Jason-CS/Sentinel-6 ALT Level 1 Product Format Specification (L1 ALT PFS)

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Change Record

Version	*Date of Version* *as on profile*	*Document Change Request (DCR) Number* *if applicable*	*Description of changes*
1 Draft	24/01/2017		Initial Draft
1A	07/02/2017		Initial version for internal review
1B	13/02/2017		Version released for System PDR
1C	13/04/2017		Version pre-released for the PDAP ITT. - Addition of corrections following System PDR reviews: RID_031. Clarifications along the document have been added to specify that the product size information is given in bytes, unless otherwise specified (see section 5). - Modification of calibration products definition in line with RID_092 and RID_093 from the System PDR. These RIDs where addressed in an ESA/EUMETSAT meeting. As a result of this meeting the L1 PGS calibration processor and the L1 PFS calibration products have been modified (see sections 4.2.3 and 4.2.5).
1D	15/05/2017		Editorial changes. Version released for PDAP ITT.
1E	18/12/2017		Includes internal EUM review comments, and new excel file description detailing NetCDF Dump for L1A and L1B. The document has been revisited to adapt latest S6 GPP PFS documentation received this summer 2017.
1F	24/01/2018		Version addressing RIDs raised during internal review of V1E
2	24/01/2018	JCS_DCR_10	Version released for PDAP KO.
2A	16/04/2018		Added NetCDF global attributes per product. Updated description and organisation of NetCDF groups. Further specify packing of netCDF variables. Minor editorial changes.
2B	19/04/2018	JCS_DCR_64	Version released for PDAP data package #2.
2C	14/09/2018		Changed: “ns” by “samples”; “np” by “pulses”; “n_lobes” by “lobes”; “np” by “pulses” [MPWG-23]; and “nl” by “looks” Long names used for global attributes when applicable. The names are aligned with L2 variable names [MPWG-23]. Clarified that global attributes specified in GPFS need to be output as well [MPWG-23].
2D	18/10/2018		Better elaborated dimensions per products

			Corrected editorial errors (e.g. erroneous cross-references)
3	24/10/2018	JCS_DCR_138	Version released for the System Check Point#2/CDR
3A	10/04/2019	JCS_DCR_180	Fixed typos. Responded to S6MAG review. Section 1.4: Added missing acronyms. Section 2.2: rephrased the content of the L1 SAFE folder. Table 2-1: Specified product timeliness and distribution, as well as added ACQ products Table 3-1: edited to add ACQ products Sections 4.2.1.1, 4.2.2.1, 4.2.4.1, and 4.2.5.1: clarified how to compute the integer values in the NetCDF file and when to use _FillValue. Section 4.2.1.3 and 4.2.2.3: avoid unlimited dimensions. Section 4.2.3 added to describe ACQ products
4	19/11/2019	JCS_DCR_312	Replaced Sentinel-6/Jason-CS by Jason-CS/Sentinel-6. Fixed typos. Section 4.2.1.3: Added dimension samples_ov. Name for CAL2 global attribute variable changed.

Table of Contents

List of Tables

1 INTRODUCTION

1.1 Purpose and scope

This is the Level 1 Product Format Specification for the Altimeter (L1 ALT PFS) for the products made by the Jason-CS/Sentinel-6 Payload Data Processing (PDP) within the Payload Data Acquisition and Processing (PDAP) facilities.

1.2 Applicable documents

AD- 1	EUM/LEO-JASCS/SPE/17/897975	Jason-CS/Sentinel-6 Generic Product Format Specifications (GPFS)
AD- 2	EUM/LEO-JASCS/SPE/17/899011	Jason-CS/Sentinel-6 Generic File Naming Convention
AD- 3	EUM/LEO-JASCS/SPE/17/912241	Sentinel-6_Jason-CS – Metadata Specification
AD- 4	EUM/LEO-JASCS/SPE/17/947129	Sentinel-6_Jason-CS – L1 NetCDF Dump

1.3 Reference documents

RD- 1	EUM/LEO-JASCS/DEF/13/695184	Sentinel-6 Glossary of Terms and Acronyms Document

1.4 Acronyms

Acronym	*Meaning*
AMR	Advanced Microwave Radiometer
CF	Climate and Forecast (Convention)
GNSS	Global Navigation Satellite System
HKTM	House Keeping Telemetry
LR	Low Resolution (i.e. pulse limited altimetry)
ISP	Instrument Source Packets
HR	High Resolution (i.e. SAR mode)
NetCDF	Network Common Data Format
PDAP	Payload Data Acquisition and Processing
PDP	Payload Data Processing
PFS	Product Format Specification
RAW	Raw (full) SAR mode information
RMC	Range Migration Corrected SAR mode information
RO	Radio Occultation
SAFE	Standard Archive Format for Europe (SAFE)
TM	Telemeter

1.5 Document structure

Section 1 provides the introduction to this document. It includes the purpose, scope, applicable documents, reference documents and the acronyms.

Section 2 introduces the Level 1 products.

Section 3 sets out conventions for the Level 1 product format specifications.

Section 4 provides a detailed description of the Level 1 product container/package.

Section 5 details the Level 1 product size.

