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# **FLEX Instrument Performance Simulator and Ground Processor Prototype**

## **Product Definition Document [GP-04]**

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**Issue: 4.2**

**Date: 15/04/2025**

## Document Signature Table

|                          | Name                   | Function                | Signature | Date       |
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## Document Change Record

| Issue/Revision | Date       | Reason for Change                                | Changed Pages/Parag.  |
|----------------|------------|--|---|
| 1.0            | 26/11/2019 | First issue for PDR                              | Note:<br>L1A product definition implements URR<br>RID MB_15 (AI_URR_08).  |
| 1.1            | 22/01/2020 | Implementations of RIDs<br>raised at PDR part 1. | Section 1.2:<br>Updated the list of Applicable<br>Documents<br><br>Section 1.4:<br>List of Acronyms updated.<br><br>Section 4.1:<br>Implemented RID PDR_MB_07,<br>PDR_MB_12, PDR_MB_13, PDR_MC_47.<br><br>Sections 4.2 and 4.3:<br>Implemented RID PDR_MC_47.<br><br>Section 4.2.9:<br>Removed product YAW90 (PDR_MB_06)<br><br>Sections 4.2.6.1, 4.3.1.1, 4.4:<br>Implemented RID PDR_MC_22.<br><br>Sections 4.5.4 to 4.5.7:<br>Implemented RID PDR_MB_09.<br><br>Section 4.6:<br>Implemented RID PDR_MC_48<br><br>New section 4.7:<br>Added to implement RID PDR_MC_48<br>and PDR_MB_13 |
| 2.0            | 30/07/2020 | CDR delivery                                     | Section 1.2:<br>Updated the list of Applicable and<br>Reference Documents   |

|     |            |  |  |
|-----|------------|--|--|
|     |            |  | <p>Section 4.1:<br/>Implemented RIDs PDR_MB_21 and PDR_MB_22.<br/>dimension "bands" renamed in "number_of_spectral_channels".</p> <p>Section 4.1.1<br/>Added the description of the Quality flags.</p> <p>Section 4.5<br/>Updated the list of ANC products (VAU_TM and RPYRES removed, INSTTM added)</p> <p>Sections 2.5, 4.1, 4.2, 4.4, 4.5:<br/>Changes agreed in [RD-3]</p> <p>Section 4.2<br/>New RAC products</p> <p>Section 4.3<br/>New SPC_SPEEOU product</p> <p>Section 4.4<br/>SCNVAL product description added</p> <p>Section 4.5<br/>Ancillary products list and description updated.</p> <p>Section 4.6<br/>L1BPP break-point section added.</p> <p>Section 4.7<br/>L1A is definitively a BRK file</p> |
| 2.1 | 27/11/2020 | Implementation of corrections as per ESA and LDO comments to the PDD v2.0. | <p>Section 1.4<br/>List of acronyms updated.</p> <p>Sections 4.1, 4.2.12, 4.2.15, 4.3.1, 4.3.3, 4.5.1, 4.6.1<br/>Added note(s) to explain the number of ACT samples.</p> <p>Section 4.1<br/>- "altitude" L1B metada updated.<br/>- NC variable giving the location on the instrument grid of the meteo tie points added.<br/>- Across track direction variations added for NC variables "FWHM", "solar_flux", "spectral_channel_center_wavelength".<br/>- removed along track dependency of</p>  |

|     |            |                      |  |
|-----|------------|----------------------|--|
|     |            |                      | <p>the NC variavle "solar_flux".</p> <p>Section 4.1.1<br/>Removed redundant tables describing quality flags meaning.</p> <p>Section 4.4<br/>Corrected SCNVAL file category to "GEC_".</p> <p>Section 4.6.1:<br/>Straylight breakpoints definition added.</p>   |
| 2.2 | 22/12/2020 | CDR closure delivery | <p>Section 4.1<br/>Implemented RID CDR-FIPSGPP-MB-18, CDR-FIPSGPP-MBe-9</p> <p>Sections 2.5, 4.x<br/>Implemented RID GPP-FIPSGPP-MC-55</p> <p>Sections 4.x<br/>Data block format description tables updated in order to implement RID GPP-FIPSGPP-MC-51</p> <p>Section 4.2.20<br/>Added, in order to define a placeholder to the foreseen but not yet defined RAC_CTE__ product (RID GPP-FIPSGPP-MC-50).</p> <p>Section 4.8<br/>Added, in order to implement RID GPP-FIPSGPP-MC-52</p> <p>Section 4.6.1:<br/>Straylight breakpoints content updated.</p> |
| 3.0 | 24/11/2021 | V3 delivery          | <p>Section 4<br/>Number of ACT and ALS samples updated.<br/>"Instrumental information" metadata identical for all the L1B, RAC and SPC products.</p> <p>Section 4.1<br/>Spectral channel naming convention updated as per LDO decision, in order to implement the RID CDR-FIPSGPP-MB-19. "spectral_channel_name" and "input_names" annotated as attribute. The order of the dimensions updated for "channel_quality_flags".</p> <p>Section 4.2</p>   |



|     |            |             |   |
|-----|------------|-------------|---|
|     |            |             | <p>RAC_DARKUB, RAC_DRKST2 and RAC_MONSL2 product removed.</p> <p>Sections 4.2.1 to 4.2.6<br/>DARK RAC products share the same format.</p> <p>Section 4.2.7<br/>RAC_MOON__ product updated.</p> <p>Section 4.2.9<br/>RAC_SUN__ product updated.</p> <p>Section 4.2.12<br/>RAC_CLOUD_ product updated.</p> <p>Sections 4.2.13 to 4.2.16<br/>LIN* RAC products share the same format.</p> <p>Section 4.3<br/>SPC_SPEEOU product removed.</p> <p>Section 4.6.2<br/>Added RSCM BRKs.</p> <p>Section 4.8<br/>Data volume updated.</p>   |
| 4.0 | 22/11/2024 | V4 delivery | <p>Sections 1.2, 1.3<br/>Updated lists of AD and RD</p> <p>Section 1.4<br/>List of acronyms updated (close FATv3-FIPS_GPP-MT-19)</p> <p>Section 4.1</p> <ul style="list-style-type: none"> <li>- "altitude" range corrected (close "FATv3-FIPS_GPP-MT-16")</li> <li>- TOA radiance uncertainty in one byte;</li> <li>- 'Defective pixels flagging', ' Geolocation' and ' Output zipping' added to 'Annotation data/Processing executed' group;</li> <li>- 'gain_uncertainty', 'relative_spatial_radiometric_accuracy' and 'relative_spectral_radiometric_accuracy' added to 'Annotation data/Instrumental information';</li> <li>- Units added to temperatures variables in Instrumental Information annotations;</li> <li>- Dimension</li> </ul> |



|  |  |   |
|--|--|---|
|  |  | <p>"vau_tm_frames_number" added to "Annotation data/Instrumental_information"</p> <ul style="list-style-type: none"> <li>- "Annotation data/Eclipse" group added</li> </ul> <p>Section 4.1.1.1<br/>Thermal stability flag takes the place of the last spare bit in the common quality bit-mask.<br/>Corrected typo LSM → LSW (closes FATv3-FIPS_GPP-MT-18)</p> <p>Sections 4.2, 4.8<br/>RAC DARKSS product removed;</p> <p>Section 4.2.1.2<br/>Removed valid_max for "cor_reflectance" and "corcorr_reflectance", Removed spectral dimension for "cloud_optical_thickness" (Close DP1v3-FIPS_GPP_MB_32)</p> <p>Section 4.2.8<br/>Metadata processing execution flags "doSNR" and "doFF" removed;<br/>Duplicated "open points" sub section removed; [K]_FF_CUBE variable added;<br/>Sun geometry angles updated (multiplicity and type)</p> <p>Sections 4.2.9 - 4.2.13<br/>Added note to explain the expected value for the new dimension<br/>"vau_tm_frames_number" added to "Annotation data/Instrumental_information."</p> <p>Section 4.2.11, 4.8<br/>RAC_DEFRTS added.</p> <p>Sections 4.2.13, 4.8<br/>RAC LIN* products removed and replaced by new RAC_NLCAL_.</p> <p>Section 4.2.6<br/>Close RID DP1v3-FIPS_GPP_MB_29</p> <p>Section 4.2.7<br/>RAC_MOONSL format defined</p> <p>Section 4.2.8<br/>Quality flags masks and meaning description updated (closes DP1v3-FIPS_GPP_MB_31)</p> |
|--|--|---|

|     |            |                         |  |
|-----|------------|-------------------------|--|
|     |            |                         | <p>Section 4.2.14<br/>RAC_CTE___ format defined</p> <p>Section 4.3<br/>Removed references to RAC (closes FATv3-FIPS_GPP-MT-21)</p> <p>Section 4.3.1<br/>SPC_SPECEO updated</p> <p>Section 4.3.2<br/>SPC_SPECSO updated</p> <p>Section 4.6.1<br/>Break-point BRK_L0___ added<br/>Removed Sun and Viewing angles from BRK_SUN_01 because already annotated in the RAC/SPC Sun products</p> <p>Section 4.8<br/>Products' data volume updated (closes indirectly RID DP1v3-FIPS_GPP_MB_28)</p> <p>Annex A<br/>Added (closes FATv3-FIPS_GPP-HM-1)</p>   |
| 4.1 | 05/03/2025 | V4 closeout delivery    | <p>Section 4.1<br/>Central wavelength shifts added to the Instrumental Information metadata under netcdf group Annotation data.</p> <p>Section 4.2.8<br/>Description field associated to the SZA/SAA/OZA/OAA updated (it closes V4 RID MB_08)</p> <p>Section 4.3.1 and 4.3.2<br/>SPC_SPECEO and SPC_SPECSO<br/>"Annotation data/Processing executed" metadata updated</p> <p>Section 4.8<br/>EO/CAL data volume updated (it closes V4 RIDs MC_08, MC_09, MC_10, MC_11, MC_12, and MT_03)</p> <p>Sections 4.2, 4.2.6, 4.2.8, 4.2.12, 4.3.1, 4.3.2, 4.6.2<br/>Open points removed (it implements V4 RID MT_02)</p> |
| 4.2 | 15/04/2025 | DRB RIDs implementation | <p>Section 4.6.4<br/>BRK_OSPCEO description added<br/>It closes DRB RID ED_14</p>  |

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# 1 INTRODUCTION

## 1.1 PURPOSE

The aim of this document is to define and provide a detailed description of the L1 data blocks format and content, as required by the [PDS-L1] open item [OI-4].

The level of details and the presence of TBD elements are related to the closing of other open items (see the list in [PDS-L1]).

## 1.2 APPLICABLE DOCUMENTS

| Document Title   | Identifier                | External Reference | Internal Reference |
|--|---------------------------|--------------------|--------------------|
| FLORIS L1 GPP ATBD   | FLX-TN-FNM-INS-0007 v4.2  | [AD219]            | [GPP-ATBD]         |
| Earth Observation Mission Software File Format Specification | PE-ID-ESA-GS-584 v.1.4    | [AD52]             | [EOCFI-FFS]        |
| FLEX FIPS/GPP L1 product specification                       | FLX-RS-FNM-INS-0047 v.4.0 | [AD53]             | [PDS-L1]           |

## 1.3 REFERENCE DOCUMENTS

| Document Title  | Identifier  | External Reference | Internal Reference |
|---|---|--------------------|--------------------|
| FLEX Acronyms Terms and Definition  | FLX-LI-ESA-SYS-0017 Rev. 1.3                            | [AD07]             | [FLX-ACR]          |
| FLEX PDGS Level-0 Product Format Definition                               | ESA-EOPG-EOEP-TN-0022 v2.8                              |                    | [PDS-L0]           |
| FLEX imaging system reference frames and conventions                      | FLX-IF-TAS-SY-0058 v1.1                                 |                    | [FLX-IF]           |
| PDR RIDs  | RID_FIPSGPP_PDR_ESA_LDO-DMS+EXP+VITdiscussedPDR, Rev. 1 |                    | [PDR-RID]          |
| MoM – Discussion on L1B outputs interfaces vs L2                          | FLX-MIN-DMS-FIPSGPP-0021 v1.0                           |                    | [RD-3]             |
| FLORIS in flight calibrations table                                       | FLX-TN-FNM-INS-0031 Rev. 4.1                            |                    | [CAL-TAB]          |
| FLEX ATBD - A SIMPLIFIED L1B TOP-OF-ATMOSPHERE RADIANCE UNCERTAINTY MODEL |   |                    | [UNC-TN]           |

## 1.4 ACRONYMS AND ABBREVIATIONS

See also [FLX-ACR].

| Code   | Meaning   |
|--------|---|
| ACT    | Across Track  |
| ALS    | Along Spectrum  |
| ALT    | Along Track   |
| AD     | Applicable Document                                     |
| AI     | Auxiliary Input   |
| AO     | Auxiliary Output  |
| APID   | Application Process Identifier                          |
| ATBD   | Algorithm Theoretical Baseline Documents                |
| AUX    | Auxiliary   |
| BRK    | FLEX breakpoint product                                 |
| CAL    | Calibration acquisition mode or data                    |
| CCDB   | Calibration and Characterisation Database               |
| CI     | Configuration Input                                     |
| CP     | Configuration Parameter                                 |
| CU     | Calibration Unit  |
| CPM    | Calibration Processor Module                            |
| DPM    | Detailed Processing Model                               |
| EO     | Earth Observation                                       |
| EO-CFI | Earth Observation CFI                                   |
| E2E    | End-to-End  |
| ESF    | Edge Spread Function                                    |
| FIPS   | Fluorescence Imaging Spectrometer Performance Simulator |
| FLEX   | Fluorescence Explorer                                   |
| GCM    | FLEX GPP Geometric Calibration Module                   |
| GCP    | Ground Control Point                                    |
| GPP    | Ground Processor Prototype                              |
| ICD    | Interface Control Document                              |
| ICU    | Instrument Control Unit                                 |
| ID     | Identifier  |
| HR     | High Resolution   |
| HRSPE  | FLEX HR Spectrometer                                    |
| kB     | Kilobyte  |
| L0     | FLEX Level 0 product                                    |
| L1     | FLEX Level 1 product                                    |
| L1BPP  | FLEX GPP L1B Module                                     |
| LDO    | Leonardo  |
| LR     | Low Resolution  |
| MB     | Mega byte   |
| MTF    | Modulation Transfer Function                            |
| NC     | See NetCDF  |
| NetCDF | Network Common Data Form                                |
| RD     | Reference Document                                      |
| L1A    | FLEX intermediate L1A product                           |
| L1B    | FLEX Level 1B product                                   |
| L1bPP  | FLEX GPP Level 1b Prototype Processor                   |
| OBS    | FLEX EO acquisition mode or data                        |
| OSPC   | Offline Spectral Calibration module                     |
| RAC    | L1 radiometric calibration products                     |
| RAW    | FLEX raw level product                                  |
| RSCM   | FLEX GPP Radiometric and Spectral Calibration Module    |
| RS     | Software Requirement Specification                      |
| SOW    | Statement Of Work                                       |



|     |                                  |
|-----|----------------------------------|
| SPC | L1 spectral calibration products |
| SV  | Orbit State Vector               |
| SW  | Software                         |
| TBC | To Be Confirmed                  |
| TBD | To Be Defined                    |
| TEL | Flex Telescope                   |
| TM  | Telemetry                        |
| TOA | Top Of Atmosphere                |
| VAU | Video Acquisition Unit           |
| WOI | Window Of Interest               |
| XML | eXtensible Markup Language       |



## 2 PRODUCT DATA CONVENTION

This section summarizes the product conventions used in this document.

### 2.1 PRODUCT NAMING CONVENTION

The names of the FLEX L1 products comply with the file naming convention defined in [PDS-L1].

### 2.2 DATA REPRESENTATION

#### 2.2.1 Data Types

The convention applies to the element data types are listed in the next table.

| Description                      | NetCDF-4 data types                   | C-type  | Abbreviation |
|----------------------------------|---------------------------------------|---|--------------|
| 8-bit signed integer             | NC_BYTE                               | char  | byte         |
| 8-bit unsigned integer           | NC_UBYTE                              | unsigned char                                     | ubyte        |
| 8-bit character                  | NC_CHAR                               | char  | char         |
| 16-bit signed integer            | NC_SHORT                              | short   | short        |
| 16-bit unsigned integer          | NC_USHORT                             | unsigned short                                    | ushort       |
| 32-bit signed integer            | NC_INT<br>NC_LONG) (or                | long int  | int32        |
| 32-bit unsigned integer          | NC_UINT                               | unsigned long int                                 | uint32       |
| 64-bit signed integer            | NC_INT64                              | long long int                                     | int64        |
| 64-bit unsigned integer          | NC_UINT64                             | unsigned long long int                            | uint64       |
| 32-bit floating point            | NC_FLOAT                              | float   | float        |
| 64-bit floating point            | NC_DOUBLE                             | double  | double       |
| variable length character string | NC_STRING<br>(or array of<br>NC_CHAR) | Does not exist, but equivalent to char[<fix_len>] | string       |

### 2.3 NETCDF FILES REPRESENTATION CONVENTION

NetCDF is a binary file format where the information is broken into four sets:

- Groups: group act as an entire NetCDF file and then may have attributes, dimensions, and variables.
- Dimensions: dimension is used to define the size of one or more of the multidimensional variables. A dimension has a length and a name. A dimension defined at top-level outside any group is available in all the groups.
- Variables: variable represents a multidimensional array of values of the same type. A variable has a name, a data type, and a size described by its list of dimensions.

- Attributes: attribute contains information about a variable (variable attribute) or about the whole NetCDF file (global attribute). Attributes may be used to specify properties as units, special values, maximum and minimum threshold values, and packing parameters. Attribute information is represented by single values or one-dimensional arrays of values.

The following convention should be used in documentations to represent all files in the NetCDF format using tables (NC\_FMT\_TBL). The goal is to increase the global readability of this kind of long tables.

Table conventions:

- Only background colours are used to differentiate NetCDF objects (groups, dimensions, variable and attributes). See next table:

**Table 2-1: format of the tables used to detail the NetCDF file content**

| Group Name                         | Element Name               | Description                                | Range or Value | Type | Dimension |
|------------------------------------|----------------------------|--|----------------|------|-----------|
|                                    | <global common attributes> | Common global attributes as defined in 2.5 |                |      |           |
| <Group_name> [ /<sub-group name> ] |                            |  |                |      |           |
|                                    | <dimension_name>           |  |                |      |           |
|                                    | <variable_name>            |  |                |      |           |
|                                    | <attribute_name>           |  |                |      |           |

- The table contains 6 columns:
  - "Group Name": the name of the NetCDF group or sub-group. Inside a group it is empty.
  - "Element Name": the name of the NetCDF dimension, variable or attribute.
  - "Description": the description of the element.
  - "Range or Value": the range or value of variables, or the value of dimensions or attributes. The variable range is given in its geophysical unit, which could be different than the storage range defined by the standard "valid\_min" and "valid\_max" attributes (in case of NetCDF "packed" storage using the standard "scale\_factor" and "add\_offset" attributes). It is possible to give only one bound of the range (i.e. [1, ]).
  - "Type": the C type of the element, not used for groups and dimensions.
  - "Dimension": the dimension of the variables or attributes, in the same order than storage and with one dimension per line
- Dimensions are always defined before variables
- Dimensions, variables and attributes may be defined at top-level outside any group; in this case they appear before the first group
- Attributes may be global or related to a group instead of a variable; in this case they must appear before dimensions

## 2.4 RELEVANT NETCDF ATTRIBUTE CONVENTIONS

Some NetCDF attribute conventions are followed and have to be detailed here (see e.g. [attribute conventions](#)):

- scale\_factor

If present for a variable, the data are to be multiplied by this factor after the data are read by the application that accesses the data.

If valid values are specified using the `valid_min`, `valid_max`, `valid_range`, or `_FillValue` attributes, those values should be specified in the domain of the data in the file (the packed data), so that they can be interpreted before the `scale_factor` and `add_offset` are applied.

- `add_offset`

If present for a variable, this number is to be added to the data after it is read by the application that accesses the data. If both `scale_factor` and `add_offset` attributes are present, the data are first scaled before the offset is added. The attributes `scale_factor` and `add_offset` can be used together to provide simple data compression to store low-resolution floating-point data as small integers in a NetCDF dataset. When scaled data are written, the application should first subtract the offset and then divide by the scale factor, rounding the result to the nearest integer to avoid a bias caused by truncation towards zero.

When `scale_factor` and `add_offset` are used for packing, the associated variable (containing the packed data) is typically of type `byte` or `(u)short`, whereas the unpacked values are intended to be of type `float` or `double`. The attributes `scale_factor` and `add_offset` should both be of the type intended for the unpacked data, e.g. `float` or `double`.

- `_FillValue`

If present for a variable, it specifies the fill value used to pre-fill disk space allocated to the variable, before its writing. All not filled and/or not reliable variable data samples shall be set to this value.

Note: If missing, NetCDF library defines and uses a default value.

- `valid_min`

If present for a variable, it specifies the minimum valid value for this variable. It should be coherent with the value of the attribute `_FillValue` (all data below this threshold should have been set to `_FillValue`).

- `valid_max`

If present for a variable, it specifies the maximum valid value for this variable. It should be coherent with the value of the attribute `_FillValue` (all data over this threshold should have been set to `_FillValue`).

Note: All the attributes described above might be defined or calculated via processing parameters read by the FLEX processors at runtime, so for some variables in `NC_FMT_TBL` the values remain empty.

## 2.5 COMMON ADDITIONAL GLOBAL ATTRIBUTES

Additional global attributes common to all FLEX files are specifically defined. These attributes aims to ensure the self-containment of the dataset. There are defined in the following table and their value should be adapted according to the file.

**Table 2-2: FLEX L1 NetCDF global attributes**

| Element Name                | Description   | Type   | Dimension |
|-----------------------------|---|--------|-----------|
| <code>NetCDF_version</code> | Description of the NetCDF library used to build the file (restituted by specific API of the NetCDF library) | string | 1         |
| <code>product_name</code>   | The name of the product folder including the file   | string | 1         |
| <code>title</code>          | A brief description of the product  | string | 1         |
| <code>institution</code>    | Identifier of the product generation centre   | string | 1         |

|                       |  |        |   |
|-----------------------|--|--------|---|
| source                | Identifier (including name and version) of the SW Processor that generated the product                     | string | 1 |
| references            | Reference Product data specification document  | string | 1 |
| contact               | URL or email of supporting organization  | string | 1 |
| creation_time         | Creation date and time ( yyyy-mm-ddThh:mm:ss.ssssssZ )   | string | 1 |
| resolution            | Dataset resolution (across- and along-track) in meters unit (except in Calibration and Ancillary products) | string | 1 |
| absolute_orbit_number | Absolute orbit number at start of validity   | uint   | 1 |
| start_time            | Product start date and time ( yyyy-mm-ddThh:mm:ss.ssssssZ )  | string | 1 |
| stop_time             | Product stop date and time ( yyyy-mm-ddThh:mm:ss.ssssssZ )   | string | 1 |
| comment               | Any additional comment on the product  | string | 1 |
| calibration_sub_type  | Calibration sub-type identifier [PDS-L1]   | string | 1 |

### **3 LEVEL 0 PRODUCT STRUCTURE AND FORMAT**

See [PDS-L0].

## 4 LEVEL 1 PRODUCT STRUCTURE AND FORMAT

This chapter reports details on the content of all the Level 1 products generated by the FLEX GPP component, focusing on the data blocks in NetCDF format.

Details on the content of the NetCDF files is summarized in tables which follow the convention described in the paragraph 2.3.

Each paragraph has a section “Open points” where questions and requests for clarifications are addressed to LDO/ESA.

### 4.1 L1 EARTH OBSERVATION PRODUCTS (L1B)

The overall structure of the L1B follows the FLEX FIPS/GPP L1 product specification [PDS-L1]:

- 1 XML header
- 3 data blocks corresponding to the 3 spectral bands LR, HR1 and HR2

Example:

```
- FLX_GPP_L1B_OBS_20190305T133000_20190305T133009_20190927T091740_00015
|--> FLX_GPP_L1B_OBS_20190305T133000_20190305T133009_20190927T091740_00015.XML
|--> FLX_GPP_L1B_OBS_20190305T133000_20190305T133009_20190927T091740_00015.LRE_NC
|--> FLX_GPP_L1B_OBS_20190305T133000_20190305T133009_20190927T091740_00015.HRE1_NC
|--> FLX_GPP_L1B_OBS_20190305T133000_20190305T133009_20190927T091740_00015.HRE2_NC
```

As specified in [PDS-L1] the data blocks of the FLEX L1B products are NetCDF files, whose structure is similar to the Sentinel-3 OLCI OL\_1\_EFR\_\_ product, but completely self-standing.

Here after the table reporting the detailed content of the NetCDF data block, valid for each one of the 3 spectral bands LR, HR1 and HR2.

Each spectral channel is identified by a string

SSS =<XX[X]><Y>\_<mmm>

- <XX[X]> is the spectral band (“HR1” or “HR2” or “LR”)
- <Y> is “B” or “U” (“B” binned, “U” un-binned channel in mixed binned/un-binned mode)
- <mmm> is an integer number progressive number going from 1 to the maximum number of spectral channels in each <XX[X]>spectral band and incremented following the increasing centre wavelengths of the channels.

Example: LRB\_7, HR2B\_14, HR1U\_100.

