	m		
					_FillValue	1	H5T_IEEE_F64LE	fill value	9.9692099683868690e+36		
123		yPosition	1	nray	long_name	20	H5T_STRING	long name	satellite position Y	H5T_IEEE_F64LE	Y Position of Satellite (m) with Earth Centered Earth Fixed (ECEF) coordinate
					units	1	H5T_STRING	unit	m		
					_FillValue	1	H5T_IEEE_F64LE	fill value	9.9692099683868690e+36		
124		zPosition	1	nray	long_name	20	H5T_STRING	long name	satellite position Z	H5T_IEEE_F64LE	Z Position of Satellite (m) with Earth Centered Earth Fixed (ECEF) coordinate
					units	1	H5T_STRING	unit	m		
					_FillValue	1	H5T_IEEE_F64LE	fill value	9.9692099683868690e+36		
125		satelliteVelocityX	1	nray	long_name	20	H5T_STRING	long name	satellite velocity X	H5T_IEEE_F64LE	X Component of Satellite Velocity (m/s) with Earth Centered Earth Fixed (ECEF) coordinate
					units	3	H5T_STRING	unit	m/s		
					_FillValue	1	H5T_IEEE_F64LE	fill value	9.9692099683868690e+36		

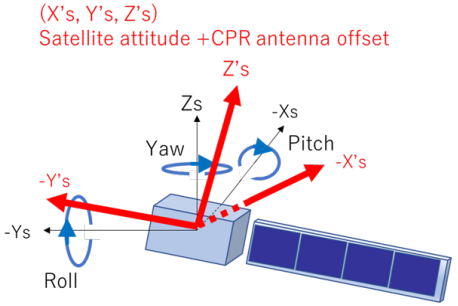
No	group	Group / Name / Role Name	Dataspace		Attribute					Datatype	Description
			Rank	Size	Name	Num	Datatype	Description	Example		
126		satelliteVelocityY	1	nray	long_name	20	H5T_STRING	long name	satellite velocity Y	H5T_IEEE_F64LE	Y Component of Satellite Velocity (m/s) with Earth Centered Earth Fixed (ECEF) coordinate
					units	3	H5T_STRING	unit	m/s		
					_FillValue	1	H5T_IEEE_F64LE	fill value	9.9692099683868690e+36		
127		satelliteVelocityZ	1	nray	long_name	20	H5T_STRING	long name	satellite velocity Z	H5T_IEEE_F64LE	Z Component of Satellite Velocity (m/s) with Earth Centered Earth Fixed (ECEF) coordinate
					units	3	H5T_STRING	unit	m/s		
					_FillValue	1	H5T_IEEE_F64LE	fill value	9.9692099683868690e+36		
128		solarElevationAngle	1	nray	long_name	21	H5T_STRING	long name	solar elevation angle	H5T_IEEE_F32LE	Solar elevation angle
					units	6	H5T_STRING	unit	degree		
					valid_range	2	H5T_IEEE_F32LE	valid range	0.0 to 180.0		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36		
129		solarAzimuthAngle	1	nray	long_name	19	H5T_STRING	long name	solar azimuth angle	H5T_IEEE_F32LE	Solar azimuth angle
					units	6	H5T_STRING	unit	degree		
					valid_range	2	H5T_IEEE_F32LE	valid range	0.0 to 360.0		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36		
130	G	**Data**									
131		operationalMode	1	nray	long_name	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)
					units	8	H5T_STRING	unit	unitless		
					valid_range	2	H5T_STD_U16LE	valid range	4 to 8		
					_FillValue	1	H5T_STD_U16LE	fill value	65535		
132		subOperationalMode	1	nray	long_name	20	H5T_STRING	long name	sub operational mode	H5T_STD_U16LE	Sub Observation Mode (operationalMode=4 1:Low 2:Middle 3:High 5:MIX Obs(Low) 6:MIX obs(Middle) 7:MIX obs(High)) (operationalMode=8 1:Contingency Obs 2:External Cal 3:Sea-Surface Cal) (operationalMode=5,6,other 0)
					units	8	H5T_STRING	unit	unitless		
					valid_range	2	H5T_STD_U16LE	valid range	0 to 7		
					_FillValue	1	H5T_STD_U16LE	fill value	65535		
133		rangeBinValidNumber	1	nray	long_name	16	H5T_STRING	long name	valid bin number	H5T_STD_I16LE	Number of Valid Range Bin with Observation mode
					units	8	H5T_STRING	unit	unitless		
					_FillValue	1	H5T_STD_I16LE	fill value	-32767		
134		rayStatusPrf	1	nray	long_name	14	H5T_STRING	long name	ray status prf	H5T_IEEE_F32LE	Pulse Repetition Frequency (PRF) at each ray
					units	2	H5T_STRING	unit	Hz		
					valid_range	2	H5T_IEEE_F32LE	valid range	0 to 10000		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36		
135		integrationNumberEcho	1	nray	long_name	30	H5T_STRING	long name	ray status transmission pulses	H5T_STD_I16LE	Pulse Integration Number of the Echo for Each Ray
					units	8	H5T_STRING	unit	unitless		
					valid_range	2	H5T_STD_I16LE	valid range	0 to 32767		
					_FillValue	1	H5T_STD_I16LE	fill value	-32767		