2 LEVEL 1 PRODUCTS OVERVIEW

2.1 Product structure

The Jason-CS/Sentinel-6 altimeter Level 1 products are generated by the Payload Data Processing (PDP) from the Poseidon-4 Level 0 products. The Level 1 products shall be compliant with the Sentinel's Standard Archive Format for Europe (SENTINEL-SAFE)[1]; the products are defined as packages. Each package contains a set of files grouped together to form the Level 1 product, and thus it is also referred to as container. The words container and package are used interchangeably throughout this document. The package format is described in detail in [AD- 1], and it will not be revisited in this document. Within this document we will describe the specifics of the Level 1 package contents only.

2.2 Product content

The altimeter Level 1 product is a container (or package) with different files:

- The ***manifest file*** provides information related to the folder contents, and it is of relevance for monitoring and archiving purposes within the PDP.
- The ***measurement data file(s) (EO data product)*** are in NetCDF format and contain the science data processed to Level 1.

A SAFE package does not need to contain a representation information file [AD- 1] since all Level 1 products are in NetCDF format which is self-describing.

2.3 Product list

The complete list of Level 1 altimeter products for the Jason-CS/Sentinel-6 mission is provided in Table 2-1. Each product has been named following the information included in [AD- 2]. A detailed description of the products contents is provided in future sections of this document.

Table 2-1: Altimeter Level 1 products list

Product Type	*Description*
P4_1A_HR_____	The L1A product contains Level 1 intermediate output of the HR processor (RAW and RMC). It includes geo-located bursts of Ku echoes (at ~9 kHz) with all instrument calibrations applied. This product includes the full rate complex waveforms input to the delay/Doppler or SAR processor.
P4_1B_HR_____	The L1B HR product is output of the HR processor. It includes geo-located, and fully calibrated multi-looked high-resolution Ku-band waveforms.
P4_1B_LR_____	The L1B LR product is output of the LR processor. It includes geo-located, and fully calibrated pulse-limited low-resolution Ku-band and C-band waveforms.
P4_1__ACQ____	Poseidon-4 Acquisition products
P4_1__ECHO___	ECHO CAL L1 products
P4_1__C1HR___	CAL1 high resolution L1 products
P4_1__C1LR___	CAL1 low resolution L1 products

[1] http://earth.esa.int/SAFE/

P4_1__CAL2___	CAL2 L1 products

2.4 File naming convention

The file name for the Level-1 products is defined in [AD- 2]. An example of Level-1 product naming is provided hereafter:

S6A_P4_1A_HR_____20150101T102500_20150101T114000_20150101T115000_4500_030_215_107_EUM__VAL_NR_001.SEN6

3 LEVEL 1 PRODUCT FORMAT SPECIFICATIONS

3.1 Level 1 package description

In the following table the composition of the package is specified for Level 1 products.

Table 3-1: Altimeter Level 1 product composition

Product Package Type		***Description***			
P4_1A_HR_____ P4_1B_LR_____ P4_1B_HR_____ P4_1__ACQ____ P4_1__ECHO___ P4_1__C1HR___ P4_1__C1LR___ P4_1__CAL2___		This is the generic package describing the structure of the Level 1 ALT for the Jason-CS/Sentinel-6 mission			
Product Level	***Diss. Timeliness***	***Product Category***			
1	NRT/STC/NTC	L1A are user products and produced at STC and NTC L1B LR, L1B HR are user products and made available at STC and NTC L1 CAL Products: Not available to the users and only processed at NRT L1 ACQ Products: Not available to the users and only processed at NRT			
Product Dissemination Unit		***Number of Package components***	***Number of Measurement Data Files***	***Number of Manifest Files***	***Number of Ancillary Data Files***
N/A		2	1	1	0
File name		***Composition***			
xfdumanifest.xml		Contains information about the product composition. Its aim is to describe the data files contained in the Level 1 package			
measurement.nc		NetCDF file including the measurement data.			

Each Level 1 product includes two files:

- A *manifest file* (xfdumanifest.xml) whose secondary metadata shall be different for Level 1A and Level 1B
- A *measurement data file* (measurement.nc) different for L1A, L1B LR, L1B HR, and L1 CAL.

The measurement data file will be NetCDF-4. The NetCDF-4 format and conventions for all Jason-CS/Sentinel-6 products are described in [AD- 1] and are applicable to this document.

The NetCDF-4 variables within the L1A and L1B products have been divided into several categories for their better understanding. These categories of variables need not appear in all Level 1 products, and the variables contained in these categories are not identical across the different products.

This classification shall not be confused with the NetCDF-4 grouping. These NetCDF-4 groups are used to simplify the division between Ku-band and C-band variables. As many variables are both available for C-band and Ku-band measurements, it is most convenient to collect them in these groups ("ku" and "c", respectively) and maintain the same variable names inside those groups.

Table 3-2 lists the categories of the Level 1 variables; the table classifies the categories per product and the groups in which they occur. Global attributes will all be in the root (/) of the NetCDF file.

Table 3-2: Categories of variables in the ALT Level 1 products and their distribution over NetCDF groups (N/A to ACQ files).