**Table 4-1: L1B NetCDF data block format description**

| Group Name | Element Name                 | Description                          | Range or Value                  | Type | Dimension |
|------------|------------------------------|--------------------------------------|---------------------------------|------|-----------|
|            | number_of_spectral_channels  | Number of spectral channels (binned) | HR1: 140<br>HR2: 269<br>LR: 235 |      |           |
|            | number_of_along_track_sample | Number of rows in the product image  |                                 |      |           |

| Group Name       | Element Name                   | Description  | Range or Value                                     | Type   | Dimension   |
|------------------|--------------------------------|--|--|--------|---|
|                  | s                              |  |  |        |   |
|                  | number_of_across_track_samples | Number of columns in the product image   | 536  |        |   |
| Measurement data |                                |  |  |        |   |
|                  | FLORIS_SSS_radiance            | Radiance for the current spectral channel SSS<br><br>Note:<br>There is one variable for each spectral channel.         |  | ushort | number_of_along_track_samples<br>number_of_across_track_samples |
|                  | standard_name                  | CF standard name   | toa_upwelling_spectral_radiance                    | string | 1   |
|                  | long_name                      | A long and more explicative name   | TOA radiance for FLEX <XX[X]> spectral channel SSS | string | 1   |
|                  | units                          | units name   | mW.m-2.sr-1.nm-1                                   | string | 1   |
|                  | valid_min                      |  |  | ushort | 1   |
|                  | valid_max                      |  |  | ushort | 1   |
|                  | _FillValue                     | Value indicating missing data  | 0  | ushort | 1   |
|                  | scale_factor                   | Scaling factor used in decoding packed data  |  | float  | 1   |
|                  | add_offset                     | Offset used to in decoding packed data   |  | float  | 1   |
|                  | L_min                          | Under saturation TOA radiance level [mW.m-2.sr-1]  |  | float  | 1   |
|                  | L_max                          | Over saturation TOA radiance level [mW.m-2.sr-1]   |  | float  | 1   |
|                  | FLORIS_SSS_radiance_unc        | Radiance uncertainty for the current spectral channel<br><br>Note:<br>There is one variable for each spectral channel. |  | ubyte  | number_of_along_track_samples<br>number_of_across_track_samples |
|                  | standard_name                  | CF standard name   | toa_upwelling_spectral_radiance_uncertainty        | string | 1   |
|                  | long_name                      | A long and more explicative name   | TOA radiance error estimates                       | string | 1   |

| Group Name                    | Element Name         | Description                                      | Range or Value  | Type   | Dimension   |
|-------------------------------|----------------------|--|---|--------|---|
|                               |                      |  | for FLEX<br><XX[X]><br>spectral<br>channel<br>SSS   |        |   |
|                               | units                | units name                                       | mW.m-<br>2.sr-1.nm-<br>1  | string | 1   |
|                               | valid_min            |  | 1   | ubyte  | 1   |
|                               | valid_max            |  | 255   | ubyte  | 1   |
|                               | _FillValue           | Value indicating missing data                    | 0   | ubyte  | 1   |
|                               | scale_factor         | Scaling factor used in<br>decoding packed data   |   | float  | 1   |
|                               | add_offset           | Offset used to in decoding<br>packed data        |   | float  | 1   |
| Annotation data               |                      |  |   |        |   |
| Annotation data/Quality flags |                      |  |   |        |   |
|                               | common_quality_flags | Common classification and<br>quality flags       |   | ubyte  | number_of_along<br>track_samples<br>number_of_across<br>track_samples |
|                               | standard_name        | CF standard name                                 | common_<br>quality_<br>flags  | string | 1   |
|                               | long_name            | A long and more explicative<br>name              | Classificati<br>on and<br>quality<br>flags<br>common<br>to all the<br>spectral<br>channels  | string | 1   |
|                               | flag_masks           | List of bit fields describing<br>boolean flags   | 1 2 4 8 16<br>32 64 128<br><br>See Table<br>4-2   | ubyte  | 8   |
|                               | flag_meanings        | List of flag meanings<br>composing this variable | "invalid<br>land<br>fresh_inlan<br>d_water<br>coastline<br>tidal_regio<br>n bright<br>sun-<br>glint_risk<br>thermal_st<br>abilize"<br><br>See | string | 1   |

| Group Name                              | Element Name          | Description   | Range or Value  | Type   | Dimension  |
|---|-----------------------|---|---|--------|--|
|   |                       |   | 4.1.1.1   |        |  |
|   | channel_quality_flags | Channel-dependent classification and quality flags        |   | ubyte  | number_of_spectral_channels<br>number_of_along_track_samples<br>number_of_across_track_samples |
|   | standard_name         | CF standard name  | channel_quality_flags   | string | 1  |
|   | long_name             | A long and more explicative name                          | Classification and quality flags depending on spectral channels         | string | 1  |
|   | flag_masks            | List of bit fields describing boolean or enumerated flags | 1 2 4 8 16<br>32 64 128<br>See Table 4-3                                | ubyte  | 8  |
|   | flag_meanings         | List of flag meanings composing this variable             | "bad dead saturated dubious spare0 spare1 spare2 spare3"<br>See 4.1.1.2 | string | 1  |
| Annotation data/Time coordinates        |                       |   |   |        |  |
|   | time_stamp            | Measurement Time Stamp for each line of the product       |   | int64  | number_of_along_track_samples  |
|   | standard_name         | CF standard name  | time  | string | 1  |
|   | long_name             | A long and more explicative name                          | Elapsed time since 01 Jan 2000 0h                                       | string | 1  |
|   | units                 |   | microseconds since 2000-01-01 00:00:00                                  | string | 1  |
|   | FillValue             | Default value for missing data                            | -1  | int64  | 1  |
| Annotation data/Geolocation coordinates |                       |   |   |        |  |
|   | longitude             | DEM corrected longitude                                   | (-180;  | int    | number_of_along  |

| Group Name               | Element Name  | Description                                 | Range or Value          | Type   | Dimension   |
|--------------------------|---------------|---|-------------------------|--------|---|
|                          |               |   | 180]                    |        | g_track_samples<br>number_of_across_track_samples               |
|                          | standard_name | CF standard name                            | longitude               | string | 1   |
|                          | long_name     | A long and more explicative name            | DEM corrected longitude | string | 1   |
|                          | units         | units name                                  | degrees_east            | string | 1   |
|                          | valid_min     |   |                         | int    | 1   |
|                          | valid_max     |   |                         | int    | 1   |
|                          | _FillValue    | Value indicating missing data               | -2147483648             | int    | 1   |
|                          | scale_factor  | Scaling factor used in decoding packed data | 1.e-06                  | float  | 1   |
|                          | latitude      | DEM corrected latitude                      | [-90; 90]               | int    | number_of_along_track_samples<br>number_of_across_track_samples |
|                          | standard_name | CF standard name                            | latitude                | string | 1   |
|                          | long_name     | A long and more explicative name            | DEM corrected latitude  | string | 1   |
|                          | units         | units name                                  | degrees_north           | string | 1   |
|                          | valid_min     |   |                         | int    | 1   |
|                          | valid_max     |   |                         | int    | 1   |
|                          | _FillValue    | Value indicating missing data               | -2147483648             | int    | 1   |
|                          | scale_factor  | Scaling factor used in decoding packed data | 1.e-06                  | float  | 1   |
|                          | altitude      | Altitude                                    | [-1000; 9000]           | short  | number_of_along_track_samples<br>number_of_across_track_samples |
|                          | standard_name | CF standard name                            | altitude                | string | 1   |
|                          | long_name     | A long and more explicative name            | Altitude over Ellipsoid | string | 1   |
|                          | units         | units name                                  | m                       | string | 1   |
|                          | valid_min     |   |                         | short  | 1   |
|                          | valid_max     |   |                         | short  | 1   |
|                          | _FillValue    | Value indicating missing data               | -32768                  | short  | 1   |
|                          | scale_factor  | Scaling factor used in decoding packed data | 1.e-06                  | float  | 1   |
| Annotation data/Geometry |               |   |                         |        |   |
|                          | SZA           | Sun Zenith Angle at tie points              | [0;180]                 | uint   | number_of_along_track_samples<br>number_of_across               |

| Group Name | Element Name  | Description                                 | Range or Value                     | Type   | Dimension   |
|------------|---------------|---|------------------------------------|--------|---|
|            |               |   |                                    |        | s_track_samples   |
|            | standard_name | CF standard name                            | SZA                                | string | 1   |
|            | long_name     | A long and more explicative name            | Sun Zenith Angle                   | string | 1   |
|            | units         | units name                                  | degrees                            | string | 1   |
|            | valid_min     |   |                                    | uint   | 1   |
|            | valid_max     |   |                                    | uint   | 1   |
|            | _FillValue    | Value indicating missing data               | 4294967295                         | uint   | 1   |
|            | scale_factor  | Scaling factor used in decoding packed data | 1.e-06                             | float  | 1   |
|            | SAA           | Sun Azimuth Angle at tie points             | (-180;180]                         | int    | number_of_along_track_samples<br>number_of_across_track_samples |
|            | standard_name | CF standard name                            | SAA                                | string | 1   |
|            | long_name     | A long and more explicative name            | Sun Azimuth Angle                  | string | 1   |
|            | units         | units name                                  | degrees                            | string | 1   |
|            | valid_min     |   |                                    | int    | 1   |
|            | valid_max     |   |                                    | int    | 1   |
|            | _FillValue    | Value indicating missing data               | -2147483648                        | int    | 1   |
|            | scale_factor  | Scaling factor used in decoding packed data | 1.e-06                             | float  | 1   |
|            | OZA           | Observation Angle at tie points             | [0;180]                            | uint   | number_of_along_track_samples<br>number_of_across_track_samples |
|            | standard_name | CF standard name                            | OZA                                | string | 1   |
|            | long_name     | A long and more explicative name            | Observation (Viewing) Zenith Angle | string | 1   |
|            | units         | units name                                  | degrees                            | string | 1   |
|            | valid_min     |   |                                    | uint   | 1   |
|            | valid_max     |   |                                    | uint   | 1   |
|            | _FillValue    | Value indicating missing data               | 4294967295                         | uint   | 1   |
|            | scale_factor  | Scaling factor used in decoding packed data | 1.e-06                             | float  | 1   |
|            | OAA           | Observation Azimuth Angle at tie points     | (-180;180]                         | int    | number_of_along_track_samples<br>number_of_across_track_samples |
|            | standard_name | CF standard name                            | OAA                                | string | 1   |
|            | long_name     | A long and more explicative name            | Observation (Viewing)              | string | 1   |

| Group Name                                 | Element Name          | Description   | Range or Value   | Type   | Dimension  |
|--|-----------------------|---|--|--------|--|
|  |                       |   | Azimuth Angle  |        |  |
|  | units                 | units name  | degrees  | string | 1  |
|  | valid_min             |   |  | int    | 1  |
|  | valid_max             |   |  | int    | 1  |
|  | _FillValue            | Value indicating missing data   | -2147483648  | int    | 1  |
|  | scale_factor          | Scaling factor used in decoding packed data                                 | 1.e-06   | float  | 1  |
| Annotation data/Meteorological information |                       |   |  |        |  |
|  | meteo_columns         | Number of meteo tie point in across track direction                         | 7  |        |  |
|  | meteo_pressure_levels | Number of pressure levels in the temperature profile provided at Tie Points | 25   |        |  |
|  | meteo_wind_vectors    | Dimensions for wind vector  | 2  |        |  |
|  | meteo_column_index    | Meteo grid column index   | [0; number_of_across_track_samples]  | ushort | meteo_columns  |
|  | standard_name         | CF standard name  | Meteo_column_index   | string | 1  |
|  | long_name             | A long and more explicative name  | Location on the instrument grid of the meteo tie points (0-relative ACT index) | string | 1  |
|  | horizontal_wind       | Horizontal wind at 10m altitude   | [-100;100]   | float  | number_of_along_track_samples<br>meteo_columns<br>meteo_wind_vectors |
|  | standard_name         | CF standard name  | Horizontal wind  | string | 1  |
|  | long_name             | A long and more explicative name  | Horizontal wind vector at 10m altitude   | string | 1  |
|  | units                 | units name  | m.s-1  | string | 1  |
|  | valid_min             |   |  | float  | 1  |
|  | valid_max             |   |  | float  | 1  |

| Group Name | Element Name             | Description                      | Range or Value                   | Type   | Dimension                                      |
|------------|--------------------------|----------------------------------|----------------------------------|--------|--|
|            | _FillValue               | Value indicating missing data    | -999                             | float  | 1  |
|            | sea_level_pressure       | Mean sea level pressure          | [0;1500]                         | float  | number_of_along_track_samples<br>meteo_columns |
|            | standard_name            | CF standard name                 | air_pressure_at_sea_level        | string | 1  |
|            | long_name                | A long and more explicative name | Mean sea level pressure          | string | 1  |
|            | units                    | units name                       | hPa                              | string | 1  |
|            | valid_min                |                                  |                                  | float  | 1  |
|            | valid_max                |                                  |                                  | float  | 1  |
|            | _FillValue               | Value indicating missing data    | -1                               | float  | 1  |
|            | total_ozone              | Total columnar ozone             | [0;100]                          | float  | number_of_along_track_samples<br>meteo_columns |
|            | standard_name            | CF standard name                 | atmosphere_mass_content_of_ozone | string | 1  |
|            | long_name                | A long and more explicative name | Total columnar ozone             | string | 1  |
|            | units                    | units name                       | Kg.m-2                           | string | 1  |
|            | valid_min                |                                  |                                  | float  | 1  |
|            | valid_max                |                                  |                                  | float  | 1  |
|            | _FillValue               | Value indicating missing data    | -1                               | float  | 1  |
|            | humidity                 | Relative humidity                | [0;100]                          | float  | number_of_along_track_samples<br>meteo_columns |
|            | standard_name            | CF standard name                 | relative_humidity                | string | 1  |
|            | long_name                | A long and more explicative name | Relative humidity                | string | 1  |
|            | units                    | units name                       | %                                | string | 1  |
|            | valid_min                |                                  |                                  | float  | 1  |
|            | valid_max                |                                  |                                  | float  | 1  |
|            | _FillValue               | Value indicating missing data    | -1                               | float  | 1  |
|            | reference_pressure_level | Reference pressure level         | [0;1500]                         | float  | meteo_pressure_levels                          |
|            | standard_name            | CF standard name                 | air_pressure                     | string | 1  |
|            | long_name                | A long and more explicative name | Reference pressure level         | string | 1  |
|            | units                    | units name                       | hPa                              | string | 1  |
|            | valid_min                |                                  |                                  | float  | 1  |
|            | valid_max                |                                  |                                  | float  | 1  |
|            | _FillValue               | Value indicating missing data    | -1                               | float  | 1  |
|            | atmospheric_temperature  | Atmospheric temperature          | [0;400]                          | float  | number_of_along                                |

| Group Name                               | Element Name                        | Description                          | Range or Value                        | Type   | Dimension   |
|--|-------------------------------------|--------------------------------------|---------------------------------------|--------|---|
|  | temperature_profile                 | profile                              |                                       |        | g_track_samples<br>meteo_columns<br>meteo_pressure_levels |
|  | standard_name                       | CF standard name                     | air_temperature                       | string | 1   |
|  | long_name                           | A long and more explicative name     | Air temperature profile               | string | 1   |
|  | units                               | units name                           | K                                     | string | 1   |
|  | valid_min                           |                                      |                                       | float  | 1   |
|  | valid_max                           |                                      |                                       | float  | 1   |
|  | _FillValue                          | Value indicating missing data        | -1                                    | float  | 1   |
|  | total_columnar_water_vapour         | Total column water vapour            | [0;100]                               | float  | number_of_along_track_samples<br>meteo_columns            |
|  | standard_name                       | CF standard name                     | atmospheric_water_vapor_content       | string | 1   |
|  | long_name                           | A long and more explicative name     | Total column water vapour             | string | 1   |
|  | units                               | units name                           | Kg.m-2                                | string | 1   |
|  | valid_min                           |                                      |                                       | float  | 1   |
|  | valid_max                           |                                      |                                       | float  | 1   |
|  | _FillValue                          | Value indicating missing data        | -1                                    | float  | 1   |
| Annotation data/Instrumental information |                                     |                                      |                                       |        |   |
|  | minmax_number                       |                                      | 2                                     |        |   |
|  | smearing_lines_number               | Number of smearing lines             | 4                                     |        |   |
|  | number_of_imaged_darkinfo_samples   | Number of imaged dark info samples   | [0, number_of_across_track_samples/2] |        |   |
|  | number_of_overscan_samples          | Number of overscan rows              | [0,...]                               |        |   |
|  | number_of_overscan_darkinfo_samples | Number of dark info in overscan rows | [0,...]                               |        |   |
|  | post_pixels_number                  | Number of Post-Pixel voltage samples | 4                                     |        |   |

| Group Name | Element Name                           | Description                                      | Range or Value                                   | Type   | Dimension                                      |
|------------|--|--|--|--------|--|
|            | dark_sides_number                      | Number of dark info samples                      | 4  |        |  |
|            | binning_info_number                    | Number of binning info                           | 2  |        |  |
|            | binning_bands_number                   | Number of binning bands                          | 5  |        |  |
|            | vau_tm_frames_number                   | Number of VAU TM frames                          | number_of_along_track_samples                    |        |  |
|            | spectral_channel_name                  | List of FLEX spectral channel identifiers.       | List of names separated by empty space           | string | 1  |
|            | gain_uncertainty                       | Uncertainty on the gain calibration coefficients | HR1: 3.5<br>HR2: 3.5<br>LR: 3.3                  | float  | Scalar   |
|            | standard_name                          | CF standard name                                 | gain_uncertainty                                 | string | 1  |
|            | long_name                              | A long and more explicative name                 | Uncertainty on the gain calibration coefficients | string | 1  |
|            | units                                  | units name                                       | %  | string | 1  |
|            | relative_spatial_radiometric_accuracy  | Uncertainty due to the RXRA                      | HR1: 0.21<br>HR2: 0.21<br>LR: 0.24               | float  | Scalar   |
|            | standard_name                          | CF standard name                                 | relative_spatial_radiometric_accuracy            | string | 1  |
|            | long_name                              | A long and more explicative name                 | Uncertainty due to the RXRA                      | string | 1  |
|            | units                                  | units name                                       | %  | string | 1  |
|            | relative_spectral_radiometric_accuracy | Uncertainty due to the RSRA                      | HR1: 0.17<br>HR2: 0.17<br>LR: 0.34               | float  | Scalar   |
|            | standard_name                          | CF standard name                                 | relative_spectral_radiometric_accuracy           | string | 1  |
|            | long_name                              | A long and more explicative name                 | Uncertainty due to the RSRA                      | string | 1  |
|            | units                                  | units name                                       | %  | string | 1  |
|            | spectral_channel_central_wavelength    | FLEX pixels characterized central wavelength     | [500,780]  | float  | number_of_spectral_channels<br>number_of_acros |

| Group Name | Element Name                             | Description                                   | Range or Value  | Type   | Dimension   |
|------------|--|---|---|--------|---|
|            |  |   |   |        | s_track_samples   |
|            | standard_name                            | CF standard name                              | spectral_channel_centre_wavelength  | string | 1   |
|            | long_name                                | A long and more explicative name              | FLEX characterized central wavelength   | string | 1   |
|            | units                                    | units name                                    | nm  | string | 1   |
|            | valid_min                                |   |   | float  | 1   |
|            | valid_max                                |   |   | float  | 1   |
|            | _FillValue                               | Value indicating missing data                 | -1  | float  | 1   |
|            | spectral_channel_centre_wavelength_shift | FLEX pixels characterized central wavelength  | [500,780]   | float  | number_of_spectral_channels<br>number_of_across_track_samples |
|            | standard_name                            | CF standard name                              | spectral_channel_centre_wavelength_shift  | string | 1   |
|            | long_name                                | A long and more explicative name              | FLEX central wavelength shifts  | string | 1   |
|            | units                                    | units name                                    | nm  | string | 1   |
|            | valid_min                                |   | -2.0  | float  | 1   |
|            | valid_max                                |   | 2.0   | float  | 1   |
|            | _FillValue                               | Value indicating missing data                 | -100  | float  | 1   |
|            | FWHM                                     | FLEX bandwidths (Full Widths at Half Maximum) | HR1:<br>0.466<br>(channels [HR1B_1-HR1B_20])<br>0.093<br>(channels [HR1U_101-HR1U_220])<br><br>HR2:<br>0.466<br>(channels [HR2B_1-HR2B_42])<br>0.093<br>(channels [HR2U_91- | float  | number_of_spectral_channels<br>number_of_across_track_samples |

| Group Name | Element Name  | Description  | Range or Value  | Type   | Dimension   |
|------------|---------------|--|---|--------|---|
|            |               |  | HR2U_316<br>)<br><br>LR:<br>1.800<br>(channels<br>[LRB_1-<br>LRB_99])<br>0.600<br>(channels<br>[LRU_298-<br>LRU_432]) |        |   |
|            | standard_name | CF standard name   | FWHM  | string | 1   |
|            | long_name     | A long and more explicative name   | FLEX bandwidth (Full Widths at Half Maximum)  | string | 1   |
|            | units         | units name   | nm  | string | 1   |
|            | valid_min     |  |   | float  | 1   |
|            | valid_max     |  |   | float  | 1   |
|            | _FillValue    | Value indicating missing data  | -1  | float  | 1   |
|            | [k]_Isun_filt | The Sun irradiance corrected for date and filtered by the ISRF at each FLEX band [k] | (~80,~2236)   | float  | number_of_spectral_channels<br>number_of_across_track_samples |
|            | standard_name | CF standard name   | solar_flux  | string | 1   |
|            | long_name     | A long and more explicative name   | Extraterrestrial in-band solar irradiance including modulation due to seasonal variations of Earth-Sun distance       | string | 1   |
|            | units         | units name   | mW.m <sup>-2</sup> .nm <sup>-1</sup>  | string | 1   |
|            | valid_min     |  |   | float  | 1   |
|            | valid_max     |  |   | float  | 1   |
|            | _FillValue    | Value indicating missing data  | -1  | float  | 1   |
|            | dynamic_range | Non-linearity dynamic range (DN)   | [0,65535]   | ushort | vau_tm_frames_number<br>minmax_number                         |
|            | standard_name | CF standard name   | dynamic_range   | string | 1   |
|            | long_name     | A long and more explicative  | Minimum   | string | 1   |

| Group Name | Element Name   | Description  | Range or Value  | Type   | Dimension   |
|------------|----------------|--|---|--------|---|
|            |                | name   | and Maximum pixel levels                                |        |   |
|            | T_expo         | Exposure time  | [400,1200 0000]   | uint   | vau_tm_frames_number  |
|            | standard_name  | CF standard name   | T_expo  | string | 1   |
|            | long_name      | A long and more explicative name                             | Exposure time   | string | 1   |
|            | woi_start      | Start row of the Window Of Interest                          | [0,1023]  | ushort | vau_tm_frames_number  |
|            | standard_name  | CF standard name   | woi_start   | string | 1   |
|            | long_name      | A long and more explicative name                             | Start row of the Window Of Interest                     | string | 1   |
|            | woi_size       | Size of the Window Of Interest                               | [0,536]   | ushort | vau_tm_frames_number  |
|            | standard_name  | CF standard name   | woi_size  | string | 1   |
|            | long_name      | A long and more explicative name                             | Size of the Window Of Interest                          | string | 1   |
|            | NBSMEAR        | Number of vertical shift for smearing info accumulation      |   | ushort | vau_tm_frames_number  |
|            | standard_name  | CF standard name   | NBSMEAR   | string | 1   |
|            | long_name      | A long and more explicative name                             | Number of vertical shift for smearing info accumulation | string | 1   |
|            | NBTAIL         | Number of over-scan rows                                     |   | ushort | vau_tm_frames_number  |
|            | standard_name  | CF standard name   | NBTAIL  | string | 1   |
|            | long_name      | A long and more explicative name                             | Number of over-scan rows                                | string | 1   |
|            | smearing_lines | Smearing lines used for smearing correction (default method) |   | float  | number_of_along_track_samples smearing_lines_number number_of_spectral_channels |
|            | standard_name  | CF standard name   | smearing_lines  | string | 1   |
|            | long_name      | A long and more explicative name                             | Smearing lines used for                                 | string | 1   |

| Group Name | Element Name     | Description   | Range or Value  | Type   | Dimension  |
|------------|------------------|---|---|--------|--|
|            |                  |   | smearing correction (default method)  |        |  |
|            | post_pixels      | Post-Pixel Voltage Reference Channel E, F, G, H used for offset correction (TBC)  | [0,65535]   | ushort | number_of_along_track_samples<br>post_pixels_number  |
|            | standard_name    | CF standard name  | post_pixels   | string | 1  |
|            | long_name        | A long and more explicative name  | Post-Pixel Voltage Reference Channel E, F, G, H used for offset correction  | string | 1  |
|            | Dark_info_imaged | Content of the dark sides (not illuminated) of the central part of the CCD (up-left, up-right, bottom-left, bottom-right) | [0,65535]   | ushort | [number_of_along_track_samples<br>number_of_across_track_samples_binned<br>4]              |
|            | standard_name    | CF standard name  | Dark info_image_d   |        |  |
|            | long_name        | A long and more explicative name  | Content of the dark sides (not illuminated) of the central part of the CCD (up-left, up-right, bottom-left, bottom-right) |        |  |
|            | overscan_rows    |   | [0,65535]   | ushort | number_of_along_track_samples<br>number_of_overscan_samples<br>number_of_spectral_channels |
|            | standard_name    | CF standard name  | Overscan rows   |        |  |
|            | long_name        | A long and more explicative name  | Overscan rows   |        |  |
|            | Dark_info_overs  | Content of the dark sides (not  | [0,65535]   | ushort | number_of_along  |

| Group Name | Element Name     | Description  | Range or Value   | Type   | Dimension   |
|------------|------------------|--|--|--------|---|
|            | can              | illuminated) of the overscan lines of the CCD (up-left, up-right, bottom-left, bottom-right)   |  |        | g_track_samples<br>number_of_overscan_darkinfo_samples<br>dark_sides_number |
|            | standard_name    | CF standard name   | Dark_info_overscan   |        |   |
|            | long_name        | A long and more explicative name   | Content of the dark sides (not illuminated) of the overscan lines of the CCD (up-left, up-right, bottom-left, bottom-right)        |        |   |
|            | spectral_binning | BINNINGSIZE defines the number of pixel to be used by binning algorithm for band#i<br><br>BANDSIZE defines the number of pixel in band#i | [0,7]<br>[0,450]   | ushort | vau_tm_frames_number<br>binning_info_number<br>binning_bands_number         |
|            | standard_name    | CF standard name   | spectral_binning   | string | 1   |
|            | long_name        | A long and more explicative name   | BINNINGSIZE<br>BANDSIZE<br>·<br>BINNINGSIZE defines the number of pixel to be used by binning algorithm for i-th band.<br>BANDSIZE | string | 1   |

| Group Name                          | Element Name      | Description  | Range or Value                                    | Type   | Dimension            |
|-------------------------------------|-------------------|--|---|--------|----------------------|
|                                     |                   |  | defines the number of pixel in i-th band          |        |                      |
|                                     | temperatures_CD   | Measure of CCD Temperature 1   | [0,65520]   | float  | vau_tm_frames_number |
|                                     | standard_name     | CF standard name   | temperatures_CD                                   | string | 1                    |
|                                     | long_name         | A long and more explicative name   | Measure of CCD Temperature 1                      | string | 1                    |
|                                     | units             | units name   | K   | string | 1                    |
|                                     | temperatures_VAU  | Measure of VAU temperatures  | [0,65520]   | float  | vau_tm_frames_number |
|                                     | standard_name     | CF standard name   | temperatures_VAU                                  | string | 1                    |
|                                     | long_name         | A long and more explicative name   | Measure of VAU temperatures                       | string | 1                    |
|                                     | units             | units name   | K   | string | 1                    |
|                                     | temperatures_FPA  | Measure of FPA temperatures  | [0,65520]   | float  | vau_tm_frames_number |
|                                     | standard_name     | CF standard name   | temperatures_FPA                                  | string | 1                    |
|                                     | long_name         | A long and more explicative name   | Measure of FPA temperatures                       | string | 1                    |
|                                     | units             | units name   | K   | string | 1                    |
| Annotation data/Processing executed |                   |  |   |        |                      |
|                                     | flag_dim          | Flags dimension  | 1   |        |                      |
|                                     | input_names       | Name of the input files used in the processing                           | List of names separated by empty space            | string | 1                    |
|                                     | offset_correction | Flag indicating if the offset correction has been applied (1) or not (0) | [0,1]   | ubyte  | flag_dim             |
|                                     | standard_name     | CF standard name   | offset_correction                                 | string | 1                    |
|                                     | long_name         | A long and more explicative name   | Flag indicating if the offset correction has been | string | 1                    |

| Group Name | Element Name             | Description   | Range or Value  | Type   | Dimension |
|------------|--------------------------|---|---|--------|-----------|
|            |                          |   | applied (1) or not (0)  |        |           |
|            | valid_min                |   | 0   | ubyte  | 1         |
|            | valid_max                |   | 1   | ubyte  | 1         |
|            | _FillValue               | Value indicating unfilled flag  | 255   | ubyte  | 1         |
|            | non_linearity_correction | Flag indicating if the non-linearity correction has been applied (1) or not (0)   | [0,1]   | ubyte  | flag_dim  |
|            | standard_name            | CF standard name  | non_linearity_correction  | string | 1         |
|            | long_name                | A long and more explicative name  | Flag indicating if the non-linearity correction has been applied (1) or not (0)   | string | 1         |
|            | valid_min                |   | 0   | ubyte  | 1         |
|            | valid_max                |   | 1   | ubyte  | 1         |
|            | _FillValue               | Value indicating unfilled flag  | 255   | ubyte  | 1         |
|            | dark_signal_removal      | Flag indicating if the dark signal correction has been applied (1) or not (0)     | [0,1]   | ubyte  | flag_dim  |
|            | standard_name            | CF standard name  | dark_signal_removal   | string | 1         |
|            | long_name                | A long and more explicative name  | Flag indicating if the dark signal correction has been applied (1) or not (0)     | string | 1         |
|            | valid_min                |   | 0   | ubyte  | 1         |
|            | valid_max                |   | 1   | ubyte  | 1         |
|            | _FillValue               | Value indicating unfilled flag  | 255   | ubyte  | 1         |
|            | smearing_correction      | Flag indicating if the smearing signal correction has been applied (1) or not (0) | [0,1]   | ubyte  | flag_dim  |
|            | standard_name            | CF standard name  | smearing_correction   | string | 1         |
|            | long_name                | A long and more explicative name  | Flag indicating if the smearing signal correction has been applied (1) or not (0) | string | 1         |