No	group	Group / Name / Role Name	Dataspace		Attribute					Datatype	Description
			Rank	Size	Name	Num	Datatype	Description	Example		
136		integrationNumberDoppler	1	nray	long_name	28	H5T_STRING	long name	ray status pulse-pair number	H5T_STD_I16LE	Integration Number of the Pulse-Pair for Each Ray
					units	8	H5T_STRING	unit	unitless		
					valid_range	2	H5T_STD_I16LE	valid range	0 to 32767		
					_FillValue	1	H5T_STD_I16LE	fill value	-32767		
137		rayHeaderCalVers	1	1	long_name	30	H5T_STRING	long name	ray header calculation version	H5T_STD_U32LE	L1b version control file version.
					units	8	H5T_STRING	unit	unitless		
					_FillValue	1	H5T_STD_U32LE	fill value	4294967295		
138		rayHeaderLambda	1	1	long_name	17	H5T_STRING	long name	ray header lambda	H5T_IEEE_F64LE	Radar Wave Length (Fixed Value)
					units	1	H5T_STRING	unit	m		
					_FillValue	1	H5T_IEEE_F64LE	fill value	9.96920996838686 90e+36		
139		radarCoefficient	1	nray	long_name	17	H5T_STRING	long name	radar coefficient	H5T_IEEE_F32LE	Radar Coefficient for Calculation of Reflectivity
					units	4	H5T_STRING	unit	$1/m^3$		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.96920996838686 90e+36		
140		pulseWidth	1	nray	long_name	11	H5T_STRING	long name	pulse width	H5T_IEEE_F32LE	Estimated Transmit Pulse Length
					units	2	H5T_STRING	unit	us		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.96920996838686 90e+36		
141		transmitPower	1	nray	long_name	14	H5T_STRING	long name	transmit power	H5T_IEEE_F32LE	Transmit Power of Each Ray
					units	1	H5T_STRING	unit	W		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.96920996838686 90e+36		
142		transmitPowerAvg	1	1	long_name	22	H5T_STRING	long name	transmit power average	H5T_IEEE_F32LE	Averaged Transmit Power for one Orbital Cycle
					units	1	H5T_STRING	unit	W		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.96920996838686 90e+36		
143		pulseShapeWarnFlag	1	nray	long_name	21	H5T_STRING	long name	pulse shape warn flag	H5T_STD_U16LE	Quality Flag for Transmit Power Estimation
					units	8	H5T_STRING	unit	unitless		
					_FillValue	1	H5T_STD_U16LE	fill value	65535		
144		receivedEchoPower	2	nray,nbin	long_name	19	H5T_STRING	long name	received echo power	H5T_IEEE_F32LE	Received Echo Power before Subtraction of Noise Power
					units	1	H5T_STRING	unit	W		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.96920996838686 90e+36		
145		noiseFloorPower	1	nray	long_name	17	H5T_STRING	long name	noise floor power	H5T_IEEE_F32LE	Received Noise Level
					units	1	H5T_STRING	unit	W		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.96920996838686 90e+36		
146		radarReflectivityFactor	2	nray,nbin	long_name	25	H5T_STRING	long name	radar reflectivity factor	H5T_IEEE_F32LE	Radar Reflectivity Factor without Attenuation Correction
					units	6	H5T_STRING	unit	mm^6/m^3		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.96920996838686 90e+36		