		L1A	L1B		CAL1 L1B		
Cat.	**Category Name**	**HR**	**LR**	**HR**	**LR**	**HR**	**Pulse**
A	Time and counter variables	data_140/ku	data_20/ku data_20/c	data_20/ku	ku c	ku	ku
B	Orbit and attitude variables	data_140/ku	data_20/ku data_20/c	data_20/ku	ku c	ku	ku
C	Configuration and quality variables	data_140/ku	data_20/ku data_20/c	data_20/ku	ku c	ku	ku
D	Altimeter range variables	data_140/ku	data_20/ku data_20/c	data_20/ku			
E	Altimeter power variables	data_140/ku	data_20/ku data_20/c	data_20/ku			
F	Altimeter engineering variables	data_140/ku	data_20/ku data_20/c	data_20/ku			
G	Altimeter characterization variables	data_140/ku	data_20/ku data_20/c	data_20/ku			
H	Surface type variables	data_140/ku	data_20/ku data_20/c	data_20/ku			
I	Waveform related variables (L1A)	data_140/ku					
J	Waveform related variables (L1B)		data_20/ku data_20/c	data_20/ku			
K	Waveform related variables (CAL1 L1B)				ku c	ku	ku
L	Stack characterization variables			data_20/ku			
M	Calibration variables				ku c	ku	ku
N	Burst calibration variables					ku	
-	Global attributes	/	/	/	/	/	/

4 LEVEL 1 DETAILED DESCRIPTION OF THE PRODUCT CONTAINER

4.1 Manifest file

A detailed description of the manifest primary and secondary data is given in [AD- 3].

4.2 Measurement data files

4.2.1 Altimeter L1A (P4_1A_HR_____)

The L1A is an intermediate output of the HR processor. Its measurement data file contains geo-located bursts of Ku echoes (at ~9 kHz) with all calibrations applied and aligned in range within each burst. The L1A includes RAW or Range Migration Correction (RMC) HR data, or they combination during Poseidon-4 HR modes transition.

The L1A only includes Ku band data. Its time tag is given referenced to the surface reflection (the instant that the theoretical middle of the burst reaches the surface). A burst is composed of 64 pulses with a mean PRF of approximately 9 kHz slightly variable along the satellite orbit, which results into a burst repetition frequency of approximately 140 Hz. The previous is of relevance to set the time dimension of the altimeter Level 1 products (see AD- 4).

Jason-CS/Sentinel-6 L1 products are NetCDF-4 and CF-1.7 compliant. A NetCDF-4 file includes **global attributes**, **groups**, **dimensions**, **variables**, and their **attributes**. The specifics for the L1A are provided hereafter.

4.2.1.1 L1A product groups, variables, and attributes

A complete list of Level 1A NetCDF variables and their associated attributes is provided as an Excel spreadsheet in the applicable document [AD- 4]. The variable names consist of lower case letters, numbers, and underscores.

The L1A **variables** have been organized in **groups** following the description provided in [AD-1]. A detailed structure of the products is given in Figure 4-1.

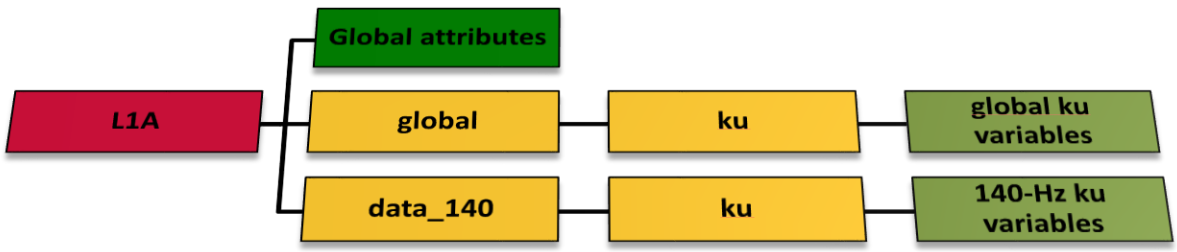

Figure 4-1 L1A product structure (NetCDF groups)

The L1A NetCDF products are organized in two layers of **groups**:

- Two posting rate groups:
  - *global*, for 1-value variables
  - *data_140*, for all variables given at the burst posting rate (approximately 140 Hz)
- Within these, one band group:

- *ku*, for Ku-band variables (note that L1A products only include Ku-band data)

The **attributes** to the NetCDF variables are one or more of the following, as listed in the various columns with the same name in [AD- 4]:

- long_name (type: char)
- standard_name (type: char)
- units (type: char)
- calendar (type: char)
- tai_utc_difference (type : double)
- leap_second (type: char)
- scale_factor (type: double)
- add_offset (type: double)
- _FillValue (type: same as variable, defined in column “Format”)
- flag_values (type: same as variable, defined in column “Format”)
- flag_mask (type: same as variable, defined in column “Format”)
- flag_meanings (type: char)
- quality_flag (type: char)
- coordinates (type: char)
- source (type: char)
- comment (type: char)

The variable names and the values of the associated attributes shall be configurable.

In case a field in the Excel spreadsheet is empty, the associated attribute shall not be added to the variable.