| Group Name | Element Name                     | Description   | Range or Value   | Type   | Dimension |
|------------|----------------------------------|---|--|--------|-----------|
|            | valid_min                        |   | 0  | ubyte  | 1         |
|            | valid_max                        |   | 1  | ubyte  | 1         |
|            | _FillValue                       | Value indicating unfilled flag  | 255  | ubyte  | 1         |
|            | straylight_correction            | Flag indicating if the straylight correction has been applied (1) or not (0)              | [0,1]  | ubyte  | flag_dim  |
|            | standard_name                    | CF standard name  | straylight_correction  | string | 1         |
|            | long_name                        | A long and more explicative name  | Flag indicating if the straylight correction has been applied (1) or not (0) | string | 1         |
|            | from_along_track_sample          | The 0-relative index of the first along track sample the straylight has been applied from |  | uint   | 1         |
|            | from_along_track_sample          | The 0-relative index of the last along track sample the straylight has been applied to    |  | uint   | 1         |
|            | valid_min                        |   | 0  | ubyte  | 1         |
|            | valid_max                        |   | 1  | ubyte  | 1         |
|            | _FillValue                       | Value indicating unfilled flag  | 255  | ubyte  | 1         |
|            | flat_field_correction            | Flag indicating if the flat field correction has been applied (1) or not (0)              | [0,1]  | ubyte  | flag_dim  |
|            | standard_name                    | CF standard name  | flat_field_correction  | string | 1         |
|            | long_name                        | A long and more explicative name  | Flag indicating if the flat field correction has been applied (1) or not (0) | string | 1         |
|            | valid_min                        |   | 0  | ubyte  | 1         |
|            | valid_max                        |   | 1  | ubyte  | 1         |
|            | _FillValue                       | Value indicating unfilled flag  | 255  | ubyte  | 1         |
|            | absolute_radiometric_calibration | Flag indicating if the absolute radiometric correction has been applied (1) or not (0)    | [0,1]  | ubyte  | flag_dim  |
|            | standard_name                    | CF standard name  | absolute_radiometric_calibration   | string | 1         |
|            | long_name                        | A long and more explicative name  | Flag indicating if the   | string | 1         |

| Group Name | Element Name                        | Description   | Range or Value  | Type   | Dimension |
|------------|-------------------------------------|---|---|--------|-----------|
|            |                                     |   | absolute radiometric correction has been applied (1) or not (0)               |        |           |
|            | valid_min                           |   | 0   | ubyte  | 1         |
|            | valid_max                           |   | 1   | ubyte  | 1         |
|            | _FillValue                          | Value indicating unfilled flag  | 255   | ubyte  | 1         |
|            | geolocation                         | Flag indicating if the geolocation has been applied (1) or not (0)                      | [0,1]   | ubyte  | flag_dim  |
|            | standard_name                       | CF standard name  | geolocation   | string | 1         |
|            | long_name                           | A long and more explicative name  | Flag indicating if the geolocation has been done (1) or not (0)               | string | 1         |
|            | valid_min                           |   | 0   | ubyte  | 1         |
|            | valid_max                           |   | 1   | ubyte  | 1         |
|            | _FillValue                          | Value indicating unfilled flag  | 255   | ubyte  | 1         |
|            | defective_pixels_flagging           | Flag indicating if the defective pixels flagging has been done (1) or not (0)           | [0,1]   | ubyte  | flag_dim  |
|            | standard_name                       | CF standard name  | defective_pixels_flagging   | string | 1         |
|            | long_name                           | A long and more explicative name  | Flag indicating if the defective pixels flagging has been done (1) or not (0) | string | 1         |
|            | valid_min                           |   | 0   | ubyte  | 1         |
|            | valid_max                           |   | 1   | ubyte  | 1         |
|            | _FillValue                          | Value indicating unfilled flag  | 255   | ubyte  | 1         |
|            | classification_and_quality_flagging | Flag indicating if the classification and quality flagging has been done (1) or not (0) | [0,1]   | ubyte  | flag_dim  |
|            | standard_name                       | CF standard name  | classification_and_quality_flagging   | string | 1         |
|            | long_name                           | A long and more explicative   | Flag  | string | 1         |

| Group Name              | Element Name        | Description   | Range or Value   | Type   | Dimension |
|-------------------------|---------------------|---|--|--------|-----------|
|                         |                     | name  | indicating if the classification and quality flagging has been done (1) or not (0) |        |           |
|                         | valid_min           |   | 0  | ubyte  | 1         |
|                         | valid_max           |   | 1  | ubyte  | 1         |
|                         | _FillValue          | Value indicating unfilled flag  | 255  | ubyte  | 1         |
|                         | output_rescaling    | Flag indicating if the output rescaling has been done (1) or not (0)                        | [0,1]  | ubyte  | flag_dim  |
|                         | standard_name       | CF standard name  | output_rescaling   | string | 1         |
|                         | long_name           | A long and more explicative name  | Flag indicating if the output rescaling has been done (1) or not (0)               | string | 1         |
|                         | valid_min           |   | 0  | ubyte  | 1         |
|                         | valid_max           |   | 1  | ubyte  | 1         |
|                         | _FillValue          | Value indicating unfilled flag  | 255  | ubyte  | 1         |
|                         | output_zipping      | Flag indicating if the zip of the outputs has been done (1) or not (0)                      | [0,1]  | ubyte  | flag_dim  |
|                         | standard_name       | CF standard name  | output_zipping   | string | 1         |
|                         | long_name           | A long and more explicative name  | Flag indicating if the zip of the outputs has been done (1) or not (0)             | string | 1         |
|                         | valid_min           |   | 0  | ubyte  | 1         |
|                         | valid_max           |   | 1  | ubyte  | 1         |
|                         | _FillValue          | Value indicating unfilled flag  | 255  | ubyte  | 1         |
| Annotation data/Eclipse |                     |   |  |        |           |
|                         | time_out_of_eclipse | Number of seconds the satellite is out of the eclipse caused by the Earth occluding the Sun |  | double | 1         |
|                         | standard_name       | CF standard name  | time_out_of_eclipse  | string | 1         |

| Group Name | Element Name  | Description   | Range or Value  | Type   | Dimension |
|------------|---------------|---|---|--------|-----------|
|            | long_name     | A long and more explicative name  | Number of seconds the satellite is out of the eclipse caused by the Earth occluding the Sun                             | string | 1         |
|            | units         | units name  | seconds   | string | 1         |
|            | _FillValue    | Value indicating missing data   | -1  | double | 1         |
|            | eclipse_entry | Elapsed time since 01 Jan 2000 0h of satellite entering the eclipse caused by Earth occluding the Sun |   | int64  | 1         |
|            | standard_name | CF standard name  | eclipse_entry   | string | 1         |
|            | long_name     | A long and more explicative name  | Elapsed time since 01 Jan 2000 0h of satellite entering the eclipse caused by Earth occluding the Sun. -1 if no eclipse | string | 1         |
|            | units         | units name  | microseconds since 2000-01-01 00:00:00  | string | 1         |
|            | _FillValue    | Value indicating missing data   | -1  | int64  | 1         |
|            | eclipse_exit  | Elapsed time since 01 Jan 2000 0h of satellite exiting the eclipse caused by Earth occluding the Sun  |   | int64  | 1         |
|            | standard_name | CF standard name  | eclipse_exit  | string | 1         |
|            | long_name     | A long and more explicative name  | Elapsed time since 01 Jan 2000 0h of satellite exiting the eclipse caused by Earth                                      | string | 1         |

| Group Name | Element Name   | Description  | Range or Value  | Type   | Dimension |
|------------|----------------|--|---|--------|-----------|
|            |                |  | occluding the Sun. - 1 if no eclipse  |        |           |
|            | units          | units name   | microseconds since 2000-01-01 00:00:00  | string | 1         |
|            | _FillValue     | Value indicating missing data  | -1  | int64  | 1         |
|            | sun_moon_entry | Elapsed time since 01 Jan 2000 0h of satellite entering the eclipse caused by Moon occluding the Sun |   | int64  | 1         |
|            | standard_name  | CF standard name   | sun_moon_entry  | string | 1         |
|            | long_name      | A long and more explicative name   | Elapsed time since 01 Jan 2000 0h of satellite entering the eclipse caused by Moon occluding the Sun. - 1 if no eclipse | string | 1         |
|            | units          | units name   | microseconds since 2000-01-01 00:00:00  | string | 1         |
|            | _FillValue     | Value indicating missing data  | -1  | int64  | 1         |
|            | sun_moon_exit  | Altitude   | Elapsed time since 01 Jan 2000 0h of satellite exiting the eclipse caused by Moon occluding the Sun. - 1 if no eclipse  | int64  | 1         |
|            | standard_name  | CF standard name   | sun_moon_exit   | string | 1         |
|            | long_name      | A long and more explicative name   | Elapsed time since  | string | 1         |

| Group Name | Element Name | Description                   | Range or Value   | Type   | Dimension |
|------------|--------------|-------------------------------|--|--------|-----------|
|            |              |                               | 01 Jan 2000 0h of satellite exiting the eclipse caused by Moon occluding the Sun. -1 if no eclipse |        |           |
|            | units        | units name                    | microseconds since 2000-01-01 00:00:00   | string | 1         |
|            | _FillValue   | Value indicating missing data | -1   | int64  | 1         |
|            |              |                               |  |        |           |

## 4.1.1 Quality flags

### 4.1.1.1 Common Quality flags

The following table describes the structure of the byte regrouping all those classification and quality flags of the L1B product that are common to all the spectral channels (byte/bit decimal highest value indicates the most significant):

**Table 4-2: Structure of common quality flags sample**

| BYTE \ BIT | 7   | 6   | 5   | 4   | 3   | 2   | 1   | 0   |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|
| 0          | THM | SGL | CLO | COA | TIR | FIW | LSW | INV |

With:

- **INV**: Invalid Pixel flag set to '1' if the pixel is invalid, i.e. its value is missing either because out of the instrument swath or because of missing or unusable Level 0 data.
- **LSW**: Land/Saline Water flag set to '1' if the pixel is over land, '0' if it is over water.
- **FIW**: Fresh Inland Water flag set to '1' if the pixel is over fresh water rivers or lakes
- **COA**: Coastline flag set to '1' if the pixel is on coastline
- **TIR**: Tidal regions flag set to '1' if the pixel is over a tidal region
- **CLO**: Preliminary Cloud flag (bright pixel) set to '1' if the pixel is bright
- **SGL**: Sun-Glint Risk flag set to '1' if the viewing and wind conditions are such that the Sun may cause glint to occur on pixels over water surfaces (This flag is set only on the basis of sun and viewing angles taking into account wind conditions, but it is not set according to radiometric data)
- **THM**: Thermal stability flag set to '1' if the pixel is thermally stable, '0' otherwise

#### 4.1.1.2 Channel-dependent Quality flags

The following table describes the structure of the byte regrouping all classification and quality flags of the L1B products depending on spectral channel (byte/bit decimal highest value indicates the most significant):

**Table 4-3: Structure of the channel quality flags sample**

| BYTE \ BIT | 7  | 6  | 5  | 4  | 3   | 2   | 1   | 0   |
|------------|----|----|----|----|-----|-----|-----|-----|
| 0          | sp | sp | sp | sp | DOU | SAT | DEA | BAD |

With:

- **BAD:** Bad pixel flag set to '1' if the pixel has poor quality (see [FLX-ACR] for the definition details)
- **DEA:** Dead pixel flag set to '1' if the pixel is not reliable (see [FLX-ACR] definition details)
- **SAT:** Saturated
- **DOU:** Dubious (TBC)
- **sp:** Spare bits, to be ignored (set to 0).

## 4.2 L1 RADIOMETRIC CALIBRATION PRODUCTS (RAC)

The overall structure of the L1 radiometric calibration products (RAC) follows the FLEX FIPS/GPP L1 product specification [PDS-L1]:

- 1 XML header
- 3 data blocks corresponding to the 3 detectors LR, HR1 and HR2

As specified in [PDS-L1] the data blocks of the FLEX L1 RAC products are NetCDF files, whose structure has some commonality with Sentinel-3 OLCI RAC products, but FLEX RAC products are completely self-standing.

In FLEX are foreseen several L1 RAC products, identified by specific semantic descriptors (see [PDS-L1]). L1 RAC products are inputs to the FLEX GPP Radiometric and Spectral Module in order to estimates and update specific radiometric calibration parameters in the CCDB files (see algorithm details in [GPP-ATBD]).

The next paragraph will report details on the format of each RAC product.

### 4.2.1 L1 RAC DARKNP: Dark signal in nominal EO mode

It collects data acquired with CU on EO Nadir port performed before sunbathing at South Pole, in order to characterize the dark signal.

Example:

```
- FLX_GPP_RAC_DARKNP_20190305T133000_20190305T133009_20190927T091740_00015
/--> FLX_GPP_RAC_DARKNP_20190305T133000_20190305T133009_20190927T091740_00015.XML
/--> FLX_GPP_RAC_DARKNP_20190305T133000_20190305T133009_20190927T091740_00015.LRE_NC
/--> FLX_GPP_RAC_DARKNP_20190305T133000_20190305T133009_20190927T091740_00015.HRE1_NC
```

/--> FLX\_GPP\_RAC\_DARKNP\_20190305T133000\_20190305T133009\_20190927T091740\_00015.HRE2.NC

Here after the table reporting the detailed content of the NetCDF data block valid for each one of the 3 spectral bands LR, HR1 and HR2 (indicated with *[k]* in the table).

**Table 4-4: L1 RAC DARKNP NetCDF data block format description**

| Group Name                    | Element Name                   | Description  | Range or Value   | Type   | Dimension   |
|-------------------------------|--------------------------------|--|--|--------|---|
|                               | number_of_spectral_channels    | Number of spectral channels (binned)                     | HR1: 140<br>HR2: 269<br>LR: 235                          |        |   |
|                               | number_of_along_track_samples  | Number of acquisitions                                   | 1200<br>[CAL-TAB]  |        |   |
|                               | number_of_across_track_samples | Number of columns in the product image                   | 536  |        |   |
| Measurement data              |                                |  |  |        |   |
|                               | [k]_DARK_FRAME                 | Reference dark signal measurements for spectral band [k] |  | float  | number_of_a_cross_track_samples<br>number_of_spectral_channels                                  |
|                               | standard_name                  | CF standard name   | [k]_DARK_FRAME   | string | 1   |
|                               | long_name                      | A long and more explicative name                         | Reference dark signal measurements for spectral band [k] | string | 1   |
|                               | units                          | units name   | DN   | string | 1   |
| Annotation data/Quality flags |                                |  |  |        |   |
|                               | quality_flags                  | Quality flags  |  | ubyte  | number_of_along_track_samples<br>number_of_a_cross_track_samples<br>number_of_spectral_channels |
|                               | standard_name                  | CF standard name   | quality_flags  | string | 1   |
|                               | long_name                      | A long and more explicative name                         | Quality flags  | string | 1   |
|                               | flag_masks                     | List of bit fields describing boolean flags              | 1 2 4 8 16 32 64 128<br>See Table 4-8                    | ubyte  | 8   |
|                               | flag_meanings                  | List of flag meanings composing this variable            | "bad dead saturated dubious invalid                      | string | 1   |

| Group Name                               | Element Name                          | Description  | Range or Value   | Type   | Dimension                     |
|--|---------------------------------------|--|--|--------|-------------------------------|
|  |                                       |  | spare0 spare1<br>spare2"<br><br>See Table 4-9                          |        |                               |
| Annotation data/Time coordinates         |                                       |  |  |        |                               |
|  | time_stamp                            | Measurement Time Stamp for each measurement                              |  | int64  | number_of_along_track_samples |
|  | standard_name                         | CF standard name   | time   | string | 1                             |
|  | long_name                             | A long and more explicative name   | Elapsed time since 01 Jan 2000 0h                                      | string | 1                             |
|  | units                                 |  | microseconds since 2000-01-01 00:00:00                                 | string | 1                             |
|  | _FillValue                            | Default value for missing data   | -1   | int64  | 1                             |
| Annotation data/Instrumental information | Same content of the L1B products 4.1. |  |  |        |                               |
| Annotation data/Processing executed      |                                       |  |  |        |                               |
|  | flag_dim                              | Flags dimension  | 1  |        |                               |
|  | input_names                           | Name of the input files used in the processing                           | List of names separated by empty space                                 | string | 1                             |
|  | output_zipping                        | Flag indicating if the zip of the outputs has been done (1) or not (0)   | [0,1]  | ubyte  | flag_dim                      |
|  | standard_name                         | CF standard name   | output_zipping   | string | 1                             |
|  | long_name                             | A long and more explicative name   | Flag indicating if the zip of the outputs has been done (1) or not (0) | string | 1                             |
|  | valid_min                             |  | 0  | ubyte  | 1                             |
|  | valid_max                             |  | 1  | ubyte  | 1                             |
|  | _FillValue                            | Value indicating unfilled flag   | 255  | ubyte  | 1                             |
|  | offset_correction                     | Flag indicating if the offset correction has been applied (1) or not (0) | [0,1]  | ubyte  | flag_dim                      |
|  | standard_name                         | CF standard name   | offset_correction  | string | 1                             |
|  | long_name                             | A long and more explicative name   | Flag indicating if the offset correction has                           | string | 1                             |

| Group Name | Element Name             | Description   | Range or Value  | Type   | Dimension |
|------------|--------------------------|---|---|--------|-----------|
|            |                          |   | been applied (1) or not (0)   |        |           |
|            | valid_min                |   | 0   | ubyte  | 1         |
|            | valid_max                |   | 1   | ubyte  | 1         |
|            | _FillValue               | Value indicating unfilled flag  | 255   | ubyte  | 1         |
|            | non_linearity_correction | Flag indicating if the non-linearity correction has been applied (1) or not (0) | [0,1]   | ubyte  | flag_dim  |
|            | standard_name            | CF standard name  | non_linearity_correction  | string | 1         |
|            | long_name                | A long and more explicative name  | Flag indicating if the non-linearity correction has been applied (1) or not (0) | string | 1         |
|            | valid_min                |   | 0   | ubyte  | 1         |
|            | valid_max                |   | 1   | ubyte  | 1         |
|            | _FillValue               | Value indicating unfilled flag  | 255   | ubyte  | 1         |

#### 4.2.1.1 Open points

"Meteorological information" metadata is TBD in [PDS-L1] §6.2.7, for this reason it is not reported in the "Annotation data" group.

### 4.2.2 L1 RAC DARKOC: Dark signal in EO mode on dark ocean

It collects data acquired with CU on EO Nadir port performed during eclipse, observing dark ocean (with moon in right geometry), in order to characterize the dark signal.

Example:

```
- FLX_GPP_RAC_DARKOC_20190305T133000_20190305T133009_20190927T091740_00015
/--> FLX_GPP_RAC_DARKOC_20190305T133000_20190305T133009_20190927T091740_00015.XML
/--> FLX_GPP_RAC_DARKOC_20190305T133000_20190305T133009_20190927T091740_00015.LRE.NC
/--> FLX_GPP_RAC_DARKOC_20190305T133000_20190305T133009_20190927T091740_00015.HRE1.NC
/--> FLX_GPP_RAC_DARKOC_20190305T133000_20190305T133009_20190927T091740_00015.HRE2.NC
```

The format of the NetCDF data block for the 3 spectral bands is identical to RAC\_DARKNP (see Table 4-4).

#### 4.2.2.1 Open points

See 4.2.1.1.

### 4.2.3 L1 RAC DARKSR: Dark on Sun diffuser in nominal mode

It collects data acquired to characterize the dark signal with the CU positioned on dark targets pointing to sun. Acquisition are made as in EO mode (spatially and spectrally binned).

Example:

```
- FLX_GPP_RAC_DARKSR_20190305T133000_20190305T133009_20190927T091740_00015  
|--> FLX_GPP_RAC_DARKSR_20190305T133000_20190305T133009_20190927T091740_00015.XML  
|--> FLX_GPP_RAC_DARKSR_20190305T133000_20190305T133009_20190927T091740_00015.LRE.NC  
|--> FLX_GPP_RAC_DARKSR_20190305T133000_20190305T133009_20190927T091740_00015.HRE1.NC  
|--> FLX_GPP_RAC_DARKSR_20190305T133000_20190305T133009_20190927T091740_00015.HRE2.NC
```

The format of the NetCDF data block for the 3 spectral bands is identical to RAC\_DARKNP (see Table 4-4).

#### 4.2.3.1 Open points

See 4.2.1.1.

### 4.2.4 L1 RAC DRKMTF: Dark for Moon MTF calibration

It collects data acquired with CU on EO port pointing to the Moon, in order to characterize the dark signal just before the acquisitions performed for MTF characterization.

Example:

```
- FLX_GPP_RAC_DRKMTF_20190305T133000_20190305T133009_20190927T091740_00015  
|--> FLX_GPP_RAC_DRKMTF_20190305T133000_20190305T133009_20190927T091740_00015.XML  
|--> FLX_GPP_RAC_DRKMTF_20190305T133000_20190305T133009_20190927T091740_00015.LRE.NC  
|--> FLX_GPP_RAC_DRKMTF_20190305T133000_20190305T133009_20190927T091740_00015.HRE1.NC  
|--> FLX_GPP_RAC_DRKMTF_20190305T133000_20190305T133009_20190927T091740_00015.HRE2.NC
```

The content of the NetCDF data block for the 3 spectral bands is identical to RAC\_DARKNP (see Table 4-4). Note that the number of acquisitions (dimension "number\_of\_along\_track\_samples") is different [CAL-TAB].

#### 4.2.4.1 Open points

See 4.2.1.1.

### 4.2.5 L1 RAC DRKSTR: Dark for Moon straylight 1

It collects data acquired with CU on EO port pointing to the Moon, in order to characterize the dark signal just before the acquisitions performed for straylight characterization by Moon (first method, measurements during S/C slewing manoeuvre).

Example:

```
- FLX_GPP_RAC_DRKSTR_20190305T133000_20190305T133009_20190927T091740_00015
/--> FLX_GPP_RAC_DRKSTR_20190305T133000_20190305T133009_20190927T091740_00015.XML
/--> FLX_GPP_RAC_DRKSTR_20190305T133000_20190305T133009_20190927T091740_00015.LRE.NC
/--> FLX_GPP_RAC_DRKSTR_20190305T133000_20190305T133009_20190927T091740_00015.HRE1.NC
/--> FLX_GPP_RAC_DRKSTR_20190305T133000_20190305T133009_20190927T091740_00015.HRE2.NC
```

The content of the NetCDF data block for the 3 spectral bands is identical to RAC\_DARKNP (see Table 4-4). Note that the number of acquisitions (dimension "number\_of\_along\_track\_samples") could be different [CAL-TAB].

#### 4.2.5.1 Open points

See 4.2.1.1.

### 4.2.6 L1 RAC MOON\_\_: Moon MTF

It collects data acquired with CU on EO port pointing to the Moon, suitable for MTF characterisation.

Example:

```
- FLX_GPP_RAC_MOON__20190305T133000_20190305T133009_20190927T091740_00015
/--> FLX_GPP_RAC_MOON__20190305T133000_20190305T133009_20190927T091740_00015.XML
/--> FLX_GPP_RAC_MOON__20190305T133000_20190305T133009_20190927T091740_00015.LRE.NC
/--> FLX_GPP_RAC_MOON__20190305T133000_20190305T133009_20190927T091740_00015.HRE1.NC
/--> FLX_GPP_RAC_MOON__20190305T133000_20190305T133009_20190927T091740_00015.HRE2.NC
```

Here after the table reporting the detailed content of the NetCDF data block valid for each one of the 3 spectral bands LR, HR1 and HR2.

**Table 4-5: L1 RAC MOON\_\_ NetCDF data block format description**

| Group Name       | Element Name                   | Description   | Range or Value                  | Type   | Dimension            |
|------------------|--------------------------------|---|---------------------------------|--------|----------------------|
|                  | number_of_along_track_samples  | Number of rows in the calibration image                                 | 300<br>[CAL-TAB]                |        |                      |
|                  | number_of_across_track_samples | Number of columns in the calibration image                              | 536                             |        |                      |
|                  | number_of_spectral_channels    | Number of spectral channels   | HR1: 140<br>HR2: 269<br>LR: 235 |        |                      |
|                  | number_of_ESF_samples_AL_T     | Number of samples at which the ESF parameters are computed along track  | 22                              |        |                      |
|                  | number_of_ESF_samples_AC_T     | Number of samples at which the ESF parameters are computed across track | 287                             |        |                      |
| Measurement data |                                |   |                                 |        |                      |
|                  | L1B_TOA_radiance               | L1B TOA radiance  |                                 | ushort | number_of_spectral_c |

| Group Name | Element Name              | Description  | Range or Value  | Type   | Dimension   |
|------------|---------------------------|--|---|--------|---|
|            |                           |  |   |        | channels<br>number_of<br>_along_trac<br>k_samples<br>number_of<br>_across_tra<br>ck_samples |
|            | standard_name             | CF standard name   | L1B_TOA_radi<br>ance                                      | string | 1   |
|            | long_name                 | A long and more explicative<br>name                        | L1B TOA<br>radiance                                       | string | 1   |
|            | units                     | units name   | mW.m-2.sr-<br>1.nm-1                                      | string | 1   |
|            | valid_min                 |  |   | ushort | 1   |
|            | valid_max                 |  |   | ushort | 1   |
|            | scale_factor              | Scaling factor used in<br>decoding packed data             |   | float  | 1   |
|            | add_offset                | Offset used to in decoding<br>packed data                  |   | float  | 1   |
|            |                           |  |   |        |   |
|            | moon_mask                 | Mask indicating the moon<br>inside the calibration product | [0,1]   | byte   | number_of<br>_along_trac<br>k_samples<br>number_of<br>_across_tra<br>ck_samples             |
|            | standard_name             | CF standard name   | moon_mask   | string | 1   |
|            | long_name                 | A long and more explicative<br>name                        | Lunar<br>calibration<br>image mask                        | string | 1   |
|            | number_of_m<br>oon_pixels | Total count value of Lunar<br>pixels in the image          |   | uint   | 1   |
|            | valid_min                 |  | 0   | byte   | 1   |
|            | valid_max                 |  | 1   | byte   | 1   |
|            | _FillValue                | Value indicating missing data                              | -1  | byte   | 1   |
|            | moon_irradiance           | Moon irradiance value                                      | [0.0, TBD]  | float  | number_of<br>_spectral_c<br>hannels   |
|            | standard_name             | CF standard name   | moon_irradiance   | string | 1   |
|            | long_name                 | A long and more explicative<br>name                        | Total lunar<br>irradiance<br>from<br>calibration<br>image | string | 1   |
|            | units                     | Units name   | W.m-2.nm-1  | string | 1   |
|            | _FillValue                | Value indicating missing data                              | -1.0  | float  | 1   |
|            | model_irradiance          | All pixels radiance values                                 | [0.0, TBD]  | float  | number_of<br>_spectral_c  |

| Group Name | Element Name         | Description  | Range or Value                                       | Type   | Dimension  |
|------------|----------------------|--|--|--------|--|
|            |                      |  |  |        | channels   |
|            | standard_name        | CF standard name                                     | irradiance_model                                     | string | 1  |
|            | long_name            | A long and more explicative name                     | Total lunar irradiance from model                    | string | 1  |
|            | units                | Units name   | W.m-2.nm-1   | string | 1  |
|            | _FillValue           | Value indicating missing data                        | -1.0   | float  | 1  |
|            | measured_model_ratio | Ratio between Measured and Modelled Lunar irradiance |  | float  | number_of_spectral_channels                              |
|            | standard_name        | CF standard name                                     | irradiance_model                                     | string | 1  |
|            | long_name            | A long and more explicative name                     | Ratio between Measured and Modelled Lunar irradiance | string | 1  |
|            | _FillValue           | Unfilled data value                                  | -1.0   | float  | 1  |
|            | MTF_ACT              | Module Transfer Function ACT                         |  | float  | number_of_spectral_channels                              |
|            | standard_name        | CF standard name                                     | MTF  | string | 1  |
|            | long_name            | A long and more explicative name                     | Module Transfer Function ACT                         | string | 1  |
|            | _FillValue           | Unfilled data value                                  | -1.0   | float  | 1  |
|            | MTF_ALT              | Module Transfer Function ALT                         |  | float  | number_of_spectral_channels                              |
|            | standard_name        | CF standard name                                     | MTF  | string | 1  |
|            | long_name            | A long and more explicative name                     | Module Transfer Function ALT                         | string | 1  |
|            | _FillValue           | Unfilled data value                                  | -1.0   | float  | 1  |
|            | ESF_x_position_ACT   | ESF relative pixel position ACT                      |  | float  | number_of_spectral_channels<br>number_of_ESF_samples_ACT |
|            | standard_name        | CF standard name                                     | ESF_x_position_ACT                                   | string | 1  |
|            | long_name            | A long and more explicative name                     | ESF relative pixel position                          | string | 1  |
|            | ESF_x_position_ALT   | ESF relative pixel position ALT                      |  | float  | number_of_spectral_channels<br>number_of_ESF_sampl       |