No	group	Group / Name / Role Name	Dataspace		Attribute					Datatype	Description
			Rank	Size	Name	Num	Datatype	Description	Example		
147		dopplerVelocity	2	nray,nbin	long_name	16	H5T_STRING	long name	doppler velocity	H5T_IEEE_F32LE	Radial Doppler Velocity (Corrected with satellite velocity contamination and Doppler reference signal)
					units	3	H5T_STRING	unit	m/s		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36		
148		spectrumWidth	2	nray,nbin	long_name	14	H5T_STRING	long name	spectrum width	H5T_IEEE_F32LE	Doppler Spectral Width
					units	3	H5T_STRING	unit	m/s		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36		
149		covarianceCoeff	3	nray,nbin,2	long_name	22	H5T_STRING	long name	covariance coefficient	H5T_IEEE_F32LE	Covariance Coefficient of Pulse-Pair with Doppler Reference Correction (Real Part and Imaginary Part)
					units	8	H5T_STRING	unit	unitless		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36		
150		binStatusFlag	2	nray,nbin	long_name	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)
					units	8	H5T_STRING	unit	unitless		
					_FillValue	1	H5T_STD_U8LE	fill value	255		
151		txRxStatusFlag	1	nray	long_name	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)
					units	8	H5T_STRING	unit	unitless		
					_FillValue	1	H5T_STD_U16LE	fill value	65535		
152		dopplerStatusFlag	1	nray	long_name	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)
					units	8	H5T_STRING	unit	unitless		
					_FillValue	1	H5T_STD_U16LE	fill value	65535		
153		sigmaZero	1	nray	long_name	10	H5T_STRING	long name	sigma zero	H5T_IEEE_F32LE	Normalized Radar Cross Section on Surface
					units	2	H5T_STRING	unit	dB		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36		
154		surfaceBinNumber	1	nray	long_name	18	H5T_STRING	long name	surface bin number	H5T_STD_I16LE	Estimated Surface Bin Number (Integer)
					units	8	H5T_STRING	unit	unitless		
					_FillValue	1	H5T_STD_I16LE	fill value	-32767		
155		surfaceBinFraction	1	nray	long_name	20	H5T_STRING	long name	surface bin fraction	H5T_IEEE_F32LE	Fraction of Surface Bin Number (-0.5 to +0.5)
					units	8	H5T_STRING	unit	unitless		
					valid_range	2	H5T_IEEE_F32LE	valid range	-0.5 to +0.5		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36		
156		surfaceEstimationFlag	1	nray	long_name	23	H5T_STRING	long name	surface estimation flag	H5T_STD_U16LE	Quality Flag for Surface Bin Estimation
					units	8	H5T_STRING	unit	unitless		
					_FillValue	1	H5T_STD_U16LE	fill value	65535		
157		rayStatusFlag	1	nray	long_name	15	H5T_STRING	long name	ray status flag	H5T_STD_U32LE	Quality Flag for onboard Signal Processing and ground L1 processing
					units	8	H5T_STRING	unit	unitless		
					_FillValue	1	H5T_STD_U32LE	fill value	4294967295		
158		rayQualityFlag	1	nray	long_name	16	H5T_STRING	long name	ray quality flag	H5T_STD_U8LE	Quality information determined by combinations of the other quality flags in "ray" (rayStatusFlag, surfaceEstimationFlag, pulseShapeWarnFlag, dopplerStatusFlag,txRxStatusFlag). When all quality flags in "ray" show no errors and no warnings, this flag indicates "0"
					units	8	H5T_STRING	unit	unitless		
					_FillValue	1	H5T_STD_U8LE	fill value	255		
159		dopplerVelocityAtSurfaceBin	1	nray	long_name	31	H5T_STRING	long name	doppler velocity at surface bin	H5T_IEEE_F32LE	Doppler velocity at the surface bin
					units	3	H5T_STRING	unit	m/s		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36		

No	group	Group / Name / Role Name	Dataspace		Attribute					Datatype	Description
			Rank	Size	Name	Num	Datatype	Description	Example		
160		satelliteVelocityContaminationInLOS	1	nray	long_name	49	H5T_STRING	long name	satellite velocity contamination in line-of-sight	H5T_IEEE_F32LE	Satellite velocity in line-of-sight (LOS)
					units	3	H5T_STRING	unit	m/s		
					_FillValue	1	H5T_IEEE_F32LE	fill value	9.9692099683868690e+36		





(*1) [Earth Observation Mission CFI Software CONVENTION DOCUMENT Sec.5.2.1&7.7]
The Satellite Orbit Frame (Xs, Ys, Zs) is defined by the satellite position vector and satellite velocity vector as shown in the left figure.
The CFI libraries apply the following convention when using Euler angles to Satellite orbit frame to Satellite reference frame.
The satellite reference frame (X's, Y's, Z's) is obtained by applying three consecutive rotations to the satellite orbit frame (Xs, Ys, Zs) :
1. Rotation around -Ys over a roll angle η
2. Rotation around the rotated -Xs over a pitch angle ξ
3. Rotation around the rotated Z^1s over a yaw angle ζ.