Please note that the attributes scale_factor and add_offset have an impact on the way a variable is written to the NetCDF product. The value written in the NetCDF product shall be determined as:

value_product = rint ((variable – add_offset) / scale_factor)

Invalid values (i.e. NaNs) shall be represented by the _FillValue.

4.2.1.2 L1A global attributes

A number of global attributes of the Level 1A products is defined in [AD- 1]. In addition to those the Level 1A products shall contain the global attributes given in Table 4-1. When multiple file names are to be listed, they are to be separated by a comma followed by a space.

Table 4-1: Altimeter L1A global attributes

Global Attributes	Description	Product
Input file information		
xref_altimeter_level0	*name of the input Level-0 file(s) to the L1 processor*	L1A

Global Attributes	Description	Product
Processing information		
xref_altimeter_characterization	*name of the characterization file*	L1A
xref_altimeter_characterization_array	*name of the characterization array file*	L1A
xref_processor_configuration	*name of the configuration file(s)*	L1A
xref_constants	*name of the constant file*	L1A
Auxiliary files information		
xref_orbit	*name of the orbit file(s)*	L1A
xref_attitude	*name of the attitude file(s)* *- 'none' in case no attitude file is used*	L1A
xref_doris_uso	*name of the USO file(s)* *- 'none' in case no USO file is used*	L1A
xref_center_of_mass	*source of the centre of mass information:* *- centre of mass file name* *- characterization file name*	L1A
xref_manoeuvre	*source of the manoeuvre flags information*	L1A
xref_surface_classification	*source of the surface classification information*	L1A
Calibration Information		
xref_cal2_correction_ku	*source of the Ku-band CAL2 correction*	L1A
xref_altimeter_power_drift_ku	*source of Ku-band power variation CAL1 correction*	L1A
xref_range_corr_internal_delay_cal_ku	*source of Ku-band delay and attcode CAL1 correction*	L1A
xref_attenuator_table_ku	*source of Ku-band ATT table*	L1A
xref_intra_burst_correction_ku	*source of Ku-band intraburst CAL1 correction*	L1A

4.2.1.3 L1A dimensions

The L1A ***dimensions*** are given in Table 4-2. To prevent inefficient data storage, dimensions in the NetCDF files shall have *limited* dimensions, so *unlimited* dimensions shall be avoided.

Table 4-2: L1A measurement.nc dimensions

L1A Dimensions			
Dimension name	***Group***	***Description***	***Value***
time	data_140/ku	Number of Ku bursts in the file (frequency of ~140 Hz)	Number of Ku-band bursts

L1A Dimensions			
Dimension name	***Group***	***Description***	***Value***
pulses	/	Number of pulses in 1 burst	64
samples	/	Number of samples in 1 waveform	256
samples_ov	/	Number of samples in 1 waveform after oversampling	256 * ov[2]
space_3d	/	3 dimensions of space (x, y, z)	3

4.2.2 Altimeter L1B (P4_1B_HR_____ and P4_1B_LR_____)

This section describes the L1B products for the Jason-CS/Sentinel-6 Altimeter. Both L1B HR and L1B LR product types are described in this section. The L1B LR NetCDF files contain two groups: "ku" (which collects all Ku-band values) and "c" (which collects all C-band values); the L1B HR only "ku".

4.2.2.1 L1B product groups, variables, and attributes

A complete list of Level 1B NetCDF **variables**, and their associated attributes is provided as an Excel spreadsheet in the applicable document [AD- 4]. The variable names consist of lower case letters, numbers, and underscores.

The L1B **variables** have been organized in **groups** following the description provided in [AD-1]. A detailed structure of the products for low resolution is given in Figure 4-2, and idem for high resolution in Figure 4-3.

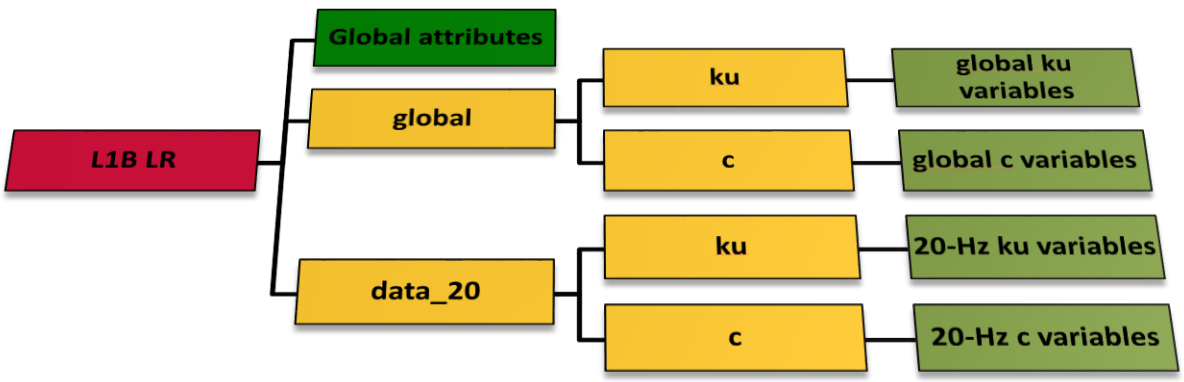

Figure 4-2 L1B Low Resolution product structure (NetCDF groups)

[2] ov is the oversampling factor. This value is provided in the variable zero_pad_fact_cal1_lrm_cnf in the P4 L1 configuration file (P4_1__CONF_AX) and can be set to 1 or 2.