| Group Name | Element Name           | Description                                     | Range or Value                               | Type   | Dimension  |
|------------|------------------------|---|--|--------|--|
|            |                        |   |  |        | es_ALT   |
|            | standard_name          | CF standard name                                | ESF_x_position_ALT                           | string | 1  |
|            | long_name              | A long and more explicative name                | ESF relative pixel position                  | string | 1  |
|            | ESF_radiance_level_ACT | ESF radiance level ACT                          |  | float  | number_of_spectral_channels<br>number_of_ESF_samples_ACT |
|            | standard_name          | CF standard name                                | ESF_radiance_level_ACT                       | string | 1  |
|            | long_name              | A long and more explicative name                | ESF radiance level                           | string | 1  |
|            | ESF_radiance_level_ALT | ESF radiance level ALT                          |  | float  | number_of_spectral_channels<br>number_of_ESF_samples_ALT |
|            | standard_name          | CF standard name                                | ESF_radiance_level_ALT                       | string | 1  |
|            | long_name              | A long and more explicative name                | ESF radiance level                           | string | 1  |
|            |                        |   |  |        |  |
|            | LSF_x_position_ACT     | Domain of LSF (set of X values) across-track    |  | float  | number_of_spectral_channels<br>number_of_ESF_samples_ACT |
|            | standard_name          | CF standard name                                | LSF_x_position_ACT                           | string | 1  |
|            | long_name              | A long and more explicative name                | Domain of LSF (set of X values) across-track | string | 1  |
|            | LSF_x_position_ALT     | Domain of LSF (set of X values) along-track     |  | float  | number_of_spectral_channels<br>number_of_ESF_samples_ALT |
|            | standard_name          | CF standard name                                | LSF_x_position_ALT                           | string | 1  |
|            | long_name              | A long and more explicative name                | Domain of LSF (set of X values) along-track  | string | 1  |
|            | LSF_values_ACT         | Normalized Line Spread Function (NLSF) computed |  | float  | number_of_spectral_channels                              |

| Group Name      | Element Name          | Description  | Range or Value   | Type   | Dimension  |
|-----------------|-----------------------|--|--|--------|--|
|                 |                       | across-track   |  |        | hannels<br>number_of<br>_ESF_sampl<br>es_ACT                             |
|                 | standard_name         | CF standard name   | LSF_values_AC<br>T   | string | 1  |
|                 | long_name             | A long and more explicative name                             | Normalized Line Spread Function (NLSF) computed across-track | string | 1  |
|                 | LSF_values_AL<br>T    | Normalized Line Spread Function (NLSF) computed along-track  |  | float  | number_of<br>_spectral_c<br>hannels<br>number_of<br>_ESF_sampl<br>es_ALT |
|                 | standard_name         | CF standard name   | LSF_values_AL<br>T   | string | 1  |
|                 | long_name             | A long and more explicative name                             | Normalized Line Spread Function (NLSF) computed along-track  | string | 1  |
| Annotation data |                       |  |  |        |  |
|                 | xyz                   | Number of Cartesian coordinates                              | 3  |        |  |
|                 | sel                   | Number of selenographic coordinates                          | 2  |        |  |
|                 | time                  | Number of annotated time stamps                              | 1  |        |  |
|                 | moon                  | Moon central point   | 1  |        |  |
|                 | time_stamp            | Measurement Time Stamp for the center of the Moon            |  | int64  | time   |
|                 | standard_name         | CF standard name   | moon_time_st<br>amp  | string | 1  |
|                 | long_name             | A long and more explicative name                             | Elapsed time since 01 Jan 2000 0h                            | string | 1  |
|                 | units                 |  | microseconds since 2000-01-01 00:00:00                       | string | 1  |
|                 | _FillValue            | Default value for missing data                               | -1   | int64  | 1  |
|                 | platform_positi<br>on | Platform J2000 XYZ position for center of the moon timestamp |  | float  | xyz  |
|                 | standard_name         | CF standard name   | platform_positi<br>on  | string | 1  |

| Group Name | Element Name     | Description  | Range or Value                                       | Type   | Dimension |
|------------|------------------|--|--|--------|-----------|
|            | long_name        | A long and more explicative name                         | Position of the platform at center pixel acquisition | string | 1         |
|            | units            | Units name   | m  | string | 1         |
|            | reference_system | Coordinates reference system                             | J2000  | string | 1         |
|            | sun_position     | Sun J2000 XYZ position for center of the moon timestamp  |  | float  | xyz       |
|            | standard_name    | CF standard name   | sun_position   | string | 1         |
|            | long_name        | A long and more explicative name                         | Position of the sun at center pixel acquisition      | string | 1         |
|            | units            | Units name   | m  | string | 1         |
|            | reference_system | Coordinates reference system                             | J2000  | string | 1         |
|            | moon_position    | moon J2000 XYZ position for center of the moon timestamp |  | float  | xyz       |
|            | standard_name    | CF standard name   | moon_position  | string | 1         |
|            | long_name        | A long and more explicative name                         | Position of the moon at center pixel acquisition     | string | 1         |
|            | units            | Units name   | m  | string | 1         |
|            | reference_system | Coordinates reference system                             | J2000  | string | 1         |
|            | phase_angle      | lunar phase angle  | [-90,90]   | float  | moon      |
|            | standard_name    | CF standard name   | moon_phase_angle                                     | string | 1         |
|            | long_name        | A long and more explicative name                         | Lunar phase angle at center pixel acquisition        | string | 1         |
|            | valid_min        |  | -90.0  | float  | 1         |
|            | valid_max        |  | 90.0   | float  | 1         |
|            | _FillValue       | Value indicating missing data                            | 999  | float  | 1         |
|            | obs_sel_position | Selenographic position of observer                       | [-90,90]   | float  | sel       |
|            | standard_name    | CF standard name   | obs_sel_pos  | string | 1         |
|            | long_name        | A long and more explicative name                         | Sensor selenographic latitude and longitude          | string | 1         |
|            | valid_min        |  | -90.0  | float  | 1         |
|            | valid_max        |  | 90.0   | float  | 1         |
|            | _FillValue       | Value indicating missing data                            | 999  | float  | 1         |

| Group Name | Element Name           | Description   | Range or Value   | Type   | Dimension |
|------------|------------------------|---|--|--------|-----------|
|            | sun_sel_position       | Selenographic position of the sun                           | [-90,90]   | float  | sel       |
|            | standard_name          | CF standard name  | sun_sel_pos  | string | 1         |
|            | long_name              | A long and more explicative name                            | Sun selenographic latitude and longitude                             | string | 1         |
|            | valid_min              |   | -90.0  | float  | 1         |
|            | valid_max              |   | 90.0   | float  | 1         |
|            | _FillValue             | Value indicating missing data                               | 999  | float  | 1         |
|            | ovs_factor             | Oversampling factor   | TBD  | float  | moon      |
|            | standard_name          | CF standard name  | oversamplingfactor   | string | 1         |
|            | long_name              | A long and more explicative name                            | Amount of times the moon has been recorded in the sampling direction | string | 1         |
|            | valid_min              |   | TBD  | float  | 1         |
|            | valid_max              |   | TBD  | float  | 1         |
|            | _FillValue             | Value indicating missing data                               | TBD  | float  | 1         |
|            | degree_of_polarisation | Degree Of Polarisation (filled if available from the model) | TBD  | float  | moon      |
|            | standard_name          | CF standard name  | degree_of_polarisation   | string | 1         |
|            | long_name              | A long and more explicative name                            | Degree Of Polarisation   | string | 1         |
|            | valid_min              |   | 0.0  | float  | 1         |
|            | valid_max              |   | 100.0  | float  | 1         |
|            | units                  | Units name  | %  | string | 1         |
|            | _FillValue             | Value indicating missing data                               | -1.0   | float  | 1         |
|            | lowest_row_index       | Moon lowest row index in the image                          | TBD  | ushort | moon      |
|            | standard_name          | CF standard name  | lowest_row_index   | string | 1         |
|            | long_name              | A long and more explicative name                            | Moon lowest row index in the image                                   | string | 1         |
|            | valid_min              |   | 0  | ushort | 1         |
|            | valid_max              |   | TBD  | ushort | 1         |
|            | _FillValue             | Value indicating missing data                               | 65535  | ushort | 1         |
|            | highest_row_index      | Moon highest row index in the image                         | TBD  | ushort | moon      |
|            | standard_name          | CF standard name  | highest_row_index  | string | 1         |
|            | long_name              | A long and more explicative                                 | Moon highest   | string | 1         |

| Group Name                               | Element Name                          | Description  | Range or Value                            | Type   | Dimension |
|--|---------------------------------------|--|---|--------|-----------|
|  |                                       | name   | row index in the image                    |        |           |
|  | valid_min                             |  | 1   | ushort | 1         |
|  | valid_max                             |  | TBD                                       | ushort | 1         |
|  | _FillValue                            | Value indicating missing data  | 65535                                     | ushort | 1         |
|  | lowest_column_index                   | Moon lowest column index in the image                                  | TBD                                       | ushort | moon      |
|  | standard_name                         | CF standard name   | lowest_column_index                       | string | 1         |
|  | long_name                             | A long and more explicative name                                       | Moon lowest column index in the image     | string | 1         |
|  | valid_min                             |  | 0   | ushort | 1         |
|  | valid_max                             |  | 1072                                      | ushort | 1         |
|  | _FillValue                            | Value indicating missing data  | 65535                                     | ushort | 1         |
|  | highest_column_index                  | Moon highest column index in the image                                 | TBD                                       | ushort | moon      |
|  | standard_name                         | CF standard name   | highest_column_index                      | string | 1         |
|  | long_name                             | A long and more explicative name                                       | Moon highest column index in the image    | string | 1         |
|  | valid_min                             |  | 1   | ushort | 1         |
|  | valid_max                             |  | 1072                                      | ushort | 1         |
|  | _FillValue                            | Value indicating missing data  | 65535                                     | ushort | 1         |
| Annotation data/Instrumental information | Same content of the L1B products 4.1. |  |   |        |           |
| Annotation data/Processing executed      |                                       |  |   |        |           |
|  | input_names                           | Name of the input files used in the processing                         | List of names separated by empty space    | string | 1         |
|  | output_zipping                        | Flag indicating if the zip of the outputs has been done (1) or not (0) | [0,1]                                     | ubyte  | flag_dim  |
|  | standard_name                         | CF standard name   | output_zipping                            | string | 1         |
|  | long_name                             | A long and more explicative name                                       | Flag indicating if the zip of the outputs | string | 1         |

| Group Name | Element Name | Description                    | Range or Value               | Type  | Dimension |
|------------|--------------|--------------------------------|------------------------------|-------|-----------|
|            |              |                                | has been done (1) or not (0) |       |           |
|            | valid_min    |                                | 0                            | ubyte | 1         |
|            | valid_max    |                                | 1                            | ubyte | 1         |
|            | _FillValue   | Value indicating unfilled flag | 255                          | ubyte | 1         |

#### 4.2.7 L1 RAC MOONSL: Moon for straylight 1

It collects data acquired with CU on EO port pointing to the Moon, suitable for straylight characterisation by Lunar acquisitions (with S/C slewing manoeuvre, TBC).

Example:

```
- FLX_GPP_RAC_MOONSL_20190305T133000_20190305T133009_20190927T091740_00015
|--> FLX_GPP_RAC_MOONSL_20190305T133000_20190305T133009_20190927T091740_00015.XML
|--> FLX_GPP_RAC_MOONSL_20190305T133000_20190305T133009_20190927T091740_00015.LRE_NC
|--> FLX_GPP_RAC_MOONSL_20190305T133000_20190305T133009_20190927T091740_00015.HRE1.NC
|--> FLX_GPP_RAC_MOONSL_20190305T133000_20190305T133009_20190927T091740_00015.HRE2.NC
```

Here after the table reporting the detailed content of the NetCDF data block valid for each one of the 3 spectral bands LR, HR1 and HR2.

**Table 4-6: L1 RAC MOONSL NetCDF data block format description**

| Group Name       | Element Name                   | Description  | Range or Value                  | Type   | Dimension   |
|------------------|--------------------------------|--|---------------------------------|--------|---|
|                  | number_of_spectral_channels    | Number of spectral channels (binned)   | HR1: 140<br>HR2: 269<br>LR: 235 |        |   |
|                  | number_of_along_track_samples  | Number of acquisitions   | 300<br>[CAL-TAB]                |        |   |
|                  | number_of_across_track_samples | Number of columns in the product image   | 536                             |        |   |
| Measurement data |                                |  |                                 |        |   |
|                  | Central_Frame_SL_Uncorrected   | Central frame of the merging of the moon with the image acquired with the inertial maneuver, after radiometric (non-SL) corrections. |                                 | float  | number_of_across_track_samples<br>number_of_spectral_channels |
|                  | standard_name                  | CF standard name   | Central_Frame_SL_Uncorrected    | string | 1   |
|                  | long_name                      | A long and more explicative name   | Central frame of the merging of | string | 1   |

| Group Name | Element Name               | Description   | Range or Value   | Type   | Dimension   |
|------------|----------------------------|---|--|--------|---|
|            |                            |   | the moon with the image acquired with the inertial maneuver, after radiometric (non-SL) corrections .                        |        |   |
|            | units                      | units name  | mW.m-2.nm-1.sr-1   | string | 1   |
|            | _FillValue                 | Unfilled value  | -999999.999  |        |   |
|            | Central_Frame_SL_Corrected | Central frame of the merging of the moon with the image acquired with the inertial maneuver, after radiometric corrections. |  | float  | number_of_across_track_samples<br>number_of_spectral_channels |
|            | standard_name              | CF standard name  | Central_Frame_SL_Corrected   | string | 1   |
|            | long_name                  | A long and more explicative name  | Central frame of the merging of the moon with the image acquired with the inertial maneuver, after radiometric corrections . | string | 1   |
|            | units                      | units name  | mW.m-2.nm-1.sr-1   | string | 1   |
|            | _FillValue                 | Unfilled value  | -999999.999  |        |   |
|            | Central_Frame_SL_Residuals | Difference between the central frame of the SL-uncorrected image and the SL-corrected image.                                |  | float  | number_of_across_track_samples<br>number_of                   |

| Group Name | Element Name                  | Description   | Range or Value  | Type   | Dimension  |
|------------|-------------------------------|---|---|--------|--|
|            |                               |   |   |        | _spectral_channels   |
|            | standard_name                 | CF standard name  | Central_Frame_SL_Residuals  | string | 1  |
|            | long_name                     | A long and more explicative name  | Difference between the central frame of the SL-uncorrected image and the SL-corrected image.  | string | 1  |
|            | units                         | units name  | mW.m-2.nm-1.sr-1  | string | 1  |
|            | _FillValue                    | Unfilled value  | -999999.999   |        |  |
|            | L1_moon_merged_SL_Uncorrected | Merge of the pushbroom acquisition of the moon with the image acquired with the inertial maneuver, after radiometric (non-SL) corrections |   | float  | number_of_along_track_samples<br>number_of_across_track_samples<br>number_of_spectral_channels |
|            | standard_name                 | CF standard name  | L1_moon_merged_SL_Uncorrected   | string | 1  |
|            | long_name                     | A long and more explicative name  | Merge of the pushbroom acquisition of the moon with the image acquired with the inertial maneuver, after radiometric (non-SL) corrections | string | 1  |
|            | units                         | units name  | mW.m-2.nm-1.sr-1  | string | 1  |

| Group Name                    | Element Name                | Description   | Range or Value  | Type   | Dimension  |
|-------------------------------|-----------------------------|---|---|--------|--|
|                               | _FillValue                  | Unfilled value  | -999999.999   |        |  |
|                               | L1_moon_merged_SL_Corrected | Merge of the pushbroom acquisition of the moon with the image acquired with the inertial maneuver, after radiometric corrections. |   | float  | number_of_along_track_samples<br>number_of_across_track_samples<br>number_of_spectral_channels |
|                               | standard_name               | CF standard name  | L1_moon_merged_SL_Corrected   | string | 1  |
|                               | long_name                   | A long and more explicative name  | Merge of the pushbroom acquisition of the moon with the image acquired with the inertial maneuver, after radiometric corrections. | string | 1  |
|                               | units                       | units name  | mW.m-2.nm-1.sr-1  | string | 1  |
|                               | _FillValue                  | Unfilled value  | -999999.999   |        |  |
| Annotation data/Quality flags |                             |   |   |        |  |
|                               | quality_flags               | Quality flags   |   | ubyte  | number_of_along_track_samples<br>number_of_across_track_samples<br>number_of_spectral_channels |
|                               | standard_name               | CF standard name  | quality_flags   | string | 1  |
|                               | long_name                   | A long and more explicative name  | Quality flags   | string | 1  |

| Group Name                       | Element Name      | Description  | Range or Value   | Type   | Dimension                     |
|----------------------------------|-------------------|--|--|--------|-------------------------------|
|                                  | flag_masks        | List of bit fields describing boolean flags                  | 1 2 4 8 16<br>32 64 128<br><br>See Table 4-8                                   | ubyte  | 8                             |
|                                  | flag_meanings     | List of flag meanings composing this variable                | "bad dead saturated dubious invalid spare0 spare1 spare2"<br><br>See Table 4-9 | string | 1                             |
| Annotation data/Time coordinates |                   |  |  |        |                               |
|                                  | time_stamp        | Measurement Time Stamp for each measurement                  |  | int64  | number_of_along_track_samples |
|                                  | standard_name     | CF standard name   | time   | string | 1                             |
|                                  | long_name         | A long and more explicative name                             | Elapsed time since 01 Jan 2000 0h  | string | 1                             |
|                                  | units             |  | microseconds since 2000-01-01 00:00:00   | string | 1                             |
|                                  | _FillValue        | Default value for missing data                               | -1   | int64  | 1                             |
| Annotation data/Geometry         |                   |  |  |        |                               |
|                                  | xyz_dim           | Number of Cartesian coordinates                              | 3  |        |                               |
|                                  | latlon_dim        | Number of selenographic coordinates                          | 2  |        |                               |
|                                  | angle_dim         | Moon central point   | 1  |        |                               |
|                                  | platform_position | Platform J2000 XYZ position for center of the moon timestamp |  | float  | xyz_dim                       |
|                                  | standard_name     | CF standard name   | platform_position  | string | 1                             |
|                                  | long_name         | A long and more explicative name                             | Position of the platform at center pixel acquisition                           | string | 1                             |
|                                  | units             | Units name   | m  | string | 1                             |
|                                  | reference_syst    | Coordinates reference system                                 | J2000  | string | 1                             |

| Group Name | Element Name     | Description  | Range or Value                                   | Type   | Dimension  |
|------------|------------------|--|--|--------|------------|
|            | em               |  |  |        |            |
|            | sun_position     | Sun J2000 XYZ position for center of the moon timestamp  |  | float  | xyz_dim    |
|            | standard_name    | CF standard name   | sun_position                                     | string | 1          |
|            | long_name        | A long and more explicative name                         | Position of the sun at center pixel acquisition  | string | 1          |
|            | units            | Units name   | m  | string | 1          |
|            | reference_system | Coordinates reference system                             | J2000  | string | 1          |
|            | moon_position    | moon J2000 XYZ position for center of the moon timestamp |  | float  | xyz_dim    |
|            | standard_name    | CF standard name   | moon_position                                    | string | 1          |
|            | long_name        | A long and more explicative name                         | Position of the moon at center pixel acquisition | string | 1          |
|            | units            | Units name   | m  | string | 1          |
|            | reference_system | Coordinates reference system                             | J2000  | string | 1          |
|            | phase_angle      | lunar phase angle  | [-90,90]   | float  | angle_dim  |
|            | standard_name    | CF standard name   | moon_phase_angle                                 | string | 1          |
|            | long_name        | A long and more explicative name                         | Lunar phase angle at center pixel acquisition    | string | 1          |
|            | valid_min        |  | -90.0  | float  | 1          |
|            | valid_max        |  | 90.0   | float  | 1          |
|            | _FillValue       | Value indicating missing data                            | 999  | float  | 1          |
|            | obs_sel_position | Selenographic position of observer                       | [-90,90]   | float  | latlon_dim |
|            | standard_name    | CF standard name   | obs_sel_pos                                      | string | 1          |
|            | long_name        | A long and more explicative name                         | Sensor selenographic latitude and longitude      | string | 1          |
|            | valid_min        |  | -90.0  | float  | 1          |
|            | valid_max        |  | 90.0   | float  | 1          |
|            | _FillValue       | Value indicating missing data                            | 999  | float  | 1          |
|            | sun_sel_position | Selenographic position of the sun                        | [-90,90]   | float  | latlon_dim |
|            | standard_name    | CF standard name   | sun_sel_po                                       | string | 1          |

| Group Name                               | Element Name                          | Description  | Range or Value   | Type   | Dimension        |
|--|---------------------------------------|--|--|--------|------------------|
|  | e                                     |  | s  |        |                  |
|  | long_name                             | A long and more explicative name                                       | Sun selenographic latitude and longitude                               | string | 1                |
|  | valid_min                             |  | -90.0  | float  | 1                |
|  | valid_max                             |  | 90.0   | float  | 1                |
|  | _FillValue                            | Value indicating missing data  | 999  | float  | 1                |
| Annotation data/Instrumental information | Same content of the L1B products 4.1. |  |  |        |                  |
| Annotation data/Processing executed      |                                       |  |  |        |                  |
|  | number_of_inputs                      | The number of inputs   |  |        |                  |
|  | input_names                           | Name of the inputs used in the processing                              |  | string | number_of_inputs |
|  | standard_name                         | CF standard name   | Input_names  | string | 1                |
|  | long_name                             | A long and more explicative name                                       | Name of the inputs used in the processing                              | string | 1                |
|  | output_zipping                        | Flag indicating if the zip of the outputs has been done (1) or not (0) | [0,1]  | ubyte  | flag_dim         |
|  | standard_name                         | CF standard name   | output_zipping   | string | 1                |
|  | long_name                             | A long and more explicative name                                       | Flag indicating if the zip of the outputs has been done (1) or not (0) | string | 1                |
|  | valid_min                             |  | 0  | ubyte  | 1                |
|  | valid_max                             |  | 1  | ubyte  | 1                |
|  | _FillValue                            | Value indicating unfilled flag   | 255  | ubyte  | 1                |

#### 4.2.8 L1 RAC SUN: Radiometric calibration using the Sun

It collects data based on sun diffuser for radiometric calibration.

Example:

```
- FLX_GPP_RAC_SUN_20190305T133000_20190305T133009_20190927T091740_00015
|--> FLX_GPP_RAC_SUN_20190305T133000_20190305T133009_20190927T091740_00015.XML
```

/--> FLX\_GPP\_RAC\_SUN\_\_\_\_\_20190305T133000\_20190305T133009\_20190927T091740\_00015.LRE\_NC  
/--> FLX\_GPP\_RAC\_SUN\_\_\_\_\_20190305T133000\_20190305T133009\_20190927T091740\_00015.HRE1.NC  
/--> FLX\_GPP\_RAC\_SUN\_\_\_\_\_20190305T133000\_20190305T133009\_20190927T091740\_00015.HRE2.NC

Here after the table reporting the detailed content of the NetCDF data block valid for each one of the 3 spectral bands LR, HR1 and HR2 (indicated with  $[k]$  in the table).

**Table 4-7: L1 RAC SUN NetCDF data block format description**

| Group Name       | Element Name                   | Description  | Range or Value   | Type   | Dimension  |
|------------------|--------------------------------|--|--|--------|--|
|                  | number_of_spectral_channels    | Number of spectral channels (binned)   | HR1: 140<br>HR2: 269<br>LR: 235                        |        |  |
|                  | number_of_along_track_samples  | Number of acquisitions   | 2800<br>[CAL-TAB]                                      |        |  |
|                  | number_of_across_track_samples | Number of columns in the product image   | 536  |        |  |
| Measurement data |                                |  |  |        |  |
|                  | [k]_ARG                        | Absolute radiometric Gain for spectral band [k]                                      |  | double | number_of_spectral_channels  |
|                  | standard_name                  | CF standard name   | [k]_ARG  | string | 1  |
|                  | long_name                      | A long and more explicative name   | Absolute radiometric Gain for spectral band [k]        | string | 1  |
|                  | units                          | units name   | mW-1.m2.sr.nm.DN                                       | string | 1  |
|                  | [k]_Isun_filt                  | The Sun irradiance corrected for date and filtered by the ISRF at each FLEX band [k] |  | double | number_of_along_track_samples<br>number_of_across_track_samples<br>number_of_spectral_channels |
|                  | standard_name                  | CF standard name   | [k]_L_cal  | string | 1  |
|                  | long_name                      | A long and more explicative name   | Radiance from the solar diffuser for spectral band [k] | string | 1  |
|                  | units                          | units name   | mW.m-2.nm-1.sr-1                                       | string | 1  |
|                  | [k]_FF_FRAME                   | Flat-field frame coefficients for spectral band [k]                                  |  | double | number_of_across_track_samples<br>number_of_spe  |

| Group Name                    | Element Name  | Description  | Range or Value   | Type   | Dimension  |
|-------------------------------|---------------|--|--|--------|--|
|                               |               |  |  |        | ctral_channels   |
|                               | standard_name | CF standard name   | [k]_FF_FRAM E  | string | 1  |
|                               | long_name     | A long and more explicative name                         | Flat-field frame coefficients for spectral band [k]      | string | 1  |
|                               | units         | units name   | DN   | string | 1  |
|                               | [k]_FF_CUBE   | Flat-field cube coefficients for spectral band [k]       |  | double | number_of_along_track_samples<br>number_of_across_track_samples<br>number_of_spectral_channels |
|                               | standard_name | CF standard name   | [k]_FF_CUBE  | string | 1  |
|                               | long_name     | A long and more explicative name                         | Flat-field cube coefficients for spectral band [k]       | string | 1  |
|                               | units         | units name   | dB   | string | 1  |
|                               | [k]_SNR       | Sun Diffuser Signal To Noise Ratio for spectral band [k] |  | double | number_of_across_track_samples<br>number_of_spectral_channels                                  |
|                               | standard_name | CF standard name   | [k]_SNR  | string | 1  |
|                               | long_name     | A long and more explicative name                         | Sun Diffuser Signal To Noise Ratio for spectral band [k] | string | 1  |
| Annotation data/Quality flags |               |  |  |        |  |
|                               | quality_flags | Quality flags  |  | ubyte  | number_of_spectral_channels<br>number_of_along_track_samples<br>number_of_across_track_samples |
|                               | standard_name | CF standard name   | quality_flags  | string | 1  |
|                               | long_name     | A long and more explicative name                         | Quality flags  | string | 1  |

| Group Name                       | Element Name  | Description                                   | Range or Value  | Type   | Dimension                     |
|----------------------------------|---------------|---|---|--------|-------------------------------|
|                                  | flag_masks    | List of bit fields describing boolean flags   | 1 2 4 8 16 32<br>64 128<br>See Table 4-8                                    | ubyte  | 8                             |
|                                  | flag_meanings | List of flag meanings composing this variable | "bad dead saturated dubious invalid spare0 spare1 spare2 "<br>See Table 4-9 | string | 1                             |
| Annotation data/Time coordinates |               |   |   |        |                               |
|                                  | time_stamp    | Measurement Time Stamp for each measurement   |   | int64  | number_of_along_track_samples |
|                                  | standard_name | CF standard name                              | time  | string | 1                             |
|                                  | long_name     | A long and more explicative name              | Elapsed time since 01 Jan 2000 0h   | string | 1                             |
|                                  | units         |   | microseconds since 2000-01-01 00:00:00                                      | string | 1                             |
|                                  | _FillValue    | Default value for missing data                | -1  | int64  | 1                             |
| Annotation data/Geometry         |               |   |   |        |                               |
|                                  | SZA           | Sun Zenith Angle                              | [0;180]   | double | number_of_along_track_samples |
|                                  | standard_name | CF standard name                              | SZA   | string | 1                             |
|                                  | long_name     | A long and more explicative name              | Sun Incidence Zenith Angle wrt SD normal/SD Z-axis                          | string | 1                             |
|                                  | units         | units name                                    | degrees   | string | 1                             |
|                                  | valid_min     |   | 0.0   | double | 1                             |
|                                  | valid_max     |   | 180.0   | double | 1                             |
|                                  | SAA           | Sun Azimuth Angle                             | ]-180;180]  | double | 1                             |

| Group Name                               | Element Name                          | Description                                 | Range or Value                                   | Type   | Dimension                      |
|--|---------------------------------------|---|--|--------|--------------------------------|
|  | standard_name                         | CF standard name                            | SAA  | string | 1                              |
|  | long_name                             | A long and more explicative name            | Sun Incidence Azimuth Angle wrt SD X-axis        | string | 1                              |
|  | units                                 | units name                                  | degrees  | string | 1                              |
|  | valid_min                             |   | -180.0   | double | 1                              |
|  | valid_max                             |   | 180.0  | double | 1                              |
|  | OZA                                   | Observation Zenith Angle                    | HR1,HR2: 25.0<br>LR: 26.1                        | double | 1                              |
|  | standard_name                         | CF standard name                            | OZA  | string | 1                              |
|  | long_name                             | A long and more explicative name            | Scattering Zenith Angle wrt SD normal/SD Z-axis  | string | 1                              |
|  | units                                 | units name                                  | degrees  | string | 1                              |
|  | valid_min                             |   | 0.0  | double | 1                              |
|  | valid_max                             |   | 180.0  | double | 1                              |
|  | OAA                                   | Observation Azimuth Angle                   | ]-180;180]                                       | int    | number_of_across_track_samples |
|  | standard_name                         | CF standard name                            | OAA  | string | 1                              |
|  | long_name                             | A long and more explicative name            | Scattering Incidence Azimuth Angle wrt SD X-axis | string | 1                              |
|  | units                                 | units name                                  | degrees  | string | 1                              |
|  | valid_min                             |   |  | int    | 1                              |
|  | valid_max                             |   |  | int    | 1                              |
|  | _FillValue                            | Value indicating missing data               | -2147483648                                      | int    | 1                              |
|  | scale_factor                          | Scaling factor used in decoding packed data | 1.e-06   | float  | 1                              |
| Annotation data/Instrumental information | Same content of the L1B products 4.1. |   |  |        |                                |
| Annotation data/Processing executed      |                                       |   |  |        |                                |
|  | flag_dim                              | Flags dimension                             | 1  |        |                                |
|  | input_names                           | Name of the input files used in             | List of names                                    | string | 1                              |

| Group Name | Element Name   | Description  | Range or Value   | Type   | Dimension |
|------------|----------------|--|--|--------|-----------|
|            |                | the processing   | separated by empty space   |        |           |
|            | output_zipping | Flag indicating if the zip of the outputs has been done (1) or not (0) | [0,1]  | ubyte  | flag_dim  |
|            | standard_name  | CF standard name   | output_zipping   | string | 1         |
|            | long_name      | A long and more explicative name                                       | Flag indicating if the zip of the outputs has been done (1) or not (0) | string | 1         |
|            | valid_min      |  | 0  | ubyte  | 1         |
|            | valid_max      |  | 1  | ubyte  | 1         |
|            | _FillValue     | Value indicating unfilled flag   | 255  | ubyte  | 1         |

#### 4.2.8.1 Quality flags

The following table describes the structure of the byte, that groups the quality flags of the RAC SUN product (byte/bit decimal highest value indicates the most significant):

**Table 4-8: Structure of the RAC\_SUN\_\_\_ quality flags sample**

| BYTE \ BIT | 7  | 6  | 5  | 4   | 3   | 2   | 1   | 0   |
|------------|----|----|----|-----|-----|-----|-----|-----|
| 0          | sp | sp | sp | INV | DOU | SAT | DEA | BAD |

With:

- **BAD**: Bad pixel flag set to '1' if the pixel has poor quality (see [FLX-ACR] for the definition details)
- **DEA**: Dead pixel flag set to '1' if the pixel is not reliable (see [FLX-ACR] definition details)
- **SAT**: Saturated
- **DOU**: Dubious (TBC)
- **INV**: Invalid
- **sp**: Spare bits, to be ignored (set to 0).