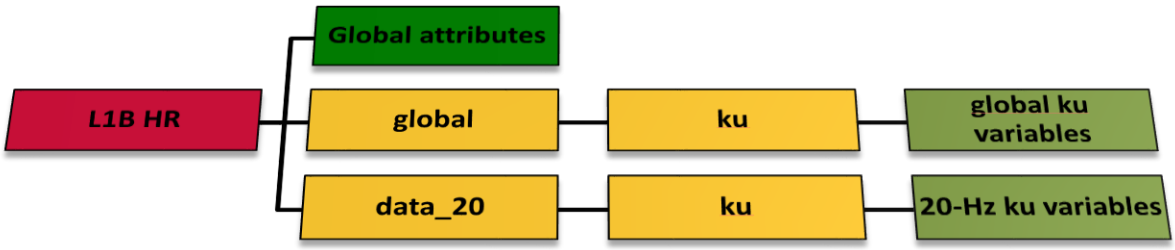

Figure 4-3 L1B High Resolution product structure (NetCDF groups)

The L1B NetCDF products are organized in two layers of **groups**:

- Two posting rate groups:
  - *global*, for variables that do not have a time dimension
  - *data_20*, for all variables given at approximately 20 Hz
- Within these, two frequency band groups for LR, and one band group for HR:
  - *ku*, for Ku-band variables (either in LR or HR products)
  - *c*, for C-band variables (only in LR products)

The **attributes** to the NetCDF variables are one or more of the following, as listed in the various columns with the same name in [AD- 4]:

- long_name (type: char)
- standard_name (type: char)
- units (type: char)
- calendar (type: char)
- tai_utc_difference (type : double)
- leap_second (type: char)
- scale_factor (type: double)
- add_offset (type: double)
- _FillValue (type: same as variable, defined in column “Format”)
- flag_values (type: same as variable, defined in column “Format”)
- flag_mask (type: same as variable, defined in column “Format”)
- flag_meanings (type: char)
- quality_flag (type: char)
- coordinates (type: char)
- source (type: char)
- comment (type: char)

The variable names and the values of the associated attributes shall be configurable.

In case a field in the Excel spreadsheet is empty, the associated attribute shall not be added to the variable.

Please note that the attributes scale_factor and add_offset have an impact on the way a variable is written to the NetCDF product. The value written in the NetCDF product shall be determined as:

value_product = rint ((variable – add_offset) / scale_factor)

Invalid values (i.e. NaNs) shall be represented by the _FillValue.

4.2.2.2 L1B global attributes

A number of global attributes of the Level 1B products is defined in [AD- 1]. In addition to those the Level 1B products shall contain the global attributes given in Table 4-3. When multiple file names are to be listed, they are to be separated by a comma followed by a space.

Table 4-3: L1B LR and L1B HR global attributes

Global Attributes	*Description*	*Product*
Input file information		
xref_altimeter_level0	*name of the input Level 0 file(s)*	L1B LR, L1B HR
Processing information		
xref_altimeter_characterization	*name of the characterization file*	L1B LR, L1B HR
xref_altimeter_characterization_array	*name of the characterization array file*	L1B LR, L1B HR
xref_processor_configuration	*name of the configuration file(s)*	L1B LR, L1B HR
xref_constants	*name of the constant file*	L1B LR, L1B HR
Auxiliary files information		
xref_orbit	*name of the orbit file(s)*	L1B LR, L1B HR
xref_attitude	*name of the attitude file(s)* *- 'none' in case no attitude file is used*	L1B LR, L1B HR
xref_doris_uso	*name of the USO drift file(s)* *- 'none' in case no USO drift file is used*	L1B LR, L1B HR
xref_center_of_mass	*source of the centre of mass information:* *- centre of mass file name* *- characterization file name*	L1B LR, L1B HR
xref_manoeuvre	*Source of the manoeuvre flags information*	L1B LR, L1B HR
xref_surface_classification	*Source of the surface classification information*	L1B LR, L1B HR
Calibration Information		
xref_cal2_correction_ku	*Source of the Ku-band CAL2 correction*	L1B LR, L1B HR

Global Attributes	Description	Product
xref_cal2_correction_c	*Source of the C-band CAL2 correction*	L1B LR
xref_altimeter_power_drift_ku	*Source of Ku-band power variation CAL1 correction*	L1B LR, L1B HR
xref_altimeter_power_drift_c	*Source of C-band power variation CAL1 correction*	L1B LR
xref_range_cor_internal_delay_cal_ku	*Source of Ku-band delay and attcode CAL1 correction*	L1B LR, L1B HR
xref_range_cor_internal_delay_cal_c	*Source of C-band delay and attcode CAL1 correction*	L1B LR
xref_attenuator_table_ku	*Source of Ku-band ATT table*	L1B LR, L1B HR
xref_attenuator_table_c	*Source of C-band ATT table*	L1B LR
xref_intra_burst_corrections_ku	*Source of Ku-band intraburst CAL1 correction*	L1B HR

4.2.2.3 L1B dimensions

The L1B **dimensions** for LR and HR are provided in Table 4-4. To prevent inefficient data storage, dimensions in the NetCDF files shall have *limited* dimensions, so *unlimited* dimensions shall be avoided.

Table 4-4: Altimeter L1B dimensions for LR and HR

L1B Dimensions (LR, HR)				
Dimension name	**Group**	**Description**	**Value**	
			L1B LR	**L1B HR**
samples	/	Number of samples in 1 waveform	256	256 * ov[3] (max value 512)
looks	/	Number of looks in 1 stack		NL[4]
space_3d	/	3 dimensions of space (x, y, z)	3	3
time	data_20/ku	Number of Ku waveforms in the file (~20 Hz)	# of Ku wfms	# of Ku wfms
time	data_20/c	Number of C waveforms in the file (~20 Hz)	# of C wfms	N/A

[3] ov is the oversampling factor. This value is provided in the variable zero_pad_fact_cal1_lrm_cnf in the P4 L1 configuration file (P4_1__CONF_AX) and can be set to 1 or 2.
[4] The number of Doppler beams/looks per stack is configurable: the maximum value is 448 (7 burst of 64 pulses per radar cycle).

4.2.3 Altimeter ACQ L1 products

This section described the ACQ L1 products for the Jason-CS/Sentinel-6 Altimeter.

The ACQ products are only produced at NRT.

4.2.3.1 ACQ product groups, variables and attributes

A complete list of the ACQ NetCDF **variables** and their associated attributes is provided as an Excel spreadsheet in the applicable document [AD- 4]. The variable names consist of lower case letters, numbers, and underscores.

The **variables** in the Level 1 ACQ products are all global.

4.2.3.2 ACQ global attributes

The global attributes define common for all products as defined in [AD- 1] are applicable to the ACQ products.

4.2.3.3 ACQ dimensions

The ACQ ***dimensions*** are given in Figure 4-5.

Table 4-5: ACQ measurement.nc dimensions

ACQ Dimensions			
Dimension name	***Group***	***Description***	***Value***
time	N/A	Number of Ku echoes received within acquisition	

4.2.4 Altimeter CAL1 L1 (P4_1__ECHO___, P4_1__C1HR___, P4_1__C1LR___)

This section describes the Calibration L1 products for the Jason-CS/Sentinel-6 Altimeter.

The L1 calibration products include the output of different calibration chains within the calibration processor:

- ECHO CAL (output of the Pulse Cal processor) contains corrections for path delay and peak/integrated power variations along the orbit for Ku-band only.
- CAL1 L1 LR (output of the CAL1 LR processor) contains corrections for path delay and peak/integrated power variations for Ku- and C-band.
- CAL1 L1 HR (output of the CAL1 HR processor) contains corrections for intra-burst amplitude and phase variation for Ku-band. It also contains corrections for path delay and peak/integrated power variations for Ku- and C-band.

4.2.4.1 CAL1 L1 product groups, variables and attributes

A complete list of the CAL1 NetCDF **variables** and their associated attributes is provided as an Excel spreadsheet in the applicable document [AD- 4]. The variable names consist of lower case letters, numbers, and underscores.

The **variables** in the Level 1 CAL products have been organized in **groups** following the description provided in [AD-1]. A detailed structure of the products for CAL1 LR and CAL1 HR is given in Figure 4-4. ECHO CAL products are provided in Figure 4-5.