**Table 4-9: RAC\_SUN\_\_\_ Quality flags masks and meanings**

| flag_masks (Hex) | flag_meaning |
|------------------|--------------|
| 00000001         | bad          |
| 00000002         | dead         |
| 00000004         | saturated    |
| 00000008         | dubious      |
| 00000400         | spare0       |
| 00000800         | spare1       |
| 00001000         | spare2       |
| 00002000         | spare3       |

## 4.2.9 L1 RAC DEFSUN: Defective pixels identification using the Sun

It collects data based on sun diffuser in order to detect and flag defective pixels.

Example:

```
- FLX_GPP_RAC_DEFSUN_20190305T133000_20190305T133009_20190927T091740_00015
|--> FLX_GPP_RAC_DEFSUN_20190305T133000_20190305T133009_20190927T091740_00015.XML
|--> FLX_GPP_RAC_DEFSUN_20190305T133000_2010305T133009_20190927T091740_00015.LRE_NC
|--> FLX_GPP_RAC_DEFSUN_20190305T133000_20190305T133009_20190927T091740_00015.HRE1.NC
|--> FLX_GPP_RAC_DEFSUN_20190305T133000_20190305T133009_20190927T091740_00015.HRE2.NC
```

Here after the table reporting the detailed content of the NetCDF data block valid for each one of the 3 spectral bands LR, HR1 and HR2 (indicated with  $[k]$  in the table).

**Table 4-10: L1 RAC DEFSUN NetCDF data block format description**

| Group Name       | Element Name                    | Description  | Range or Value   | Type   | Dimension   |
|------------------|---------------------------------|--|--|--------|---|
|                  | number_of_spectral_channels     | Number of spectral channels (un-binned)  | HR1: 220<br>HR2: 433<br>LR: 433  |        |   |
|                  | number_of_along_track_samples   | Number of acquisitions   | 500<br>[CAL-TAB]   |        |   |
|                  | number_of_across_track_samples  | Number of columns in the product image   | 1072   |        |   |
| Measurement data |                                 |  |  |        |   |
|                  | [k]_new_bad_pixel_map_unbinned  | Map for new bad pixels for spectral band [k] (un-binned), not taking into account already known defective pixels |  | ubyte  | number_of_across_track_samples<br>number_of_spectral_channels |
|                  | standard_name                   | CF standard name   | [k]_bad_pixel_map_unbinned   | string | 1   |
|                  | long_name                       | A long and more explicative name   | Map for new bad pixels for spectral band [k] (un-binned), not taking into account already known defective pixels | string | 1   |
|                  | valid_min                       |  | 0  | ubyte  | 1   |
|                  | valid_max                       |  | 1  | ubyte  | 1   |
|                  | _FillValue                      | Unfilled value   | 255  | ubyte  | 1   |
|                  | [k]_new_dead_pixel_map_unbinned | Map for new def pixels for spectral band [k] (un-binned), not taking into account already known defective pixels |  | ubyte  | number_of_across_track_samples<br>number_of_spectral_channels |

| Group Name                               | Element Name                          | Description   | Range or Value  | Type   | Dimension                     |
|--|---------------------------------------|---|---|--------|-------------------------------|
|  | standard_name                         | CF standard name  | [k_dead_pixel_map_unbinned  | string | 1                             |
|  | long_name                             | A long and more explicative name  | Map for new dead pixels for spectral band [k] (un-binned), not taking into account already known defective pixels | string | 1                             |
|  | valid_min                             |   | 0   | ubyte  | 1                             |
|  | valid_max                             |   | 1   | ubyte  | 1                             |
|  | _FillValue                            | Unfilled value  | 255   | ubyte  | 1                             |
| Annotation data/Time coordinates         |                                       |   |   |        |                               |
|  | time_stamp                            | Measurement Stamp for each measurement  |   | int64  | number_of_along_track_samples |
|  | standard_name                         | CF standard name  | time  | string | 1                             |
|  | long_name                             | A long and more explicative name  | Elapsed time since 01 Jan 2000 0h   | string | 1                             |
|  | units                                 |   | microseconds since 2000-01-01 00:00:00  | string | 1                             |
|  | _FillValue                            | Default value for missing data  | -1  | int64  | 1                             |
| Annotation data/Instrumental information | Same content of the L1B products 4.1. | Note:<br>Dimension <i>vau_tm_frames_number</i> is nominally equal to<br><br><i>4* number_of_along_track_samples</i> ,<br><br>where 4 is the number of WOI foreseen for this calibration (see [CAL-TAB]) |   |        |                               |
| Annotation data/Processing executed      |                                       |   |   |        |                               |
|  | input_names                           | Name of the input files used in the processing  | List of names separated by empty space  | string | 1                             |
|  | output_zipping                        | Flag indicating if the zip of the outputs has been done (1) or not (0)  | [0,1]   | ubyte  | flag_dim                      |
|  | standard_name                         | CF standard name  | output_zipping  | string | 1                             |

| Group Name | Element Name | Description                      | Range or Value   | Type   | Dimension |
|------------|--------------|----------------------------------|--|--------|-----------|
|            | e            |                                  |  |        |           |
|            | long_name    | A long and more explicative name | Flag indicating if the zip of the outputs has been done (1) or not (0) | string | 1         |
|            | valid_min    |                                  | 0  | ubyte  | 1         |
|            | valid_max    |                                  | 1  | ubyte  | 1         |

#### 4.2.9.1 Open points

"Quality flags" metadata is TBD in [PDS-L1] §6.2.4, for this reason it is not reported in the "Annotation data" group.

### 4.2.10 L1 RAC DEFDAR: Defective pixels identification using eclipse measurements (dark targets)

It collects data based on measurements of dark targets during eclipse, in order to detect and flag defective pixels.

Example:

```
- FLX_GPP_RAC_DEFDAR_20190305T133000_20190305T133009_20190927T091740_00015
|--> FLX_GPP_RAC_DEFDAR_20190305T133000_20190305T133009_20190927T091740_00015.XML
|--> FLX_GPP_RAC_DEFDAR_20190305T133000_20190305T133009_20190927T091740_00015.LRE.NC
|--> FLX_GPP_RAC_DEFDAR_20190305T133000_20190305T133009_20190927T091740_00015.HRE1.NC
|--> FLX_GPP_RAC_DEFDAR_20190305T133000_20190305T133009_20190927T091740_00015.HRE2.NC
```

Here after the table reporting the detailed content of the NetCDF data block valid for each one of the 3 spectral bands LR, HR1 and HR2 (indicated with  $[k]$  in the table).

**Table 4-11: L1 RAC DEFDAR NetCDF data block format description**

| Group Name       | Element Name                   | Description                             | Range or Value                  | Type | Dimension |
|------------------|--------------------------------|---|---------------------------------|------|-----------|
|                  | number_of_spectral_channels    | Number of spectral channels (un-binned) | HR1: 220<br>HR2: 433<br>LR: 433 |      |           |
|                  | number_of_along_track_samples  | Number of acquisitions                  | 10<br>[CAL-TAB]                 |      |           |
|                  | number_of_across_track_samples | Number of columns in the product image  | 1072                            |      |           |
| Measurement data |                                |   |                                 |      |           |

| Group Name                       | Element Name                    | Description   | Range or Value  | Type   | Dimension   |
|----------------------------------|---------------------------------|---|---|--------|---|
|                                  | [k]_new_bad_pixel_map_unbinned  | Map for new bad pixels for spectral band [K] (un-binned)  |   | ubyte  | number_of_across_track_samples<br>number_of_spectral_channels |
|                                  | standard_name                   | CF standard name  | [k]_bad_pixel_map_unbinned                                | string | 1   |
|                                  | long_name                       | A long and more explicative name                          | Map for new bad pixels for spectral band [K] (un-binned)  | string | 1   |
|                                  | valid_min                       |   | 0   | ubyte  | 1   |
|                                  | valid_max                       |   | 1   | ubyte  | 1   |
|                                  | _FillValue                      | Unfilled value  | 255   | ubyte  | 1   |
|                                  | [k]_new_dead_pixel_map_unbinned | Map for new dead pixels for spectral band [K] (un-binned) |   | ubyte  | number_of_across_track_samples<br>number_of_spectral_channels |
|                                  | standard_name                   | CF standard name  | [k]_dead_pixel_map_unbinned                               | string | 1   |
|                                  | long_name                       | A long and more explicative name                          | Map for new dead pixels for spectral band [K] (un-binned) | string | 1   |
|                                  | valid_min                       |   | 0   | ubyte  | 1   |
|                                  | valid_max                       |   | 1   | ubyte  | 1   |
|                                  | _FillValue                      | Unfilled value  | 255   | ubyte  | 1   |
| Annotation data/Time coordinates |                                 |   |   |        |   |
|                                  | time_stamp                      | Measurement Time Stamp for each measurement               |   | int64  | number_of_along_track_samples                                 |
|                                  | standard_name                   | CF standard name  | time  | string | 1   |
|                                  | long_name                       | A long and more explicative name                          | Elapsed time since 01 Jan 2000 0h                         | string | 1   |
|                                  | units                           |   | microseconds since 2000-01-01 00:00:00                    | string | 1   |
|                                  | _FillValue                      | Default value for missing data                            | -1  | int64  | 1   |
| Annotation data/Instrument       | Same content of the L1B         | Note:<br>Dimension  |   |        |   |

| Group Name                          | Element Name   | Description  | Range or Value   | Type   | Dimension |
|-------------------------------------|----------------|--|--|--------|-----------|
| ntal information                    | products 4.1.  | <i>vau_tm_frames_number</i> is nominally equal to<br><br><i>4* number_of_along_track_samples</i> ,<br><br>where 4 is the number of WOI foreseen for this calibration (see [CAL-TAB]) |  |        |           |
| Annotation data/Processing executed |                |  |  |        |           |
|                                     | input_names    | Name of the input files used in the processing   | List of names separated by empty space                                 | string | 1         |
|                                     | output_zipping | Flag indicating if the zip of the outputs has been done (1) or not (0)   | [0,1]  | ubyte  | flag_dim  |
|                                     | standard_name  | CF standard name   | output_zipping   | string | 1         |
|                                     | long_name      | A long and more explicative name   | Flag indicating if the zip of the outputs has been done (1) or not (0) | string | 1         |
|                                     | valid_min      |  | 0  | ubyte  | 1         |
|                                     | valid_max      |  | 1  | ubyte  | 1         |
|                                     | _FillValue     | Value indicating unfilled flag   | 255  | ubyte  | 1         |

#### 4.2.10.1 Open points

"Quality flags" metadata is TBD in [PDS-L1] §6.2.5, for this reason it is not reported in the "Annotation data" group.

### 4.2.11 L1 RAC DEFRTS: RTS monitoring using eclipse measurements (dark targets)

It collects 36 acquisitions (such to reach the required duration, i.e. 8h) based on measurements of dark targets during eclipse, in order to monitor transients between two or more stable levels of dark current.

Example:

```
- FLX_GPP_RAC_DEFRTS_20190305T133000_20190305T133009_20190927T091740__00015  
/--> FLX_GPP_RAC_DEFRTS_20190305T133000_20190305T133009_20190927T091740__00015.XML
```

/--> FLX\_GPP\_RAC\_DEFRTS\_20190305T133000\_2010305T133009\_20190927T091740\_00015.LRE\_NC  
/--> FLX\_GPP\_RAC\_DEFRTS\_20190305T133000\_20190305T133009\_20190927T091740\_00015.HRE1\_NC  
/--> FLX\_GPP\_RAC\_DEFRTS\_20190305T133000\_20190305T133009\_20190927T091740\_00015.HRE2\_NC

Here after the table reporting the detailed content of the NetCDF data block valid for each one of the 3 spectral bands LR, HR1 and HR2 (indicated with  $[k]$  in the table).

**Table 4-12: L1 RAC DEFRTS NetCDF data block format description**

| Group Name                  | Element Name                   | Description  | Range or Value   | Type   | Dimension   |
|-----------------------------|--------------------------------|--|--|--------|---|
|                             | number_of_spectral_channels    | Number of spectral channels (un-binned)                        | HR1: 220<br>HR2: 433<br>LR: 433                              |        |   |
|                             | number_of_across_track_samples | Number of columns in the product image                         | 1072   |        |   |
|                             | scalar_dim                     | Scalar dimension   | 1  |        |   |
| Measurement data            |                                |  |  |        |   |
|                             | RTS_pixel_map                  | RTS map for spectral band $[k]$ (un-binned)                    |  | uint64 | number_of_across_track_samples<br>number_of_spectral_channels |
|                             | standard_name                  | CF standard name   | RTS_pixel_map  | string | 1   |
|                             | long_name                      | A long and more explicative name                               | RTS burst count for every pixel(i,j)                         | string | 1   |
|                             | _FillValue                     | Unfilled value   | max(uint 32)   | ubyte  | 1   |
| Measurement data/Quadrant E |                                |  |  |        |   |
|                             | Mean_value                     | Mean value of all the measurements contained in quadrant E     |  | double | scalar_dim  |
|                             | standard_name                  | CF standard name   | Mean_value   | string | 1   |
|                             | long_name                      | A long and more explicative name                               | Mean value of all the measurements contained in quadrant : E | string | 1   |
|                             | units                          |  | DN   | string | 1   |
|                             | RTS_pixels_pcg                 | Percentage (i.e. ratio X 100) of the RTS pixels for quadrant E |  | double | scalar_dim  |

| Group Name                  | Element Name   | Description  | Range or Value   | Type   | Dimension  |
|-----------------------------|----------------|--|--|--------|------------|
|                             | standard_name  | CF standard name   | RTS_pixels_pcg   | string | 1          |
|                             | long_name      | A long and more explicative name                               | Percentage (i.e. ratio X 100) of the RTS pixels for quadrant : E | string | 1          |
|                             | units          |  | %  | string | 1          |
|                             | RTS_pixels     | Number of RTS pixels for quadrant E                            |  | uint64 | scalar_dim |
|                             | standard_name  | CF standard name   | RTS_pixels   | string | 1          |
|                             | long_name      | A long and more explicative name                               | Number of RTS pixels for quadrant : E                            | string | 1          |
|                             | units          |  | DN   | string | 1          |
| Measurement data/Quadrant F |                |  |  |        |            |
|                             | Mean_value     | Mean value of all the measurements contained in quadrant F     |  | double | scalar_dim |
|                             | standard_name  | CF standard name   | Mean_value   | string | 1          |
|                             | long_name      | A long and more explicative name                               | Mean value of all the measurements contained in quadrant : F     | string | 1          |
|                             | units          |  | DN   | string | 1          |
|                             | RTS_pixels_pcg | Percentage (i.e. ratio X 100) of the RTS pixels for quadrant F |  | double | scalar_dim |
|                             | standard_name  | CF standard name   | RTS_pixels_pcg   | string | 1          |
|                             | long_name      | A long and more explicative name                               | Percentage (i.e. ratio X 100) of the RTS pixels for quadrant : F | string | 1          |
|                             | units          |  | %  | string | 1          |

| Group Name                  | Element Name   | Description  | Range or Value   | Type   | Dimension  |
|-----------------------------|----------------|--|--|--------|------------|
|                             | RTS_pixels     | Number of RTS pixels for quadrant F                            |  | uint64 | scalar_dim |
|                             | standard_name  | CF standard name   | RTS_pixels   | string | 1          |
|                             | long_name      | A long and more explicative name                               | Number of RTS pixels for quadrant : F                            | string | 1          |
|                             | units          |  | DN   | string | 1          |
| Measurement data/Quadrant_G |                |  |  |        |            |
|                             | Mean_value     | Mean value of all the measurements contained in quadrant G     |  | double | scalar_dim |
|                             | standard_name  | CF standard name   | Mean_value   | string | 1          |
|                             | long_name      | A long and more explicative name                               | Mean value of all the measurements contained in quadrant : G     | string | 1          |
|                             | units          |  | DN   | string | 1          |
|                             | RTS_pixels_pcg | Percentage (i.e. ratio X 100) of the RTS pixels for quadrant G |  | double | scalar_dim |
|                             | standard_name  | CF standard name   | RTS_pixels_pcg   | string | 1          |
|                             | long_name      | A long and more explicative name                               | Percentage (i.e. ratio X 100) of the RTS pixels for quadrant : G | string | 1          |
|                             | units          |  | %  | string | 1          |
|                             | RTS_pixels     | Number of RTS pixels for quadrant G                            |  | uint64 | scalar_dim |
|                             | standard_name  | CF standard name   | RTS_pixels   | string | 1          |
|                             | long_name      | A long and more explicative name                               | Number of RTS pixels for quadrant : G                            | string | 1          |
|                             | units          |  | DN   | string | 1          |
| Measurement                 |                |  |  |        |            |

| Group Name                                  | Element Name                  | Description  | Range or Value   | Type   | Dimension                     |
|---|-------------------------------|--|--|--------|-------------------------------|
| data/Quadrant_H                             |                               |  |  |        |                               |
|   | Mean_value                    | Mean value of all the measurements contained in quadrant H     |  | double | scalar_dim                    |
|   | standard_name                 | CF standard name   | Mean_value   | string | 1                             |
|   | long_name                     | A long and more explicative name                               | Mean value of all the measurements contained in quadrant : H     | string | 1                             |
|   | units                         |  | DN   | string | 1                             |
|   | RTS_pixels_pcg                | Percentage (i.e. ratio X 100) of the RTS pixels for quadrant H |  | double | scalar_dim                    |
|   | standard_name                 | CF standard name   | RTS_pixels_pcg   | string | 1                             |
|   | long_name                     | A long and more explicative name                               | Percentage (i.e. ratio X 100) of the RTS pixels for quadrant : H | string | 1                             |
|   | units                         |  | %  | string | 1                             |
|   | RTS_pixels                    | Number of RTS pixels for quadrant H                            |  | uint64 | scalar_dim                    |
|   | standard_name                 | CF standard name   | RTS_pixels   | string | 1                             |
|   | long_name                     | A long and more explicative name                               | Number of RTS pixels for quadrant : H                            | string | 1                             |
|   | units                         |  | DN   | string | 1                             |
| Annotation data/DEFDAR_YYY                  |                               | Annotations for each yyy-th input LO_DEFDAR                    |  |        |                               |
|   | number_of_along_track_samples | Number of frames in the product image                          | 27   |        |                               |
| Annotation data/DEFDAR_YYY/Time coordinates |                               |  |  |        |                               |
|   | time_stamp                    | Measurement Time Stamp for each measurement                    |  | int64  | number_of_along_track_samples |

| Group Name  | Element Name                          | Description   | Range or Value   | Type   | Dimension |
|---|---------------------------------------|---|--|--------|-----------|
|   | standard_name                         | CF standard name  | time   | string | 1         |
|   | long_name                             | A long and more explicative name  | Elapsed time since 01 Jan 2000 0h                                      | string | 1         |
|   | units                                 |   | microseconds since 2000-01-01 00:00:00                                 | string | 1         |
|   | _FillValue                            | Default value for missing data  | -1   | int64  | 1         |
| Annotation data/DEFDAR_yyy/Instrumental information | Same content of the L1B products 4.1. | Note:<br>Dimension <i>vau_tm_frames_number</i> is nominally equal to<br><br><i>2* number_of_along_track_samples</i> ,<br><br>where 4 is the number of WOI foreseen for this calibration (see [CAL-TAB]) |  |        |           |
| Annotation data/Processing executed                 |                                       |   |  |        |           |
|   | input_names                           | Name of the input files used in the processing  | List of names separated by empty space                                 | string | 1         |
|   | output_zipping                        | Flag indicating if the zip of the outputs has been done (1) or not (0)  | [0,1]  | ubyte  | flag_dim  |
|   | standard_name                         | CF standard name  | output_zipping   | string | 1         |
|   | long_name                             | A long and more explicative name  | Flag indicating if the zip of the outputs has been done (1) or not (0) | string | 1         |
|   | valid_min                             |   | 0  | ubyte  | 1         |
|   | valid_max                             |   | 1  | ubyte  | 1         |
|   | _FillValue                            | Value indicating unfilled flag  | 255  | ubyte  | 1         |

#### 4.2.11.1 Open points

"Quality flags" metadata is TBD in [PDS-L1] §6.2.6, for this reason it is not reported in the "Annotation data" group.

The above netCDF content is TBC by LDO/ESA.

### 4.2.12 L1 RAC CLOUD: Radiometric calibration using deep convective cloud measurements

It collects data based on deep convective clouds measurements for radiometric calibration.

Example:

```
- FLX_GPP_RAC_CLOUD_20190305T133000_20190305T133009_20190927T091740_00015
|--> FLX_GPP_RAC_CLOUD_20190305T133000_20190305T133009_20190927T091740_00015.XML
|--> FLX_GPP_RAC_CLOUD_20190305T133000_20190305T133009_20190927T091740_00015.LRE_NC
|--> FLX_GPP_RAC_CLOUD_20190305T133000_20190305T133009_20190927T091740_00015.HRE1_NC
|--> FLX_GPP_RAC_CLOUD_20190305T133000_20190305T133009_20190927T091740_00015.HRE2_NC
```

Here after the table reporting the detailed content of the NetCDF data block valid for each one of the 3 spectral bands LR, HR1 and HR2.

**Table 4-13: L1 RAC CLOUD NetCDF data block format description**

| Group Name       | Element Name                   | Description                            | Range or Value                  | Type   | Dimension  |
|------------------|--------------------------------|--|---------------------------------|--------|--|
|                  | number_of_spectral_channels    | Number of spectral channels (binned)   | HR1: 140<br>HR2: 269<br>LR: 235 |        |  |
|                  | number_of_along_track_samples  | Number of rows in the product image    | TBD<br>[CAL-TAB]                |        |  |
|                  | number_of_across_track_samples | Number of columns in the product image | 536                             |        |  |
|                  | number_of_statistics           | Number of statistics                   | 3                               |        |  |
| Measurement data |                                |  |                                 |        |  |
|                  | cor_reflectance                | HR/LR co-registered TOA reflectances   |                                 | float  | number_of_spectral_channels<br>number_of_along_track_samples<br>number_of_across_track_samples |
|                  | standard_name                  | CF standard name                       | cor_reflectance                 | string | 1  |
|                  | long_name                      | A long and more explicative name       | HR/LR co-registered TOA         | string | 1  |

| Group Name | Element Name                      | Description  | Range or Value  | Type   | Dimension  |
|------------|-----------------------------------|--|---|--------|--|
|            |                                   |  | reflectances  |        |  |
|            | valid_min                         |  | 0.0   | float  | 1  |
|            | _FillValue                        | Value indicating missing data  | -1.0  | float  | 1  |
|            | scale_factor                      | Scaling factor used in decoding packed data  | 1.0   | float  | 1  |
|            | add_offset                        | Offset used to in decoding packed data   | 0.0   | float  | 1  |
|            | corcorr_reflectance               | HR/LR co-registered TOA reflectances corrected for gaseous absorption  |   | float  | number_of_spectral_channels<br>number_of_along_track_samples<br>number_of_across_track_samples |
|            | standard_name                     | CF standard name   | corcorr_reflectance   | string | 1  |
|            | long_name                         | A long and more explicative name   | HR/LR co-registered TOA reflectances corrected for gaseous absorption | string | 1  |
|            | valid_min                         |  | 0.0   | float  | 1  |
|            | _FillValue                        | Value indicating missing data  | -1.0  | float  | 1  |
|            | scale_factor                      | Scaling factor used in decoding packed data  | 1.0   | float  | 1  |
|            | add_offset                        | Offset used to in decoding packed data   | 0.0   | float  | 1  |
|            | dcc_mask                          | Deep Convective Cloud mask image   | [0,1]   | ubyte  | number_of_along_track_samples<br>number_of_across_track_samples                                |
|            | standard_name                     | CF standard name   | dcc_mask  | string | 1  |
|            | long_name                         | A long and more explicative name   | Deep Convective Cloud mask image                                      | string | 1  |
|            | number_of_DC_C_pixels             | Number of pixels flagged as Deep Convective Cloud  |   | uint   | 1  |
|            | valid_min                         |  | 0   | byte   | 1  |
|            | valid_max                         |  | 1   | byte   | 1  |
|            | _FillValue                        | Value indicating missing data  | -1  | byte   | 1  |
|            | statistics_of_corcorr_reflectance | Statistics (standard deviation, mean and medium) of HR/LR co-registered TOA reflectances corrected for gaseous |   | float  | number_of_spectral_channels<br>number_of   |

| Group Name | Element Name              | Description   | Range or Value   | Type   | Dimension  |
|------------|---------------------------|---|--|--------|--|
|            |                           | absorption for each DCC sample  |  |        | _statistics  |
|            | standard_name             | CF standard name  | statistics_of_corcorr_reflectance  | string | 1  |
|            | long_name                 | A long and more explicative name  | Statistics (standard deviation, mean and medium) of HR/LR co-registered TOA reflectances corrected for gaseous absorption calculated over all DCC pixels | string | 1  |
|            | cloud_optical_thickness   | Cloud Optical Thickness for each DCC sample   |  | float  | number_of_along_track_samples<br>number_of_across_track_samples                                |
|            | standard_name             | CF standard name  | cloud_optical_thickness  | string | 1  |
|            | long_name                 | A long and more explicative name  | Cloud Optical Thickness for each DCC sample  | string | 1  |
|            | corcorr_reflectance_ratio | Ratio between measured and modelled reflectance (coregistered and corrected for gaseous absorption) for each DCC sample |  | float  | number_of_spectral_channels<br>number_of_along_track_samples<br>number_of_across_track_samples |
|            | standard_name             | CF standard name  | corcorr_reflectance_ratio  | string | 1  |
|            | long_name                 | A long and more explicative name  | Ratio between measured and modelled reflectance (coregistered and corrected for  | string | 1  |

| Group Name                               | Element Name                          | Description   | Range or Value  | Type   | Dimension   |
|--|---------------------------------------|---|---|--------|---|
|  |                                       |   | gaseous absorption) for each DCC sample   |        |   |
|  | statistics_of_corr_reflectance_ratio  | Statistics (standard deviation, mean and medium) of the ratio between measured and modelled reflectance (corrected for gaseous absorption) calculated over all DCC pixels                               |   | float  | number_of_spectral_channels<br>number_of_statistics |
|  | standard_name                         | CF standard name  | statistics_of_corr_reflectance_ratio  | string | 1   |
|  | long_name                             | A long and more explicative name  | Statistics (standard deviation, mean and medium) of the ratio between measured and modelled reflectance (corrected for gaseous absorption) calculated over all DCC pixels | string | 1   |
| Annotation data/Instrumental information | Same content of the L1B products 4.1. | Note:<br>Dimension <i>vau_tm_frames_number</i> is nominally equal to<br><br><i>2* number_of_along_track_samples</i> ,<br><br>where 4 is the number of WOI foreseen for this calibration (see [CAL-TAB]) |   |        |   |
| Annotation data/Processing executed      |                                       |   |   |        |   |
|  | input_names                           | Name of the input files used in the processing  | List of names separated by empty space  | string | 1   |

Note:

EXPRIVIA does not exclude that some parameters could be updated in the proposed format.

#### 4.2.13 L1 RAC NLCAL\_: Radiometric linearity assessment

It collects data acquired with CU on EO Nadir port pointing at desert (from RAW/LO LINDES), pointing at ocean (from RAW/LO LINSEA), pointing at dark ocean during eclipse (from RAW/LO LINDAR), with CU on EO solar port (from RAW/LO LINSUN), in order to assess the radiometric linearity.

Example:

```
- FLX_GPP_RAC_NLCAL_20190305T133000_20190305T133009_20190927T091740_00015
/--> FLX_GPP_RAC_NLCAL_20190305T133000_20190305T133009_20190927T091740_00015.XML
/--> FLX_GPP_RAC_NLCAL_20190305T133000_20190305T133009_20190927T091740_00015.LRE_NC
/--> FLX_GPP_RAC_NLCAL_20190305T133000_20190305T133009_20190927T091740_00015.HRE1_NC
/--> FLX_GPP_RAC_NLCAL_20190305T133000_20190305T133009_20190927T091740_00015.HRE2_NC
```

Here after the table reporting the detailed content of the NetCDF data block valid for each one of the 3 spectral bands LR, HR1 and HR2 (indicated with  $[k]$  in the table).

**Table 4-14: L1 RAC NLCAL NetCDF data block format description**

| Group Name       | Element Name                   | Description   | Range or Value  | Type   | Dimension   |
|------------------|--------------------------------|---|---|--------|---|
|                  | number_of_spectral_channels    | Number of spectral channels (binned)  | HR1: 140<br>HR2: 269<br>LR: 235                             |        |   |
|                  | number_of_across_track_samples | Number of columns in the product image                                      | 536   |        |   |
|                  | number_of_products             | Number of LO_LIN* products in input   |   |        |   |
| Measurement data |                                |   |   |        |   |
|                  | NL_DN                          | Non linearity for each spectral band $[k]$                                  |   | double | number_of_across_track_samples<br>number_of_spectral_channels<br>number_of_products |
|                  | standard_name                  | CF standard name  | NL_DN   |        | 1   |
|                  | long_name                      | A long and more explicative name  | For each pixel $(i,j)$ the value of NL(DN) for each product |        | 1   |
|                  | units                          | units name  | DN  |        | 1   |
|                  | _FillValue                     | Unfilled value  | -999999.999   |        | 1   |
|                  | P_NL_0                         | Fit parameter order 0th of NL vs DN for each spectral channel of band $[k]$ |   | double | number_of_across_track_samples  |

| Group Name   | Element Name                  | Description   | Range or Value  | Type   | Dimension  |
|--|-------------------------------|---|---|--------|--|
|  |                               |   |   |        | number_of_spectral_channels  |
|  | standard_name                 | CF standard name  | P_NL_0  | string | 1  |
|  | long_name                     | A long and more explicative name                                      | For each pixel (i,j) the parameter order 0th of linear regression | string | 1  |
|  | units                         | units name  |   | string | 1  |
|  | _FillValue                    | Unfilled value  | -999999.999   | double | 1  |
|  | P_NL_1                        | Fit param of order 1th NL vs DN for each spectral channel of band [k] |   | double | number_of_across_track_samples<br>number_of_spectral_channels                                  |
|  | standard_name                 | CF standard name  | P_NL_1  | string | 1  |
|  | long_name                     | A long and more explicative name                                      | For each pixel (i,j) the parameter order 1st of linear regression | string | 1  |
|  | units                         | units name  | DN-1  | string | 1  |
|  | _FillValue                    | Unfilled value  | -999999.999   | double | 1  |
| Annotation data/<br>LINxxx_yyy                     |                               | Annotations for each yyy-th input LO__LINxxx product                  |   |        |  |
|  | number_of_along_track_samples | Number of acquisitions  |   |        |  |
| Annotation data/<br>LINxxx_yyy/Q<br>uQuality flags |                               |   |   |        |  |
|  | quality_flags                 | Quality flags   |   | ubyte  | number_of_spectral_channels<br>number_of_along_track_samples<br>number_of_across_track_samples |
|  | standard_name                 | CF standard name  | quality_flags   | string | 1  |
|  | long_name                     | A long and more explicative name                                      | Quality flags   | string | 1  |

| Group Name  | Element Name                          | Description  | Range or Value   | Type   | Dimension                     |
|---|---------------------------------------|--|--|--------|-------------------------------|
|   | flag_masks                            | List of bit fields describing boolean flags  | 1 2 4 8 16<br>32 64 128<br>See Table 4-8                                   | ubyte  | 8                             |
|   | flag_meanings                         | List of flag meanings composing this variable  | "bad dead saturated dubious invalid spare0 spare1 spare2"<br>See Table 4-9 | string | 1                             |
| Annotation data/LINxxx_yyy/Time coordinates         |                                       |  |  |        |                               |
|   | time_stamp                            | Measurement Time Stamp for each measurement  |  | int64  | number_of_along_track_samples |
|   | standard_name                         | CF standard name   | time   | string | 1                             |
|   | long_name                             | A long and more explicative name   | Elapsed time since 01 Jan 2000 0h  | string | 1                             |
|   | units                                 |  | microseconds since 2000-01-01 00:00:00                                     | string | 1                             |
|   | _FillValue                            | Default value for missing data   | -1   | int64  | 1                             |
| Annotation data/LINxxx_yyy/Instrumental information | Same content of the L1B products 4.1. | Note:<br>Dimension <i>vau_tm_frames_number</i> is nominally equal to<br><br><i>WOI*</i><br><i>number_of_along_track_samples</i> ,<br><br>where WOI is the number of WOI (2 for LINDES, 4 for LINSEA) foreseen for this calibration (see [CAL-TAB]) |  |        |                               |
| Annotation data/Processing executed                 |                                       |  |  |        |                               |
|   | flag_dim                              |  | 1  |        |                               |
|   | input_names                           | Name of the input files used in the processing   | List of names separated by   | string | 1                             |

| Group Name | Element Name             | Description   | Range or Value  | Type   | Dimension |
|------------|--------------------------|---|---|--------|-----------|
|            |                          |   | empty space   |        |           |
|            | output_zipping           | Flag indicating if the zip of the outputs has been done (1) or not (0)          | [0,1]   | ubyte  | flag_dim  |
|            | standard_name            | CF standard name  | output_zipping  | string | 1         |
|            | long_name                | A long and more explicative name  | Flag indicating if the zip of the outputs has been done (1) or not (0)          | string | 1         |
|            | valid_min                |   | 0   | ubyte  | 1         |
|            | valid_max                |   | 1   | ubyte  | 1         |
|            | _FillValue               | Value indicating unfilled flag  | 255   | ubyte  | 1         |
|            | offset_correction        | Flag indicating if the offset correction has been applied (1) or not (0)        | [0,1]   | ubyte  | flag_dim  |
|            | standard_name            | CF standard name  | offset_correction   | string | 1         |
|            | long_name                | A long and more explicative name  | Flag indicating if the offset correction has been applied (1) or not (0)        | string | 1         |
|            | valid_min                |   | 0   | ubyte  | 1         |
|            | valid_max                |   | 1   | ubyte  | 1         |
|            | _FillValue               | Value indicating unfilled flag  | 255   | ubyte  | 1         |
|            | non_linearity_correction | Flag indicating if the non-linearity correction has been applied (1) or not (0) | [0,1]   | ubyte  | flag_dim  |
|            | standard_name            | CF standard name  | non_linearity_correction  | string | 1         |
|            | long_name                | A long and more explicative name  | Flag indicating if the non-linearity correction has been applied (1) or not (0) | string | 1         |
|            | valid_min                |   | 0   | ubyte  | 1         |
|            | valid_max                |   | 1   | ubyte  | 1         |
|            | _FillValue               | Value indicating unfilled flag  | 255   | ubyte  | 1         |
|            | dark_calibration         |   |   |        |           |
|            | standard_name            | CF standard name  | dark_calibration  | string | 1         |
|            | long_name                | A long and more explicative   | Flag  | string | 1         |

| Group Name | Element Name | Description                    | Range or Value  | Type  | Dimension |
|------------|--------------|--------------------------------|---|-------|-----------|
|            |              | name                           | indicating if the dark vcalibration has been applied (1) or not (0) |       |           |
|            | valid_min    |                                | 0   | ubyte | 1         |
|            | valid_max    |                                | 1   | ubyte | 1         |
|            | _FillValue   | Value indicating unfilled flag | 255   | ubyte | 1         |

#### 4.2.13.1 Open points

“Meteorological information” metadata is TBD in [PDS-L1] §6.2.8, for this reason it is not reported in the “Annotation data” group.  
The above netCDF content is TBC by LDO/ESA.

### 4.2.14 L1 RAC CTE: Monitoring of CCD Charge Transfer Efficiency (CTE) using overscan rows

It collects data based on sun diffuser for monitoring of CTE using overscan rows.

Example:

```
- FLX_GPP_RAC_CTE___20190305T133000_20190305T133009_20190927T091740_00015
|--> FLX_GPP_RAC_CTE___20190305T133000_20190305T133009_20190927T091740_00015.XML
|--> FLX_GPP_RAC_CTE___20190305T133000_20190305T133009_20190927T091740_00015.LRE.NC
|--> FLX_GPP_RAC_CTE___20190305T133000_20190305T133009_20190927T091740_00015.HRE1.NC
|--> FLX_GPP_RAC_CTE___20190305T133000_20190305T133009_20190927T091740_00015.HRE2.NC
```

Here after the table reporting the detailed content of the NetCDF data block valid for each one of the 3 spectral bands LR, HR1 and HR2 (indicated with  $[k]$  in the table).

**Table 4-15: L1 RAC CTE\_\_\_ NetCDF data block format description**

| Group Name  | Element Name                   | Description                            | Range or Value                  | Type | Dimension |
|-------------|--------------------------------|--|---------------------------------|------|-----------|
|             | number_of_spectral_channels    | Number of spectral channels (binned)   | HR1: 140<br>HR2: 269<br>LR: 235 |      |           |
|             | number_of_along_track_samples  | Number of acquisitions                 | 1200<br>[CAL-TAB]               |      |           |
|             | number_of_across_track_samples | Number of columns in the product image | 536                             |      |           |
| Measurement |                                |  |                                 |      |           |

| Group Name | Element Name         | Description  | Range or Value          | Type   | Dimension   |
|------------|----------------------|--|-------------------------|--------|---|
| data       |                      |  |                         |        |   |
|            | flex_X_tail_bottom   | Bottom smear tails for each spectral band [k]      |                         | double | number_of_across_track_samples<br>number_of_spectral_channels |
|            | standard_name        | CF standard name                                   | flex_X_tail_bottom      | string | 1   |
|            | long_name            | A long and more explicative name                   | Bottom smear tails      | string | 1   |
|            | units                | units name   | DN                      | string | 1   |
|            | flex_X_tail_up       | Upper smear tails for each spectral band [k]       |                         | double | number_of_across_track_samples<br>number_of_spectral_channels |
|            | standard_name        | CF standard name                                   | flex_X_tail_up          | string | 1   |
|            | long_name            | A long and more explicative name                   | Upper smear tails       | string | 1   |
|            | units                | units name   | DN                      | string | 1   |
|            | flex_CTE_bottom      | Bottom CTE measurements for each spectral band [k] |                         | double | number_of_spectral_channels                                   |
|            | standard_name        | CF standard name                                   | flex_CTE_bottom         | string | 1   |
|            | long_name            | A long and more explicative name                   | Bottom CTE measurements | string | 1   |
|            | units                | units name   | DN                      | string | 1   |
|            | flex_CTE_up          | Upper CTE measurements for each spectral band [k]  |                         | double | number_of_spectral_channels                                   |
|            | standard_name        | CF standard name                                   | flex_CTE_up             | string | 1   |
|            | long_name            | A long and more explicative name                   | Upper CTE measurements  | string | 1   |
|            | units                | units name   | DN                      | string | 1   |
|            | flex_CTE_bias_bottom | Bottom CTE biases for each spectral band [k]       |                         | double | number_of_spectral_channels                                   |
|            | standard_name        | CF standard name                                   | flex_CTE_bias_bottom    | string | 1   |
|            | long_name            | A long and more explicative name                   | Bottom CTE biases       | string | 1   |
|            | units                | units name   | DN                      | string | 1   |
|            | flex_CTE_bias_up     | Upper CTE biases for each spectral band [k]        |                         | double | number_of_spectral_channels                                   |

| Group Name                    | Element Name         | Description  | Range or Value                                    | Type   | Dimension  |
|-------------------------------|----------------------|--|---|--------|--|
|                               |                      |  |   |        | channels   |
|                               | standard_name        | CF standard name                                     | flex_CTE_bias_up                                  | string | 1  |
|                               | long_name            | A long and more explicative name                     | Upper CTE biases                                  | string | 1  |
|                               | units                | units name   | DN  | string | 1  |
|                               | flex_CTE_flag_bottom | Bottom CTE exceeded flags for each spectral band [k] |   | double | number_of_spectral_channels  |
|                               | standard_name        | CF standard name                                     | flex_CTE_flag_bottom                              | string | 1  |
|                               | long_name            | A long and more explicative name                     | Bottom CTE exceeded flags                         | string | 1  |
|                               | units                | units name   | DN  | string | 1  |
|                               | flex_CTE_flag_up     | Upper CTE exceeded flags for each spectral band [k]  |   | double | number_of_spectral_channels  |
|                               | standard_name        | CF standard name                                     | flex_CTE_flag_up                                  | string | 1  |
|                               | long_name            | A long and more explicative name                     | Upper CTE exceeded flags                          | string | 1  |
|                               | units                | units name   | DN  | string | 1  |
| Annotation data/Quality flags |                      |  |   |        |  |
|                               | quality_flags        | Quality flags  |   | ubyte  | number_of_along_track_samples<br>number_of_across_track_samples<br>number_of_spectral_channels |
|                               | standard_name        | CF standard name                                     | quality_flags                                     | string | 1  |
|                               | long_name            | A long and more explicative name                     | Quality flags                                     | string | 1  |
|                               | flag_masks           | List of bit fields describing boolean flags          | 1 2 4 8 16<br>32 64 128<br>See Table 4-8          | ubyte  | 8  |
|                               | flag_meanings        | List of flag meanings composing this variable        | "bad dead saturated dubious invalid spare0 spare1 | string | 1  |

| Group Name                               | Element Name                          | Description  | Range or Value   | Type   | Dimension                     |
|--|---------------------------------------|--|--|--------|-------------------------------|
|  |                                       |  | spare2"  |        |                               |
|  |                                       |  | See Table 4-9  |        |                               |
| Annotation data/Time coordinates         |                                       |  |  |        |                               |
|  | time_stamp                            | Measurement Time Stamp for each measurement                            |  | int64  | number_of_along_track_samples |
|  | standard_name                         | CF standard name   | time   | string | 1                             |
|  | long_name                             | A long and more explicative name                                       | Elapsed time since 01 Jan 2000 0h                                      | string | 1                             |
|  | units                                 |  | microseconds since 2000-01-01 00:00:00                                 | string | 1                             |
|  | _FillValue                            | Default value for missing data   | -1   | int64  | 1                             |
| Annotation data/Instrumental information | Same content of the L1B products 4.1. |  |  |        |                               |
| Annotation data/Processing executed      |                                       |  |  |        |                               |
|  | number_of_inputs                      | The number of inputs   |  |        |                               |
|  | input_names                           | Name of the inputs used in the processing                              |  | string | number_of_inputs              |
|  | standard_name                         | CF standard name   | Input_names  | string | 1                             |
|  | long_name                             | A long and more explicative name                                       | Name of the inputs used in the processing                              | string | 1                             |
|  | output_zipping                        | Flag indicating if the zip of the outputs has been done (1) or not (0) | [0,1]  | ubyte  | flag_dim                      |
|  | standard_name                         | CF standard name   | output_zipping   | string | 1                             |
|  | long_name                             | A long and more explicative name                                       | Flag indicating if the zip of the outputs has been done (1) or not (0) | string | 1                             |
|  | valid_min                             |  | 0  | ubyte  | 1                             |
|  | valid_max                             |  | 1  | ubyte  | 1                             |

| Group Name | Element Name             | Description   | Range or Value  | Type   | Dimension |
|------------|--------------------------|---|---|--------|-----------|
|            | _FillValue               | Value indicating unfilled flag  | 255   | ubyte  | 1         |
|            | offset_correction        | Flag indicating if the offset correction has been applied (1) or not (0)        | [0,1]   | ubyte  | flag_dim  |
|            | standard_name            | CF standard name  | offset_correction   | string | 1         |
|            | long_name                | A long and more explicative name  | Flag indicating if the offset correction has been applied (1) or not (0)        | string | 1         |
|            | valid_min                |   | 0   | ubyte  | 1         |
|            | valid_max                |   | 1   | ubyte  | 1         |
|            | _FillValue               | Value indicating unfilled flag  | 255   | ubyte  | 1         |
|            | non_linearity_correction | Flag indicating if the non-linearity correction has been applied (1) or not (0) | [0,1]   | ubyte  | flag_dim  |
|            | standard_name            | CF standard name  | non_linearity_correction  | string | 1         |
|            | long_name                | A long and more explicative name  | Flag indicating if the non-linearity correction has been applied (1) or not (0) | string | 1         |
|            | valid_min                |   | 0   | ubyte  | 1         |
|            | valid_max                |   | 1   | ubyte  | 1         |
|            | _FillValue               | Value indicating unfilled flag  | 255   | ubyte  | 1         |

#### 4.2.14.1 Open points

The above netCDF content is TBC by LDO/ESA.

### 4.3 L1 SPECTRAL CALIBRATION PRODUCTS (SPC)

The overall structure of the L1 spectral calibration products (SPC) follows the FLEX FIPS/GPP L1 product specification [PDS-L1]:

- 1 XML header
- 3 data blocks corresponding to the 3 detectors LR, HR1 and HR2

As specified in [PDS-L1] the data blocks of the FLEX L1 SPC products are NetCDF files, whose structure has some commonality with the Sentinel-3 OLCI SPC products, but FLEX SPC products are completely self-standing.

In FLEX are foreseen 2 different L1 SPC products, identified by a specific semantic descriptor (see [PDS-L1]).

L1 SPC products are inputs to the FLEX GPP Radiometric and Spectral Module in order to estimates and update specific spectral calibration parameters in the CCDB files.

The next paragraph will report details on the format of each SPC product.

### 4.3.1 L1 SPC SPECEO: Spectral calibration in nominal EO mode

It collects measurements for spectral calibration acquired with the CU positioned on EO port in nominal mode (channels spatially and spectrally binned).

Example:

```
- FLX_GPP_SPC_SPECEO_20190305T133000_20190305T133009_20190927T091740_00015
/--> FLX_GPP_SPC_SPECEO_20190305T133000_20190305T133009_20190927T091740_00015.XML
/--> FLX_GPP_SPC_SPECEO_20190305T133000_20190305T133009_20190927T091740_00015.LRE_NC
/--> FLX_GPP_SPC_SPECEO_20190305T133000_20190305T133009_20190927T091740_00015.HRE1_NC
/--> FLX_GPP_SPC_SPECEO_20190305T133000_20190305T133009_20190927T091740_00015.HRE2_NC
```

Here after the table reporting the detailed content of the NetCDF data block valid for all the 3 spectral bands LR, HR1 and HR2.

**Table 4-16: L1 SPC SPECEO NetCDF data block format description**

| Group Name       | Element Name                   | Description  | Range or Value            | Type   | Dimension   |
|------------------|--------------------------------|--|---------------------------|--------|---|
|                  | number_of_across_track_samples | Number of across track samples   | 536                       |        |   |
|                  | number_of_spectral_features    | Number of spectral features  | HR1: 1<br>HR2: 1<br>LR: 4 |        |   |
|                  | number_of_polynomial_coeff     | Number of polynomial coefficients  | 2 (TBC)                   |        |   |
|                  | min_max                        | Range min max  | 2                         |        |   |
| Measurement data |                                |  |                           |        |   |
|                  | max_corr_coeff                 | The maximum Pearson correlation coefficient between the measured spectrum and the shifted reference spectrum | [-1.0,1.0]                | float  | number_of_spectral_features<br>number_of_across_track_samples |
|                  | standard_name                  | CF standard name   | max_corr_coeff            | string | 1   |
|                  | long_name                      | A long and more  | The maximum               | string | 1   |

| Group Name | Element Name             | Description  | Range or Value   | Type   | Dimension   |
|------------|--------------------------|--|--|--------|---|
|            |                          | explicative name   | Pearson correlation coefficient between the measured spectrum and the shifted reference spectrum                                       |        |   |
|            | valid_min                |  | -1.0   | float  | 1   |
|            | valid_max                |  | 1.0  | float  | 1   |
|            | _FillValue               | Unfilled data value  | -2.0   | float  | 1   |
|            | spectral_shift           | The spectral shift that maximizes the Pearson correlation coefficient between the measured spectrum and the shifted reference spectrum             |  | float  | number_of_spectral_features<br>number_of_across_track_samples |
|            | standard_name            | CF standard name   | spectral_shift   | string | 1   |
|            | long_name                | A long and more explicative name   | The spectral shift that maximizes the Pearson correlation coefficient between the measured spectrum and the shifted reference spectrum | string | 1   |
|            | spectral_response_change | The SR change corresponding to the maximum of the Pearson correlation coefficient between the measured spectrum and the shifted reference spectrum |  | float  | number_of_spectral_features<br>number_of_across_track_samples |
|            | standard_name            | CF standard name   | spectral_response_change   | string | 1   |
|            | long_name                | A long and more explicative name   | The SR change corresponding to the maximum of  | string | 1   |

| Group Name | Element Name                  | Description  | Range or Value   | Type   | Dimension   |
|------------|-------------------------------|--|--|--------|---|
|            |                               |  | the Pearson correlation coefficient between the measured spectrum and the shifted reference spectrum   |        |   |
|            | wl_shift_poly                 | The polynomial coefficients of the polynomial function that describes the shift of the center wavelength in function of the across-track pixel |  | float  | number_of_spectral_features<br>number_of_polynomial_coeff |
|            | standard_name                 | CF standard name   | wl_shift_poly  | string | 1   |
|            | long_name                     | A long and more explicative name   | The polynomial coefficients of the polynomial function that describes the shift of the center wavelength in function of the across-track pixel | string | 1   |
|            | spectral_response_change_poly | The polynomial coefficients of the polynomial function that describes the change in SR in function of the across-track pixel                   |  | float  | number_of_spectral_features<br>number_of_polynomial_coeff |
|            | standard_name                 | CF standard name   | spectral_response_change_poly  | string | 1   |
|            | long_name                     | A long and more explicative name   | The polynomial coefficients of the polynomial function that describes the change in SR in function of the across-track pixel                   | string | 1   |
|            | wl_shift_poly_errors          | Residuals of the polynomial fit through the center   |  | float  | number_of_spectral_features<br>number_of_                 |

| Group Name | Element Name                         | Description  | Range or Value   | Type   | Dimension   |
|------------|--------------------------------------|--|--|--------|---|
|            |                                      | wavelength shifts in function of the across-track pixel  |  |        | across_track_samples  |
|            | standard_name                        | CF standard name   | wl_shift_poly_errors   | string | 1   |
|            | long_name                            | A long and more explicative name   | Residuals of the polynomial fit through the center wavelength shifts in function of the across-track pixel                       | string | 1   |
|            | rmse_of_wl_shift                     | The root-mean square error between the polynomial fit through the center wavelength shifts in function of the across-track pixel |  | float  | number_of_spectral_features                                   |
|            | standard_name                        | CF standard name   | rmse_of_wl_shift   | string | 1   |
|            | long_name                            | A long and more explicative name   | The root-mean square error between the polynomial fit through the center wavelength shifts in function of the across-track pixel | string | 1   |
|            | spectral_response_change_poly_errors | Residuals of the polynomial fit through the SR change in function of the across-track pixel                                      |  | float  | number_of_spectral_features<br>number_of_across_track_samples |
|            | standard_name                        | CF standard name   | spectral_response_change_poly_errors   | string | 1   |
|            | long_name                            | A long and more explicative name   | Residuals of the polynomial fit through the SR change in function of the across-track pixel                                      | string | 1   |
|            | rmse_of_spectral_response_change     | The root-mean square error between the   |  | float  | number_of_spectral_features                                   |

| Group Name                               | Element Name                          | Description  | Range or Value  | Type   | Dimension  |
|--|---------------------------------------|--|---|--------|--|
|  |                                       | polynomial fit through the SR change in function of the across-track pixel |   |        |  |
|  | standard_name                         | CF standard name   | rmse_of_spectral_response_change  | string | 1  |
|  | long_name                             | A long and more explicative name   | The root-mean square error between the polynomial fit through the SR change in function of the across-track pixel | string | 1  |
| Annotation data                          |                                       |  |   |        |  |
|  | spectral_features_minmax_wl           | Feature spectral range (min, max)  | HR1:<br>684, 693<br><br>HR2:<br>755, 775<br><br>LR:<br>510, 531<br>584, 604<br>644, 670<br>710, 750               | float  | number_of_spectral_features<br>number_of_across_track_samples<br>min_max |
|  | standard_name                         | CF standard name   | spectral_features_minmax_wl   | string | 1  |
|  | long_name                             | A long and more explicative name   | Feature spectral range (min, max)   | string | 1  |
|  | units                                 | Units name   | nm  | string | 1  |
| Annotation data/Instrumental information | Same content of the L1B products 4.1. |  |   |        |  |
| Annotation data/Processing executed      |                                       |  |   |        |  |
|  | flag_dim                              | Flags dimension  | 1   |        |  |
|  | input_names                           | Name of the input files used in the processing                             | List of names separated by empty space  | string | 1  |
|  | offset_correction                     | Flag indicating if the offset correction has been applied (1) or not (0)   | [0,1]   | ubyte  | flag_dim   |
|  | standard_name                         | CF standard  | offset_correction   | string | 1  |