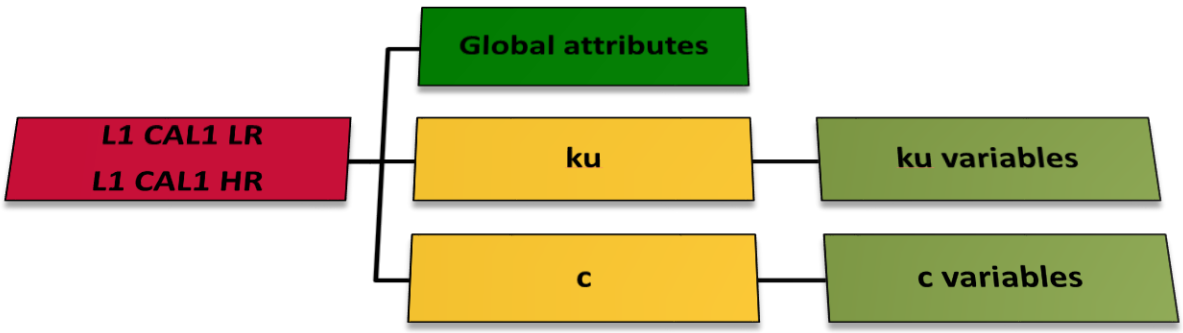

Figure 4-4 CAL1 LR and HR product structure with NetCDF groups

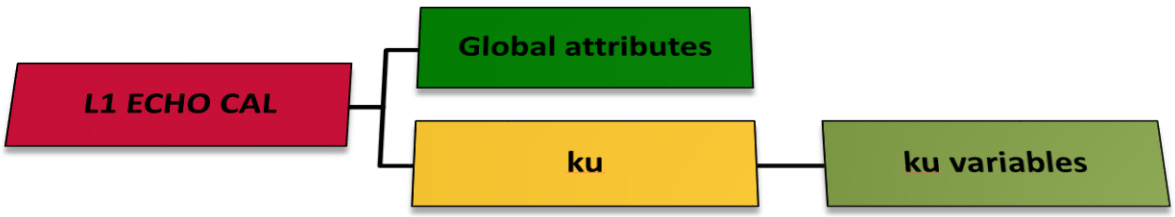

Figure 4-5 ECHO CAL product structure with NetCDF groups

The L1 CAL1 NetCDF products are organized in one layer only. The calibration products contain groups to separate the Ku- and C-band variables:

- One or two frequency band groups:
  - *ku*, for Ku-band variables
  - *c*, for C-band variables (only for CAL1 LR and CAL1 HR products).

The **attributes** to the NetCDF variables are one or more of the following, as listed in the various columns with the same name in [AD- 4]:

- long_name (type: char)
- standard_name (type: char)
- units (type: char)
- calendar (type: char)
- tai_utc_difference (type : double)
- leap_second (type: char)
- scale_factor (type: double)
- add_offset (type: double)
- _FillValue (type: same as variable, defined in column “Format”)

- flag_values (type: same as variable, defined in column “Format”)
- flag_mask (type: same as variable, defined in column “Format”)
- flag_meanings (type: char)
- quality_flag (type: char)
- coordinates (type: char)
- source (type: char)
- comment (type: char)

The variable names and the values of the associated attributes shall be configurable.

In case a field in the Excel spreadsheet is empty, the associated attribute shall not be added to the variable.

Please note that the attributes scale_factor and add_offset have impact on the way a variable is written to the NetCDF product. The value written in the NetCDF product shall be determined as:

value_product = rint ((variable – add_offset) / scale_factor)

Invalid values (i.e. NaNs) shall be represented by the _FillValue.

4.2.4.2 CAL1 L1 global attributes (also applicable to CAL2)

A number of global attributes of the CAL products is defined in [AD- 1]. In addition to those the CAL products shall contain the global attributes given in Table 4-6. When multiple file names are to be listed, they are to be separated by a comma followed by a space.

Table 4-6: CAL1 LR, HR and ECHO global attributes; also applicable to CAL2

Global Attributes	*Description*	*Product*
Input file information		
xref_altimeter_level0	*Name of the input Level-0 file(s) to the L1 processor*	ALL
Processing information		
xref_altimeter_characterization	*Name of the characterization file*	ALL
xref_altimeter_characterization_array	*name of the characterization array file*	ALL
xref_processor_configuration	*name of the configuration file(s)*	ALL
xref_constants	*name of the constant file*	ALL
Auxiliary file information		
xref_orbit	*name of the orbit file(s)*	ALL
xref_doris_uso	*name of the USO drift file(s)* *- ‘none’ in case no USO drift file is used*	CAL1 LR, CAL1 HR, ECHO CAL
Calibration Information		
xref_cal2_correction_ku	*source of the Ku-band CAL2 correction*	CAL1 LR, CAL1 HR, ECHO CAL

Global Attributes	Description	Product
xref_cal2_correction_c	*source of the C-band CAL2 correction*	CAL1 LR, CAL1 HR
xref_attenuator_table_ku	*source of Ku-band ATT table*	ALL
xref_attenuator_table_c	*source of C-band ATT table*	CAL1 LR, CAL1 HR, CAL2

4.2.4.3 CAL1 L1 dimensions

The CAL1 L1 **dimensions** are provided in Table 4-7.

Table 4-7: Altimeter CAL1 L1 dimensions

		CAL1 L1 Dimensions			
Dimension name	Group	Description	Value		
			CAL1 L1 LR	CAL1 L1 HR	ECHO CAL
lobes	/	Number of side lobes which are characterized	4[5]	4	4
pulses	/	Number of Ku-band pulses in 1 burst		64	
samples	/	Number of samples in one waveform	this is configurable and identical for the three CAL1 modes		
time	ku	Number of Ku-band calibrations in the file	# of Ku wfms	# of Ku wfms	# of Ku wfms
time	c	Number of C-band calibrations in the file	# of C wfms		

4.2.5 Altimeter CAL2 L1 (P4_1__CAL2___)

The CAL2 may not be of need in Poseidon-4 due to its digital architecture. Nevertheless, a L1 CAL2 product for monitoring purposes is added to the L1 PFS.

4.2.5.1 CAL2 L1 product groups, variables and attributes

A complete list of CAL2 NetCDF **variables** and their associated attributes is provided as an Excel spreadsheet in the applicable document [AD- 4]. The variable names consist of lower case letters, numbers, and underscores.

The L1 CAL2 **variables** have been organized in **groups** following the description provided in [AD-1]. A detailed structure of the product is given in Figure 4-6.