| Group Name | Element Name             | Description   | Range or Value  | Type   | Dimension |
|------------|--------------------------|---|---|--------|-----------|
|            |                          | name  |   |        |           |
|            | long_name                | A long and more explicative name  | Flag indicating if the offset correction has been applied (1) or not (0)        | string | 1         |
|            | valid_min                |   | 0   | ubyte  | 1         |
|            | valid_max                |   | 1   | ubyte  | 1         |
|            | _FillValue               | Value indicating unfilled flag  | 255   | ubyte  | 1         |
|            | non_linearity_correction | Flag indicating if the non-linearity correction has been applied (1) or not (0)   | [0,1]   | ubyte  | flag_dim  |
|            | standard_name            | CF standard name  | non_linearity_correction  | string | 1         |
|            | long_name                | A long and more explicative name  | Flag indicating if the non-linearity correction has been applied (1) or not (0) | string | 1         |
|            | valid_min                |   | 0   | ubyte  | 1         |
|            | valid_max                |   | 1   | ubyte  | 1         |
|            | _FillValue               | Value indicating unfilled flag  | 255   | ubyte  | 1         |
|            | dark_signal_removal      | Flag indicating if the dark signal correction has been applied (1) or not (0)     | [0,1]   | ubyte  | flag_dim  |
|            | standard_name            | CF standard name  | dark_signal_removal   | string | 1         |
|            | long_name                | A long and more explicative name  | Flag indicating if the dark signal correction has been applied (1) or not (0)   | string | 1         |
|            | valid_min                |   | 0   | ubyte  | 1         |
|            | valid_max                |   | 1   | ubyte  | 1         |
|            | _FillValue               | Value indicating unfilled flag  | 255   | ubyte  | 1         |
|            | smearing_correction      | Flag indicating if the smearing signal correction has been applied (1) or not (0) | [0,1]   | ubyte  | flag_dim  |
|            | standard_name            | CF standard name  | smearing_correction   | string | 1         |
|            | long_name                | A long and more explicative name  | Flag indicating if the smearing signal correction has been applied              | string | 1         |

| Group Name | Element Name                     | Description   | Range or Value   | Type   | Dimension |
|------------|----------------------------------|---|--|--------|-----------|
|            |                                  |   | (1) or not (0)   |        |           |
|            | valid_min                        |   | 0  | ubyte  | 1         |
|            | valid_max                        |   | 1  | ubyte  | 1         |
|            | _FillValue                       | Value indicating unfilled flag  | 255  | ubyte  | 1         |
|            | straylight_correction            | Flag indicating if the straylight correction has been applied (1) or not (0)              | [0,1]  | ubyte  | flag_dim  |
|            | standard_name                    | CF standard name  | straylight_correction  | string | 1         |
|            | long_name                        | A long and more explicative name  | Flag indicating if the straylight correction has been applied (1) or not (0) | string | 1         |
|            | from_along_track_sample          | The 0-relative index of the first along track sample the straylight has been applied from |  | uint   | 1         |
|            | from_along_track_sample          | The 0-relative index of the last along track sample the straylight has been applied to    |  | uint   | 1         |
|            | valid_min                        |   | 0  | ubyte  | 1         |
|            | valid_max                        |   | 1  | ubyte  | 1         |
|            | _FillValue                       | Value indicating unfilled flag  | 255  | ubyte  | 1         |
|            | flat_field_correction            | Flag indicating if the flat field correction has been applied (1) or not (0)              | [0,1]  | ubyte  | flag_dim  |
|            | standard_name                    | CF standard name  | flat_field_correction  | string | 1         |
|            | long_name                        | A long and more explicative name  | Flag indicating if the flat field correction has been applied (1) or not (0) | string | 1         |
|            | valid_min                        |   | 0  | ubyte  | 1         |
|            | valid_max                        |   | 1  | ubyte  | 1         |
|            | _FillValue                       | Value indicating unfilled flag  | 255  | ubyte  | 1         |
|            | absolute_radiometric_calibration | Flag indicating if the absolute radiometric   | [0,1]  | ubyte  | flag_dim  |

| Group Name | Element Name                        | Description   | Range or Value   | Type   | Dimension |
|------------|-------------------------------------|---|--|--------|-----------|
|            |                                     | correction has been applied (1) or not (0)  |  |        |           |
|            | standard_name                       | CF standard name  | absolute_radiometric_calibration   | string | 1         |
|            | long_name                           | A long and more explicative name  | Flag indicating if the absolute radiometric correction has been applied (1) or not (0) | string | 1         |
|            | valid_min                           |   | 0  | ubyte  | 1         |
|            | valid_max                           |   | 1  | ubyte  | 1         |
|            | _FillValue                          | Value indicating unfilled flag  | 255  | ubyte  | 1         |
|            | geolocation                         | Flag indicating if the geolocation has been applied (1) or not (0)                      | [0,1]  | ubyte  | flag_dim  |
|            | standard_name                       | CF standard name  | geolocation  | string | 1         |
|            | long_name                           | A long and more explicative name  | Flag indicating if the geolocation has been done (1) or not (0)                        | string | 1         |
|            | valid_min                           |   | 0  | ubyte  | 1         |
|            | valid_max                           |   | 1  | ubyte  | 1         |
|            | _FillValue                          | Value indicating unfilled flag  | 255  | ubyte  | 1         |
|            | defective_pixels_flagging           | Flag indicating if the defective pixels flagging has been done (1) or not (0)           | [0,1]  | ubyte  | flag_dim  |
|            | standard_name                       | CF standard name  | defective_pixels_flagging  | string | 1         |
|            | long_name                           | A long and more explicative name  | Flag indicating if the defective pixels flagging has been done (1) or not (0)          | string | 1         |
|            | valid_min                           |   | 0  | ubyte  | 1         |
|            | valid_max                           |   | 1  | ubyte  | 1         |
|            | _FillValue                          | Value indicating unfilled flag  | 255  | ubyte  | 1         |
|            | classification_and_quality_flagging | Flag indicating if the classification and quality flagging has been done (1) or not (0) | [0,1]  | ubyte  | flag_dim  |
|            | standard_name                       | CF standard name  | classification_and_quality_flagging  | string | 1         |

| Group Name | Element Name     | Description  | Range or Value  | Type   | Dimension |
|------------|------------------|--|---|--------|-----------|
|            |                  |  | ng  |        |           |
|            | long_name        | A long and more explicative name                                       | Flag indicating if the classification and quality flagging has been done (1) or not (0) | string | 1         |
|            | valid_min        |  | 0   | ubyte  | 1         |
|            | valid_max        |  | 1   | ubyte  | 1         |
|            | _FillValue       | Value indicating unfilled flag   | 255   | ubyte  | 1         |
|            | output_rescaling | Flag indicating if the output rescaling has been done (1) or not (0)   | [0,1]   | ubyte  | flag_dim  |
|            | standard_name    | CF standard name   | output_rescaling  | string | 1         |
|            | long_name        | A long and more explicative name                                       | Flag indicating if the output rescaling has been done (1) or not (0)                    | string | 1         |
|            | valid_min        |  | 0   | ubyte  | 1         |
|            | valid_max        |  | 1   | ubyte  | 1         |
|            | _FillValue       | Value indicating unfilled flag   | 255   | ubyte  | 1         |
|            | output_zipping   | Flag indicating if the zip of the outputs has been done (1) or not (0) | [0,1]   | ubyte  | flag_dim  |
|            | standard_name    | CF standard name   | output_zipping  | string | 1         |
|            | long_name        | A long and more explicative name                                       | Flag indicating if the zip of the outputs has been done (1) or not (0)                  | string | 1         |
|            | valid_min        |  | 0   | ubyte  | 1         |
|            | valid_max        |  | 1   | ubyte  | 1         |
|            | _FillValue       | Value indicating unfilled flag   | 255   | ubyte  | 1         |

Note:

EXPRIVIA does not exclude that some parameters could be updated in the proposed format.

#### 4.3.2 L1 SPC SPECSD: Spectral calibration with CU on sun diffuser

It collects measurements for spectral calibration acquired with the CU positioned on sun diffuser.

Example:

```
- FLX_GPP_SPC_SPECS_D_20190305T133000_20190305T133009_20190927T091740_00015
/--> FLX_GPP_SPC_SPECS_D_20190305T133000_20190305T133009_20190927T091740_00015.XML
/--> FLX_GPP_SPC_SPECS_D_20190305T133000_20190305T133009_20190927T091740_00015.LRE_NC
/--> FLX_GPP_SPC_SPECS_D_20190305T133000_20190305T133009_20190927T091740_00015.HRE1_NC
/--> FLX_GPP_SPC_SPECS_D_20190305T133000_20190305T133009_20190927T091740_00015.HRE2_NC
```

Here after the table reporting the detailed content of the NetCDF data block valid for all the 3 spectral bands LR, HR1 and HR2.

**Table 4-17: L1 SPC SPECS\_D NetCDF data block format description**

| Group Name       | Element Name                   | Description  | Range or Value   | Type   | Dimension   |
|------------------|--------------------------------|--|--|--------|---|
|                  | number_of_across_track_samples | Number of across track samples   | 536  |        |   |
|                  | number_of_spectral_features    | Number of spectral features  | HR1: 1<br>HR2: 1<br>LR: TBD  |        |   |
|                  | number_of_polynomial_coeff     | Number of polynomial coefficients  | 2 (TBC)  |        |   |
|                  | min_max                        | Range min max  | 2  |        |   |
| Measurement data |                                |  |  |        |   |
|                  | max_corr_coeff                 | The maximum Pearson correlation coefficient between the measured spectrum and the shifted reference spectrum | [-1.0,1.0]   | float  | number_of_spectral_features<br>number_of_across_track_samples |
|                  | standard_name                  | CF standard name   | max_corr_coeff   | string | 1   |
|                  | long_name                      | A long and more explicative name   | The maximum Pearson correlation coefficient between the measured spectrum and the shifted reference spectrum | string | 1   |
|                  | valid_min                      |  | -1.0   | float  | 1   |
|                  | valid_max                      |  | 1.0  | float  | 1   |
|                  | _FillValue                     | Unfilled data value  | -2.0   | float  | 1   |
|                  | spectral_shift                 | The spectral shift that maximizes the Pearson correlation coefficient  |  | float  | number_of_spectral_features                                   |

| Group Name | Element Name             | Description  | Range or Value   | Type   | Dimension   |
|------------|--------------------------|--|--|--------|---|
|            |                          | between the measured spectrum and the shifted reference spectrum   |  |        | number_of_across_track_samples                                |
|            | standard_name            | CF standard name   | spectral_shift   | string | 1   |
|            | long_name                | A long and more explicative name   | The spectral shift that maximizes the Pearson correlation coefficient between the measured spectrum and the shifted reference spectrum             | string | 1   |
|            | spectral_response_change | The SR change corresponding to the maximum of the Pearson correlation coefficient between the measured spectrum and the shifted reference spectrum |  | float  | number_of_spectral_features<br>number_of_across_track_samples |
|            | standard_name            | CF standard name   | spectral_response_change   | string | 1   |
|            | long_name                | A long and more explicative name   | The SR change corresponding to the maximum of the Pearson correlation coefficient between the measured spectrum and the shifted reference spectrum | string | 1   |
|            | wl_shift_poly            | The polynomial coefficients of the polynomial function that describes the shift of the center wavelength in function of the across-track pixel     |  | float  | number_of_spectral_features<br>number_of_polynomial_coeff     |
|            | standard_name            | CF standard name   | wl_shift_poly  | string | 1   |
|            | long_name                | A long and more explicative name   | The polynomial coefficients of the polynomial function that describes the shift of the   | string | 1   |

| Group Name | Element Name                  | Description  | Range or Value   | Type   | Dimension   |
|------------|-------------------------------|--|--|--------|---|
|            |                               |  | center wavelength in function of the across-track pixel  |        |   |
|            | spectral_response_change_poly | The polynomial coefficients of the polynomial function that describes the change in SR in function of the across-track pixel     |  | float  | number_of_spectral_features<br>number_of_polynomial_coeff     |
|            | standard_name                 | CF standard name   | spectral_response_change_poly  | string | 1   |
|            | long_name                     | A long and more explicative name   | The polynomial coefficients of the polynomial function that describes the change in SR in function of the across-track pixel | string | 1   |
|            | wl_shift_poly_errors          | Residuals of the polynomial fit through the center wavelength shifts in function of the across-track pixel                       |  | float  | number_of_spectral_features<br>number_of_across_track_samples |
|            | standard_name                 | CF standard name   | wl_shift_poly_errors   | string | 1   |
|            | long_name                     | A long and more explicative name   | Residuals of the polynomial fit through the center wavelength shifts in function of the across-track pixel                   | string | 1   |
|            | rmse_of_wl_shift              | The root-mean square error between the polynomial fit through the center wavelength shifts in function of the across-track pixel |  | float  | number_of_spectral_features                                   |
|            | standard_name                 | CF standard name   | rmse_of_wl_shift   | string | 1   |
|            | long_name                     | A long and more explicative name   | The root-mean square error between the polynomial fit through the center wavelength  | string | 1   |

| Group Name      | Element Name                         | Description   | Range or Value  | Type   | Dimension  |
|-----------------|--------------------------------------|---|---|--------|--|
|                 |                                      |   | shifts in function of the across-track pixel  |        |  |
|                 | spectral_response_change_poly_errors | Residuals of the polynomial fit through the SR change in function of the across-track pixel                       |   | float  | number_of_spectral_features<br>number_of_across_track_samples            |
|                 | standard_name                        | CF standard name  | spectral_response_change_poly_errors  | string | 1  |
|                 | long_name                            | A long and more explicative name  | Residuals of the polynomial fit through the SR change in function of the across-track pixel                       | string | 1  |
|                 | rmse_of_spectral_response_change     | The root-mean square error between the polynomial fit through the SR change in function of the across-track pixel |   | float  | number_of_spectral_features  |
|                 | standard_name                        | CF standard name  | rmse_of_spectral_response_change  | string | 1  |
|                 | long_name                            | A long and more explicative name  | The root-mean square error between the polynomial fit through the SR change in function of the across-track pixel | string | 1  |
| Annotation data |                                      |   |   |        |  |
|                 | spectral_features_minmax_wl          | Feature spectral range (min, max)   | HR1:<br>677, 697<br><br>HR2:<br>740, 780<br><br>LR:<br>TBD  | float  | number_of_spectral_features<br>number_of_across_track_samples<br>min_max |
|                 | standard_name                        | CF standard name  | spectral_features_minmax_wl   | string | 1  |
|                 | long_name                            | A long and more explicative name  | Feature spectral range (min, max)   | string | 1  |
|                 | units                                | Units name  | nm  | string | 1  |

| Group Name                               | Element Name                          | Description   | Range or Value  | Type   | Dimension |
|--|---------------------------------------|---|---|--------|-----------|
| Annotation data/Instrumental information | Same content of the L1B products 4.1. |   |   |        |           |
| Annotation data/Processing executed      |                                       |   |   |        |           |
|  | flag_dim                              | Flags dimension   | 1   |        |           |
|  | input_names                           | Name of the input files used in the processing                                  | List of names separated by empty space  | string | 1         |
|  | offset_correction                     | Flag indicating if the offset correction has been applied (1) or not (0)        | [0,1]   | ubyte  | flag_dim  |
|  | standard_name                         | CF standard name  | offset_correction   | string | 1         |
|  | long_name                             | A long and more explicative name  | Flag indicating if the offset correction has been applied (1) or not (0)        | string | 1         |
|  | valid_min                             |   | 0   | ubyte  | 1         |
|  | valid_max                             |   | 1   | ubyte  | 1         |
|  | _FillValue                            | Value indicating unfilled flag  | 255   | ubyte  | 1         |
|  | non_linearity_correction              | Flag indicating if the non-linearity correction has been applied (1) or not (0) | [0,1]   | ubyte  | flag_dim  |
|  | standard_name                         | CF standard name  | non_linearity_correction  | string | 1         |
|  | long_name                             | A long and more explicative name  | Flag indicating if the non-linearity correction has been applied (1) or not (0) | string | 1         |
|  | valid_min                             |   | 0   | ubyte  | 1         |
|  | valid_max                             |   | 1   | ubyte  | 1         |
|  | _FillValue                            | Value indicating unfilled flag  | 255   | ubyte  | 1         |
|  | dark_signal_removal                   | Flag indicating if the dark signal correction has been applied (1) or not (0)   | [0,1]   | ubyte  | flag_dim  |
|  | standard_name                         | CF standard name  | dark_signal_removal   | string | 1         |
|  | long_name                             | A long and more explicative name  | Flag indicating if the dark signal correction has been applied (1) or not (0)   | string | 1         |

| Group Name | Element Name            | Description   | Range or Value  | Type   | Dimension |
|------------|-------------------------|---|---|--------|-----------|
|            | valid_min               |   | 0   | ubyte  | 1         |
|            | valid_max               |   | 1   | ubyte  | 1         |
|            | _FillValue              | Value indicating unfilled flag  | 255   | ubyte  | 1         |
|            | smearing_correction     | Flag indicating if the smearing signal correction has been applied (1) or not (0)         | [0,1]   | ubyte  | flag_dim  |
|            | standard_name           | CF standard name  | smearing_correction   | string | 1         |
|            | long_name               | A long and more explicative name  | Flag indicating if the smearing signal correction has been applied (1) or not (0) | string | 1         |
|            | valid_min               |   | 0   | ubyte  | 1         |
|            | valid_max               |   | 1   | ubyte  | 1         |
|            | _FillValue              | Value indicating unfilled flag  | 255   | ubyte  | 1         |
|            | straylight_correction   | Flag indicating if the straylight correction has been applied (1) or not (0)              | [0,1]   | ubyte  | flag_dim  |
|            | standard_name           | CF standard name  | straylight_correction   | string | 1         |
|            | long_name               | A long and more explicative name  | Flag indicating if the straylight correction has been applied (1) or not (0)      | string | 1         |
|            | from_along_track_sample | The 0-relative index of the first along track sample the straylight has been applied from |   | uint   | 1         |
|            | from_along_track_sample | The 0-relative index of the last along track sample the straylight has been applied to    |   | uint   | 1         |
|            | valid_min               |   | 0   | ubyte  | 1         |
|            | valid_max               |   | 1   | ubyte  | 1         |
|            | _FillValue              | Value indicating unfilled flag  | 255   | ubyte  | 1         |
|            | flat_field_correction   | Flag indicating if the flat field correction has been applied (1) or not (0)              | [0,1]   | ubyte  | flag_dim  |
|            | standard_name           | CF standard name  | flat_field_correction   | string | 1         |
|            | long_name               | A long and more explicative name  | Flag indicating if the flat field correction has been applied (1) or not (0)      | string | 1         |

| Group Name | Element Name                        | Description   | Range or Value   | Type   | Dimension |
|------------|-------------------------------------|---|--|--------|-----------|
|            | valid_min                           |   | 0  | ubyte  | 1         |
|            | valid_max                           |   | 1  | ubyte  | 1         |
|            | _FillValue                          | Value indicating unfilled flag  | 255  | ubyte  | 1         |
|            | absolute_radiometric_calibration    | Flag indicating if the absolute radiometric correction has been applied (1) or not (0)  | [0,1]  | ubyte  | flag_dim  |
|            | standard_name                       | CF standard name  | absolute_radiometric_calibration   | string | 1         |
|            | long_name                           | A long and more explicative name  | Flag indicating if the absolute radiometric correction has been applied (1) or not (0) | string | 1         |
|            | valid_min                           |   | 0  | ubyte  | 1         |
|            | valid_max                           |   | 1  | ubyte  | 1         |
|            | _FillValue                          | Value indicating unfilled flag  | 255  | ubyte  | 1         |
|            | geolocation                         | Flag indicating if the geolocation has been applied (1) or not (0)                      | [0,1]  | ubyte  | flag_dim  |
|            | standard_name                       | CF standard name  | geolocation  | string | 1         |
|            | long_name                           | A long and more explicative name  | Flag indicating if the geolocation has been done (1) or not (0)                        | string | 1         |
|            | valid_min                           |   | 0  | ubyte  | 1         |
|            | valid_max                           |   | 1  | ubyte  | 1         |
|            | _FillValue                          | Value indicating unfilled flag  | 255  | ubyte  | 1         |
|            | defective_pixels_flagging           | Flag indicating if the defective pixels flagging has been done (1) or not (0)           | [0,1]  | ubyte  | flag_dim  |
|            | standard_name                       | CF standard name  | defective_pixels_flagging  | string | 1         |
|            | long_name                           | A long and more explicative name  | Flag indicating if the defective pixels flagging has been done (1) or not (0)          | string | 1         |
|            | valid_min                           |   | 0  | ubyte  | 1         |
|            | valid_max                           |   | 1  | ubyte  | 1         |
|            | _FillValue                          | Value indicating unfilled flag  | 255  | ubyte  | 1         |
|            | classification_and_quality_flagging | Flag indicating if the classification and quality flagging has been done (1) or not (0) | [0,1]  | ubyte  | flag_dim  |
|            | standard_name                       | CF standard name  | classification_and   | string | 1         |

| Group Name | Element Name     | Description  | Range or Value  | Type   | Dimension |
|------------|------------------|--|---|--------|-----------|
|            | _name            |  | d_quality_flagging  |        |           |
|            | long_name        | A long and more explicative name                                       | Flag indicating if the classification and quality flagging has been done (1) or not (0) | string | 1         |
|            | valid_min        |  | 0   | ubyte  | 1         |
|            | valid_max        |  | 1   | ubyte  | 1         |
|            | _FillValue       | Value indicating unfilled flag   | 255   | ubyte  | 1         |
|            | output_rescaling | Flag indicating if the output rescaling has been done (1) or not (0)   | [0,1]   | ubyte  | flag_dim  |
|            | standard_name    | CF standard name   | output_rescaling  | string | 1         |
|            | long_name        | A long and more explicative name                                       | Flag indicating if the output rescaling has been done (1) or not (0)                    | string | 1         |
|            | valid_min        |  | 0   | ubyte  | 1         |
|            | valid_max        |  | 1   | ubyte  | 1         |
|            | _FillValue       | Value indicating unfilled flag   | 255   | ubyte  | 1         |
|            | output_zipping   | Flag indicating if the zip of the outputs has been done (1) or not (0) | [0,1]   | ubyte  | flag_dim  |
|            | standard_name    | CF standard name   | output_zipping  | string | 1         |
|            | long_name        | A long and more explicative name                                       | Flag indicating if the zip of the outputs has been done (1) or not (0)                  | string | 1         |
|            | valid_min        |  | 0   | ubyte  | 1         |
|            | valid_max        |  | 1   | ubyte  | 1         |
|            | _FillValue       | Value indicating unfilled flag   | 255   | ubyte  | 1         |

Note:

EXPRIVIA does not exclude that some parameters could be updated in the proposed format.

## 4.4 GEOMETRIC (GEC) SCENE VAL (SCNVAL) PRODUCT

Sceneval SCNVAL product contains absolute localization correction information for the reference spectrometer band and HR\_LR interband correction information for the other spectrometer.

Example:

```
- FLX_GPP_GEC_SCNVAL_20190621T001000_20190621T001043_001  
|-> FLX_GPP_GEC_SCNVAL_20190621T001000_20190621T001043_001.XML  
|-> FLX_GPP_GEC_SCNVAL_20190621T001000_20190621T001043_001.LRE_.XML  
|-> FLX_GPP_GEC_SCNVAL_20190621T001000_20190621T001043_001.LRE_.TXT  
|-> FLX_GPP_GEC_SCNVAL_20190621T001000_20190621T001043_001.HRE2.XML  
|-> FLX_GPP_GEC_SCNVAL_20190621T001000_20190621T001043_001.HRE2.TXT
```

Which spectrometer channel is used as absolute reference is configurable, but we suggest and assume that the longest available wavelength LR channel is used in combination with the corresponding HR2 channel for interband. In this case the files containing absolute localization correction information are recognizable by ".LRE\_" just before the filetype file extension, and those for the HR-LR interband correction information are recognizable by ".HR2\_" just before the filetype file extension.

The SCNVAL product folder contains 2 types of output datablock files:

- Scene Residuals files which contain info for each GCP
- Scene Parameter files which contain other info

The residual files have a ".TXT" extension and the parameter file have an ".XML" extension. The format of the reference and interband files is the same with a slightly different interpretation for some fields considering that GCPs are used for absolute location and TPs for interband.