[5] This parameter is configurable

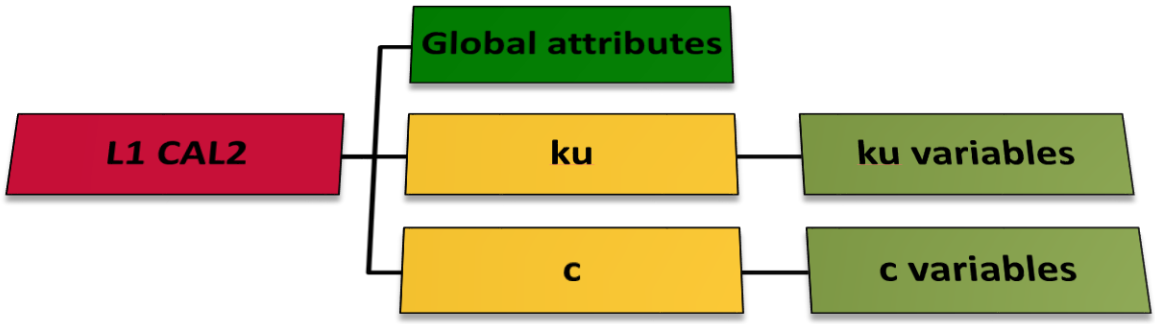

Figure 4-6 L1 CAL2 product structure using NetCDF groups

The L1 CAL2 NetCDF products are organized in one layer only. The calibration products have only one groups layer:

- Two frequency band groups:
  - *ku*, for Ku-band variables
  - *c*, for C-band variables

The **attributes** to the NetCDF variables are one or more of the following, as listed in the various columns with the same name in [AD- 4]:

- long_name (type: char)
- standard_name (type: char)
- units (type: char)
- calendar (type: char)
- tai_utc_difference (type : double)
- leap_second (type: char)
- scale_factor (type: double)
- add_offset (type: double)
- _FillValue (type: same as variable, defined in column “Format”)
- flag_values (type: same as variable, defined in column “Format”)
- flag_mask (type: same as variable, defined in column “Format”)
- flag_meanings (type: char)
- quality_flag (type: char)
- coordinates (type: char)
- source (type: char)
- comment (type: char)

The variable names and the values of the associated attributes shall be configurable.

In case a field in the Excel spreadsheet is empty, the associated attribute shall not be added to the variable.

Please note that the attributes scale_factor and add_offset have impact on the way a variable is written to the product. The value written in the product shall be determined as:

value_product = rint ((variable – add_offset) / scale_factor)

Invalid values (i.e. NaNs) shall be represented by the _FillValue.

4.2.5.2 CAL2 global attributes

Identical to CAL1; for further reference please see Table 4-9.

4.2.5.3 CAL2 dimensions

The **dimensions** of the CAL2 products are given in Table 4-8.

Table 4-8: Altimeter CAL2 L1 dimensions

CAL2 L1 Dimensions			
Dimension name	***Group***	***Description***	***Value***
pulses	/	Number of Ku-band pulses in 1 burst	64
samples	/	CAL2 waveform (frequency) number of samples	256
samples_ov	/	CAL2 waveform (time) number of samples	256 * 64
time	ku	Number of Ku-band calibrations in the file	# Ku wfms
time	c	Number of C-band calibrations in the file	# C wfms

5 PRODUCT SIZE

The size of altimeter Level 1 products are provided in [AD- 4]. The rule of thumb is that the product size can be calculated from the number of variables, their dimension and byte sizes, and their frequency of occurrence during a fixed period (for example an orbit). The rule is applied under the next list of considerations.

Variables have one or more dimensions, and the size of the dimensions can vary based on the product type. The "dimension number" listed in [AD- 4] reflects this.

Dimensionless data fields occur only once in the data set, and thus have negligible impact on the product size. They are ignored here.

The duty cycle is the fraction of time that the altimeter is expected to produce a certain dataset. So far, the expectation is to provide HR-RMC over Open Ocean (58%), HR-RAW over Coastal Regions (15%) and LR everywhere (100%).

Additional assumptions with respect to the number of samples in a waveform, the number of echoes in a burst, are given in Table 5-1.

Table 5-1: Assumptions made in sizing the Level 1 products.

Variable	Value
Oversampling factor for HR[7]	1
Number of echoes per burst (pulses)	64
Number of samples per waveform in LR (samples)	256
Number of samples per waveform in HR RAW/RMC (samples)	512
Number of beams in LR-RMC (beams)	64
Number of looks per stack in L1B (looks)	448
Duty cycle for HR-RMC	0.58
Duty cycle for HR-RAW	0.15
Duty cycle for LR	1.00
Length of orbit (seconds)	6745.00
Length of day (seconds)	86400.00
Internal NetCDF compression factor	0.50

CAL products duty cycle is expected to be 0.01.

The NetCDF format allows for internal compression. Earlier experiments with test data have shown that a compression rate of about 50% can be achieved for these types of data files. The ALT L1 configuration file includes the NetCDF compression as a configurable variable.

There is an additional number of bytes on the Level 1 product due to the other components (e.g. manifest). The estimated overhead due to these additions is less than 0.5 MB.

[7] This is left as a placeholder for LR for Day-2 evolutions