#### 4.4.1 SCNVAL: Scene Residuals files

Are ASCII files contain the following 21 columns in a tabular format in order to be easily readable and plottable. In particular the file contains the following field columns:

1. N: GCP/TP counter
2. PrePix: Predicted ACT pixel
3. PreLin: Predicted ALT line
4. FoundPix: Found ACT pixel
5. FoundLin: Found ALT line
6. OptimalPixA: Optimal ACT LOS versor component x 1E3
7. OptimalLinA: Optimal ALT LOS versor component x 1E3
8. RatioPixA: local sampling interval of ACT LOS versor component x 1E3
9. RatioLinA: local sampling interval of ALT LOS versor component x 1E3
10. SNR: Correlation peak Signal-To-Noise-Ratio (used as registration confidence indicator)
11. Weight: If 0 the GCP is identified as outlier; if -1 it is kept aside for independent verification, otherwise it is the weight of the GCP in the least squares modelling
12. Path: WRS2 path number; TP reference image ACT column
13. Row: WRS2 row number; TP reference image ALT line
14. Num: GCP number within WRS2 scene; zero for interband
15. Latitude: GCP/TP latitude (degrees)
16. Longitude: GCP/TP longitude (degrees)
17. Alt: GCP/TP altitude (meters)
18. PrePixA: Predicted ACT LOS versor component x 1E3
19. PreLinA: Predicted ALT LOS versor component x 1E3

- 20. FoundPixA: Predicted ACT LOS versor component x 1E3
- 21. FoundLinA: Predicted ALT LOS versor component x 1E3

An example absolute location scene residual file follows:

| /Mex/TEST/RUN_GCM/FLX_GPP_AUX_SCNVAL_20190621T001000_20190621T001043_001/FLX_GPP_AUX_SCNVAL_20190621T001000_20190621T001043_001.LRE.TXT byte 158 of 5519 |    |         |         |         |          |            |             |             |           |           |        |        |      |     |           |           |           |            |           |            |           |           |
|--|----|---------|---------|---------|----------|------------|-------------|-------------|-----------|-----------|--------|--------|------|-----|-----------|-----------|-----------|------------|-----------|------------|-----------|-----------|
| 1  | 2  | N       | PrePix  | PreLin  | FoundPix | FoundLin   | OptimalPixA | OptimalLinA | RatioPixA | RatioLinA | SNR    | Weight | Path | Row | Num       | Latitude  | Longitude | Alt        | PrePixA   | PreLinA    | FoundPixA | FoundLinA |
| 1  | 0  | 338.000 | 68.000  | 460.388 | 48.344   | 27.381901  | 12.297952   | -2.830      | 1.623     | 8.098     | -1.000 | 200    | 30   | 27  | 42.819881 | -2.300018 | 1111      | 26.760534  | 19.179468 | 27.242738  | 12.413243 |           |
| 2  | 1  | 462.000 | 60.000  | 460.388 | 48.344   | 71.751208  | 11.967894   | -2.241      | 1.620     | 5.758     | 2.203  | 200    | 30   | 29  | 42.745995 | -1.057331 | 691       | 71.132102  | 19.206230 | 71.851395  | 12.012972 |           |
| 3  | 2  | 313.000 | 208.000 | 311.434 | 196.380  | 19.346380  | 12.369546   | -2.960      | 1.720     | 8.530     | 2.625  | 200    | 31   | 1   | 42.237904 | -2.667006 | 1207      | 17.704625  | 19.176783 | 18.253218  | 12.349860 |           |
| 4  | 3  | 338.000 | 279.000 | 336.493 | 266.871  | 27.330890  | 12.298355   | -2.815      | 1.769     | 14.744    | 3.102  | 200    | 31   | 2   | 41.909592 | -2.715647 | 1455      | 26.709521  | 19.179453 | 27.244923  | 12.329231 |           |
| 5  | 4  | 416.000 | 169.000 | 414.746 | 157.072  | 55.387314  | 12.086090   | -2.339      | 1.692     | 10.158    | 2.792  | 200    | 31   | 18  | 42.311329 | -2.223473 | 757       | 54.767335  | 19.194371 | 55.303181  | 12.144986 |           |
| 6  | 5  | 469.000 | 395.000 | 467.979 | 371.430  | 74.472646  | 11.948385   | -1.960      | 1.847     | 11.058    | -1.000 | 200    | 31   | 23  | 41.392985 | -2.425506 | 1107      | 73.833187  | 19.208199 | 74.375016  | 11.967560 |           |
| 7  | 6  | 412.000 | 347.000 | 410.880 | 334.016  | 54.001129  | 12.096184   | -2.305      | 1.618     | 7.237     | 2.455  | 200    | 31   | 23  | 41.548161 | -2.569933 | 1115      | 53.381075  | 19.193364 | 53.866901  | 12.053034 |           |
| 8  | 7  | 492.000 | 212.000 | 471.638 | 212.489  | 75.856203  | 11.936444   | -2.951      | 1.724     | 4.326     | 0.000  | 200    | 31   | 29  | 42.015304 | -2.123660 | 1202      | 75.237438  | 19.209148 | 82.285519  | 19.493025 |           |
| 9  | 8  | 406.000 | 255.000 | 404.540 | 242.455  | 51.727889  | 12.115945   | -2.438      | 1.742     | 7.159     | 2.445  | 200    | 31   | 33  | 41.948933 | -2.429773 | 1303      | 51.107513  | 19.191894 | 51.708722  | 12.146990 |           |
| 10   | 9  | 256.000 | 51.000  | 254.111 | 40.396   | -2.205963  | 12.538366   | -3.250      | 1.614     | 12.365    | 2.964  | 200    | 30   | 14  | 42.966064 | -2.548556 | 854       | -2.802493  | 19.174622 | -2.247363  | 12.603263 |           |
| 11   | 10 | 153.000 | 47.000  | 150.716 | 36.872   | -39.277286 | 12.864953   | -3.652      | 1.613     | 5.858     | -1.000 | 201    | 30   | 16  | 43.072941 | -2.895638 | 594       | -39.900645 | 19.185686 | -39.275334 | 12.605904 |           |
| 12   | 11 | 241.000 | 121.000 | 239.005 | 110.432  | -7.822287  | 12.383897   | -2.956      | 1.660     | 10.036    | 2.781  | 201    | 30   | 18  | 42.677429 | -2.748773 | 804       | -8.248993  | 19.186445 | -7.639600  | 11.964425 |           |
| 13   | 12 | 79.000  | 88.000  | 76.306  | 77.988   | -65.956725 | 13.115058   | -3.811      | 1.644     | 7.024     | 2.423  | 201    | 30   | 20  | 42.961651 | -3.245478 | 735       | -66.580710 | 19.203039 | -65.873820 | 13.112642 |           |
| 14   | 13 | 149.000 | 132.000 | 146.937 | 120.984  | -46.632184 | 12.877418   | -3.853      | 1.670     | 4.348     | 0.000  | 201    | 30   | 23  | 42.713673 | -3.092661 | 614       | -41.255772 | 19.186445 | -40.720450 | 12.589960 |           |
| 15   | 14 | 71.000  | 140.000 | 68.419  | 130.006  | -68.784711 | 13.142064   | -3.877      | 1.680     | 6.030     | 2.256  | 201    | 30   | 24  | 42.745914 | -3.390422 | 814       | -69.408724 | 19.205095 | -68.742937 | 13.257530 |           |
| 16   | 15 | 325.000 | 268.000 | 323.304 | 255.904  | 22.602126  | 12.335757   | -2.883      | 1.762     | 13.120    | -1.000 | 201    | 31   | 14  | 41.969311 | -2.742220 | 1766      | 21.980549  | 19.178048 | 22.568876  | 12.311767 |           |
| 17   | 16 | 53.000  | 304.000 | 49.831  | 293.152  | -75.449423 | 13.205809   | -3.711      | 1.798     | 10.826    | 2.638  | 202    | 31   | 16  | 42.070354 | -3.820707 | 932       | -76.073385 | 19.209827 | -75.219431 | 13.175260 |           |
| 18   | 17 | 183.000 | 395.000 | 180.849 | 383.086  | -28.473340 | 12.766566   | -3.578      | 1.856     | 14.054    | 3.065  | 201    | 31   | 18  | 41.564453 | -3.522043 | 1062      | -29.096646 | 19.180200 | -28.495565 | 12.760234 |           |
| 19   | 18 | 244.000 | 218.000 | 229.181 | 201.390  | -11.144609 | 12.614017   | -2.852      | 1.723     | 2.247     | 0.000  | 201    | 31   | 21  | 42.292423 | -2.971186 | 1437      | -11.767426 | 19.175032 | -6.571507  | 9.532182  |           |
| 20   | 19 | 249.000 | 276.000 | 246.974 | 264.107  | -4.764797  | 12.559832   | -3.243      | 1.723     | 10.837    | 2.551  | 201    | 31   | 22  | 42.006847 | -3.035349 | 1371      | -5.387412  | 19.174623 | -4.762798  | 12.444537 |           |
| 21   | 20 | 183.000 | 395.000 | 180.849 | 383.086  | -28.473340 | 12.766566   | -3.578      | 1.856     | 14.054    | 3.065  | 201    | 31   | 18  | 41.564453 | -3.522043 | 1062      | -29.096646 | 19.180200 | -28.495565 | 12.760234 |           |
| 22   | 21 | 244.000 | 218.000 | 229.181 | 201.390  | -11.144609 | 12.614017   | -2.852      | 1.723     | 2.247     | 0.000  | 201    | 31   | 21  | 42.292423 | -2.971186 | 1437      | -11.767426 | 19.175032 | -6.571507  | 9.532182  |           |
| 23   | 22 | 310.000 | 339.000 | 308.278 | 326.561  | 17.214817  | 12.878550   | -2.962      | 1.671     | 4.462     | 3.049  | 201    | 31   | 26  | 41.680599 | -2.934867 | 1121      | 16.593016  | 19.176447 | 17.174393  | 12.311579 |           |
| 24   | 23 | 350.000 | 212.000 | 348.239 | 199.967  | 31.542208  | 12.265171   | -2.739      | 1.721     | 12.317    | -1.000 | 201    | 31   | 24  | 42.187305 | -2.542895 | 1119      | 30.921033  | 19.180705 | 31.564004  | 12.189059 |           |
| 25   | 24 | 169.000 | 346.000 | 166.510 | 334.290  | -33.614515 | 12.812991   | -3.506      | 1.820     | 12.209    | 2.953  | 201    | 31   | 25  | 41.784950 | -3.475090 | 967       | -34.237946 | 19.182514 | -33.527872 | 12.749300 |           |
| 26   | 25 | 310.000 | 339.000 | 308.278 | 326.561  | 17.214817  | 12.878550   | -2.962      | 1.671     | 4.462     | 3.049  | 201    | 31   | 26  | 41.680599 | -2.934867 | 1121      | 16.593016  | 19.176447 | 17.174393  | 12.311579 |           |
| 27   | 26 | 284.000 | 414.000 | 282.124 | 401.574  | 7.837805   | 12.454452   | -3.083      | 1.864     | 7.985     | 2.505  | 201    | 31   | 27  | 41.386543 | -3.178307 | 1240      | 7.215638   | 19.174617 | 7.824037   | 12.506965 |           |
| 28   | 27 | 93.000  | 373.000 | 90.769  | 361.810  | -60.770909 | 13.065672   | -4.031      | 1.844     | 10.471    | -2.820 | 201    | 31   | 28  | 41.741886 | -3.816442 | 857       | -61.394834 | 19.199267 | -60.841474 | 13.130383 |           |
| 29   | 28 | 372.000 | 410.000 | 370.977 | 396.600  | 39.694745  | 12.203307   | -2.510      | 1.861     | 4.549     | -1.000 | 201    | 31   | 29  | 41.219386 | -2.835047 | 1197      | 39.073951  | 19.185168 | 39.481291  | 11.986556 |           |
| 30   | 29 | 389.000 | 313.000 | 387.520 | 300.339  | 45.625724  | 12.158648   | -2.520      | 1.793     | 8.875     | 2.664  | 201    | 31   | 33  | 41.716122 | -2.593169 | 1168      | 45.005226  | 19.188483 | 45.592494  | 12.128041 |           |
| 31   | 30 | 35.000  | 404.000 | 32.232  | 392.818  | -81.759451 | 13.266297   | -3.974      | 1.870     | 11.875    | 2.300  | 201    | 31   | 34  | 41.668743 | -4.105496 | 946       | -82.383539 | 19.214167 | -81.686985 | 13.232989 |           |
| 32   | 31 | 124.000 | 425.000 | 121.361 | 414.073  | -49.802467 | 12.962102   | -3.661      | 1.871     | 7.442     | 2.717  | 201    | 31   | 37  | 41.492233 | -3.810911 | 1067      | -50.443626 | 19.191501 | -49.705435 | 12.845886 |           |
| 33   | 32 | 111.000 | 179.000 | 108.760 | 168.812  | -54.320435 | 13.004494   | -3.877      | 1.706     | 3.170     | 1.504  | 201    | 31   | 38  | 42.543320 | -3.332743 | 827       | -54.944268 | 19.194576 | -54.366471 | 13.222600 |           |

Figure 4-1. Absolute location scene residual file

A portion of an interband scene residual file follows:

| /Mex/TEST/RUN_GCM/FLX_GPP_AUX_SCNVAL_20190621T001000_20190621T001043_001/FLX_GPP_AUX_SCNVAL_20190621T001000_20190621T001043_001.HREL.TXT byte 178 of 12995 |   |         |         |         |          |            |             |             |           |           |        |        |      |     |           |           |           |            |           |            |           |           |
|--|---|---------|---------|---------|----------|------------|-------------|-------------|-----------|-----------|--------|--------|------|-----|-----------|-----------|-----------|------------|-----------|------------|-----------|-----------|
| 1  | 2 | N       | PrePix  | PreLin  | FoundPix | FoundLin   | OptimalPixA | OptimalLinA | RatioPixA | RatioLinA | SNR    | Weight | Path | Row | Num       | Latitude  | Longitude | Alt        | PrePixA   | PreLinA    | FoundPixA | FoundLinA |
| 1  | 0 | 48.655  | 77.722  | 49.086  | 76.957   | -76.591009 | -0.596188   | -3.448      | 1.622     | 15.219    | -1.000 | 47     | 47   | 0   | 42.852661 | -3.402671 | 0         | -76.340348 | -0.026188 | -76.465521 | -0.497605 |           |
| 2  | 1 | 99.203  | 77.802  | 99.846  | 77.060   | -58.391913 | -0.440838   | -2.719      | 1.588     | 15.400    | 3.133  | 97     | 47   | 0   | 42.807400 | -3.225420 | 0         | -58.140277 | -0.026163 | -58.377055 | -0.492799 |           |
| 3  | 2 | 147.744 | 77.869  | 148.105 | 77.269   | -41.089480 | -0.293175   | -2.317      | 1.607     | 13.002    | 3.005  | 147    | 47   | 0   | 42.763737 | -3.058047 | 0         | -40.983696 | -0.026146 | -40.992866 | -0.399562 |           |
| 4  | 3 | 198.288 | 77.905  | 198.871 | 77.638   | -22.888195 | -0.137879   | -2.234      | 1.472     | 11.430    | 2.997  | 197    | 47   | 0   | 42.716133 | -2.883206 | 0         | -22.634801 | -0.026138 | -22.896145 | -0.071770 |           |
| 5  | 4 | 246.833 | 77.922  | 247.252 | 77.998   | -5.542033  | -0.010085   | -1.880      | 1.464     | 11.829    | 2.927  | 247    | 47   | 0   | 42.672222 | -2.716247 | 0         | -5.288046  | -0.026142 | -5.510878  | -0.026285 |           |
| 6  | 5 | 297.381 | 77.946  | 297.893 | 78.105   | 12.614827  | -0.164932   | -1.697      | 1.548     | 13.918    | -1.000 | 297    | 47   | 0   | 42.626347 | -2.541648 | 0         | 12.869457  | -0.026161 | 12.567715  | -0.076351 |           |
| 7  | 6 | 345.929 | 129.260 | 346.283 | 129.536  | 29.987880  | -0.312837   | -1.385      | 1.646     | 12.858    | 2.996  | 347    | 47   | 0   | 42.580195 | -2.375669 | 0         | 30.243147  | -0.026191 | 29.940537  | -0.383980 |           |
| 8  | 7 | 396.465 | 77.897  | 397.000 | 78.817   | 48.148605  | -0.467826   | -1.439      | 1.634     | 14.881    | 3.138  | 397    | 47   | 0   | 42.533218 | -2.201555 | 0         | 48.404251  | -0.026237 | 48.032233  | -0.536940 |           |
| 9  | 8 | 445.017 | 77.852  | 445.215 | 78.872   | 65.435791  | -0.615136   | -0.700      | 1.622     | 14.798    | 3.104  | 447    | 47   | 0   | 42.488213 |           |           |            |           |            |           |           |

- nParsTot: total number of parameters estimated
- nPolyPars: number of parameters of generic polynomial
- ParNames: estimated parameter names
- ParValue: estimated parameter values
- ParSigma: estimated parameter standard deviation (the following lines contain the covariance matrix)
- Rotx/Roty/Rotz: covariance matrix components
- InputNames: The list of input file names

An example absolute location scene parameter file follows:

```
26T102638_001/FLX_GPP_AUX_SCNVAL_20190926T102557_20190926T102638_001.LRE_.XML byte 889
<?xml version ="1.0" encoding="UTF-8"?>
<ScenePars>
  <MJD>7208.43</MJD>
  <POO>136.777</POO>
  <latitude>42.9292</latitude>
  <longitude>1.42793</longitude>
  <nGCPs>19</nGCPs>
  <Noutliers>5</Noutliers>
  <chisqdf>0.013742</chisqdf>
  <rmsErrIn>5.48081e-05</rmsErrIn>
  <rmsErrOut>0.000264691</rmsErrOut>
  <epow>1</epow>
  <BaseFuncs>2</BaseFuncs>
  <nParsTot>3</nParsTot>
  <nPolyPars>0</nPolyPars>
  <ParNames> Rotx          Roty          Rotz          </ParNames>
  <ParValue> -0.001962577  -0.002104733  -0.005489754 </ParValue>
  <ParSigma> 0.01048378   0.01087183   0.2162127    </ParSigma>
  <Rotx> 1.099096e-04 -2.066529e-05  8.918496e-04</Rotx>
  <Roty> -2.066529e-05  1.181967e-04 -1.078890e-03</Roty>
  <Rotz> 8.918496e-04 -1.078890e-03  4.674792e-02</Rotz>
  <InputNames> FLX_GPP_ANC_ATTRES_20190926T102557_20190926T102638_202
</ScenePars>
```

**Figure 4-3. Absolute location scene parameter file**

An example interband scene parameter file follows:

```
6T102638_001/FLX_GPP_AUX_SCNVAL_20190926T102557_20190926T102638_001.HRE2.XML byte 894
<?xml version="1.0" encoding="UTF-8"?>
<ScenePars>
  <MJD>7208.43</MJD>
  <POO>136.827</POO>
  <latitude>42.7477</latitude>
  <longitude>1.34892</longitude>
  <nGCPs>122</nGCPs>
  <Noutliers>10</Noutliers>
  <chisqdf>0.000278025</chisqdf>
  <rmsErrIn>8.01277e-06</rmsErrIn>
  <rmsErrOut>6.84316e-05</rmsErrOut>
  <epow>1</epow>
  <BaseFuncs>2</BaseFuncs>
  <nParsTot>3</nParsTot>
  <nPolyPars>0</nPolyPars>
  <ParNames> Rotx          Roty          Rotz          </ParNames>
  <ParValue> 7.635023e-05  0.001563175  0.006367349  </ParValue>
  <ParSigma> 0.003067212  0.003079237  0.06669245   </ParSigma>
  <Rotx> 9.407791e-06  -1.346200e-11  5.114061e-09</Rotx>
  <Roty> -1.346200e-11  9.481703e-06  -1.224779e-05</Roty>
  <Rotz> 5.114061e-09  -1.224779e-05  4.447882e-03</Rotz>
  <InputNames> FLX_GPP__ANC_ATTRES_20190926T102557_20190926T102638_202
</ScenePars>
```

Figure 4-4. Interband scene parameter file

## 4.5 L1 ANCILLARY PRODUCTS (ANC)

The overall structure of the L1 ancillary follows the FLEX FIPS/GPP L1 product specification [PDS-L1]:

- 1 XML header
- 1 data block

As specified in [PDS-L1] the data block of the FLEX ancillary products is a NetCDF file. For restituted Orbit and Attitude ancillary files the data block is embedded in a single XML file including the header [EOCFI-FFS].

### 4.5.1 L1 ANC: Rotation matrices and Line Of Sight (ROTLOS)

Example:

```
- FLX_GPP__ANC_ROTLOS_20190621T001000_20190621T001006_20200110T105052__00014
|--> FLX_GPP__ANC_ROTLOS_20190621T001000_20190621T001006_20200110T105052__00014.XML
|--> FLX_GPP__ANC_ROTLOS_20190621T001000_20190621T001006_20200110T105052__00014.NC
```

Here after the table reporting the detailed content of the NetCDF data block.

Table 4-18: ANC ROTLOS NetCDF data block format description

| Group Name | Element Name | Description | Range or Value | Type | Dimension |
|------------|--------------|-------------|----------------|------|-----------|
| Instrument |              |             |                |      |           |

| Group Name                        | Element Name               | Description   | Range or Value                         | Type   | Dimension                                |
|-----------------------------------|----------------------------|---|--|--------|--|
| Geometry model                    |                            |   |  |        |  |
|                                   | dim_flex_ACT_pixels_binned | The number binned samples in across track direction | 536                                    |        |  |
|                                   | directions                 | Directions  | 2                                      |        |  |
|                                   | dim_rot_mat                | Rotation matrix dimension                           | 3                                      |        |  |
| Instrument Geometric model/FLORIS |                            |   |  |        |  |
|                                   | platf_to_instr_rot         | Platform to instrument rotation matrix              |  | double | dim_rot_mat<br>dim_rot_mat               |
|                                   | standard_name              | CF standard name                                    | platf_to_instr_rot                     | string | 1  |
|                                   | long_name                  | A long and more explicative name                    | Platform to instrument rotation matrix | string | 1  |
| Instrument Geometric model/LR     |                            |   |  |        |  |
|                                   | lr_los                     | LR Line Of Sight                                    |  | double | dim_flex_ACT_pixels_binned<br>directions |
|                                   | standard_name              | CF standard name                                    | lr_los                                 | string | 1  |
|                                   | long_name                  | A long and more explicative name                    | LR Line Of Sight                       | string | 1  |
|                                   | units                      | units name  | Unit vector                            | string | 1  |
| Instrument Geometric model/HR1    |                            |   |  |        |  |
|                                   | hr1_los                    | LR Line Of Sight                                    |  | double | dim_flex_ACT_pixels_binned<br>directions |
|                                   | standard_name              | CF standard name                                    | hr1_los                                | string | 1  |
|                                   | long_name                  | A long and more explicative name                    | HR1 Line Of Sight                      | string | 1  |
|                                   | units                      | units name  | Unit vector                            | string | 1  |
| Instrument Geometric model/HR2    |                            |   |  |        |  |
|                                   | hr2_los                    | HR2 Line Of Sight                                   |  | double | dim_flex_ACT_pixels_binned<br>directions |
|                                   | standard_name              | CF standard name                                    | hr2_los                                | string | 1  |
|                                   | long_name                  | A long and more explicative name                    | HR2 Line Of Sight                      | string | 1  |
|                                   | units                      | units name  | Unit vector                            | string | 1  |

## 4.5.2 L1 ANC: Restituted Attitude Quaternion file (ATTRES)

Example:

- FLX\_GPP\_\_ANC\_ATTRES\_20190621T001000\_20190621T001006\_20200110T105028\_\_00014.XML

The content of this file follows the format described in [EOCFI-FFS] and tailored for FLEX as described in [PDS-L1].

## 4.5.3 L1 ANC: Restituted Orbit State Vector file (ORBRES)

Example:

- FLX\_GPP\_\_ANC\_ORBRES\_20190621T001000\_20190621T001006\_20200110T105028\_\_00014.XML

The content of this file follows the format described in [EOCFI-FFS] and tailored for FLEX as described in [PDS-L1].

# 4.6 L1 BREAK-POINT PRODUCTS

## 4.6.1 L1BPP break-point products

The overall structure of the L1 breakpoint products generated by the L1BPP module follows the FLEX FIPS/GPP L1 product specification [PDS-L1]:

- 1 XML header
- 3 data blocks corresponding to the 3 detectors LR, HR1 and HR2

As specified in [PDS-L1] the data blocks of the FLEX ancillary products are NetCDF files.

Example:

```
- FLX_GPP__BRK_LGEO01_20190305T133000_20190305T133009_20190927T091740__00015
|--> FLX_GPP__BRK_LGEO01_20190305T133000_20190305T133009_20190927T091740__00015.XML
|--> FLX_GPP__BRK_LGEO01_20190305T133000_20190305T133009_20190927T091740__00015.LRE_NC
|--> FLX_GPP__BRK_LGEO01_20190305T133000_20190305T133009_20190927T091740__00015.HRE1.NC
|--> FLX_GPP__BRK_LGEO01_20190305T133000_20190305T133009_20190927T091740__00015.HRE2.NC
```

The next table reports the list and a brief description of the semantic descriptors of each L1BPP break-point:

**Table 4-19: L1BPP BRK semantic descriptors**

| Semantic Descriptor<br><XXXXXX> | Description  |
|---------------------------------|--|
| BRK_L1A                         | Break-point file characterizing the L1A product (see next section)                     |
| BRK_L0                          | Break-point including only the ingested L0 DN in spatial dimension channel by channel, |

|                   |   |
|-------------------|---|
|                   | plus time stamps and TM metadata.   |
| <b>BRK_LGEO01</b> | Break-point including only localization info (no measurement data are available)  |
| <b>BRK_LCLS01</b> | The L1B processing was stopped just after the first quality flagging. Break-point includes the common_quality_flags, filled for land/water, fresh inland, tidal regions, coastline and sun glint.   |
| <b>BRK_LCLS02</b> | The L1B processing was stopped just after the bright pixels detection and flagging. Break-point includes the common_quality_flags fully filled.   |
| <b>BRK_LDEF01</b> | The L1B processing was stopped just after the defective pixel flagging. Break-point includes the channel_quality_flags fully filled.  |
| <b>BRK_LOFC01</b> | The L1B processing was stopped just before the offset correction (GPP-ATBD-L1BPP-3 in [GPP-ATBD]). Break-point includes the values of the offset correction terms and the digital numbers (FLORIS_SSS_DN) of each spectral channels at this stage of the processing.  |
| <b>BRK_LNLI01</b> | The L1B processing was stopped just before the Non-linearity correction (GPP-ATBD-L1BPP-4 in [GPP-ATBD]). Break-point includes non-linearity gains and biases, and the digital numbers (FLORIS_SSS_DN) of each spectral channels at this stage of the processing.   |
| <b>BRK_LDRK01</b> | The L1B processing was stopped just before the dark signal correction (GPP-ATBD-L1BPP-5 in [GPP-ATBD]). Break-point includes the dark offset correction terms, and the digital numbers (FLORIS_SSS_DN) of each spectral channels at this stage of the processing.   |
| <b>BRK_LSME01</b> | The L1B processing was stopped just before the Smearing signal correction (GPP-ATBD-L1BPP-6 in [GPP-ATBD]). Break-point includes the smearing correction terms, and the digital numbers (FLORIS_SSS_DN) of each spectral channels at this stage of the processing.  |
| <b>BRK_LSTR01</b> | The L1B processing was stopped just before the HRSPE straylight correction (GPP-ATBD-L1BPP-7 in [GPP-ATBD]). Break-point includes HRSPE straylight correction terms, and the spectrally un-binned and interpolated data cube in input to this stage of the processing.  |
| <b>BRK_LSTR02</b> | The L1B processing was stopped after the HRSPE straylight correction, and just before the TEL straylight correction (GPP-ATBD-L1BPP-7 in [GPP-ATBD]). Break-point includes TEL straylight correction terms, and the spectrally un-binned and interpolated data cube in input to this stage of the processing. |
| <b>BRK_LFFC01</b> | The L1B processing was stopped just before the Flat-Field correction (GPP-ATBD-L1BPP-8 in [GPP-ATBD]). Break-point includes flat field correction terms, and the digital numbers (FLORIS_SSS_DN) of each spectral channels at this stage of the processing.   |
| <b>BRK_LABS01</b> | The L1B processing was stopped just before the application of the absolute radiometric calibration gains (GPP-ATBD-L1BPP-9 in [GPP-ATBD]). Break-point includes the absolute radiometric calibration gains, and the calibrated TOA radiances (FLORIS_SSS_DN) of each spectral channels.                       |

Here after the table reporting the detailed content of the NetCDF data block (valid for all the 3 detectors LR, HR1 and HR2).

The format is quite identical to L1B product, with these remarks:

The differences are in these NetCDF groups:

- "Measurement data": Compared to L1B, the measurements are the EO measurements as collected in L0 (is always valid for BRK\_L1A\_\_\_), expressed in floating point and representing the current status of data at the processing stage at which the break-point refers.
- "Annotation data": Compared to L1B no meteorological info are annotated, while other variables can be present or missing depending on the beak-point (see next table).

- "Breakpoint variables": New group foreseen for all the breakpoint files generated by the GPP modules (see [L1-PDS]). This group is thought to gather all the parameters dump from a specific break-point. Radiometric and Spectral calibration correction parameters are collected here.

**Table 4-20: BRK NetCDF data block format description**

| Group Name                    | Element Name  | Description  | Range or Value                           | Type   | Dimension   |
|-------------------------------|---|--|--|--------|---|
|                               | number_of_spectral_channels   | Number of spectral channels (binned)   | HR1: 140<br>HR2: 269<br>LR: 235          |        |   |
|                               | number_of_along_track_samples   | Number of rows in the product image  |  |        |   |
|                               | number_of_across_track_samples  | Number of columns in the product image   | 536                                      |        |   |
| Measurement data              | This NetCDF group is missing for these breakpoints:<br><br>- BRK_LGEO01<br>- BRK_STRL01<br>- BRK_STRL02 |  |  |        |   |
|                               | FLORIS_SSS_DN   | DN for the current spectral channel SSS<br><br>Note:<br>There is one variable for each spectral channel.<br><br>It represents TOA radiances [mW/m2/sr/nm] only for these break-pints:<br><br>- BRK_L1A__ |  | float  | number_of_along_track_samples<br>number_of_across_track_samples |
|                               | standard_name   | CF standard name   | Digital Number                           | string | 1   |
|                               | long_name   | A long and more explicative name   | DN for FLEX <XX[X]> spectral channel SSS | string | 1   |
|                               | scale_factor  | Scaling factor used in decoding packed data  |  | float  | 1   |
|                               | add_offset  | Offset used to in decoding packed data   |  | float  | 1   |
| Annotation data               |   |  |  |        |   |
| Annotation data/Quality flags | Same content of the L1B products 4.1.<br><br>This NetCDF  |  |  |        |   |

| Group Name                                 | Element Name  | Description   | Range or Value | Type | Dimension |
|--|---|---|----------------|------|-----------|
|  | group is missing for these breakpoints:<br><br>- BRK_LGEO01<br>- BRK_LO_____  |   |                |      |           |
| Annotation data/Time coordinates           | Same content of the L1B products 4.1.   |   |                |      |           |
| Annotation data/Geolocation coordinates    | Same content of the L1B products 4.1.   |   |                |      |           |
| Annotation data/Geometry                   | Same content of the L1B products 4.1.   |   |                |      |           |
| Annotation data/Meteorological information | This NetCDF group is present only for BRK_L1A____.<br><br>Same content of the L1B products 4.1.                       |   |                |      |           |
| Annotation data/Instrumental information   | Same content of the L1B products 4.1.   |   |                |      |           |
| Annotation data/Processing executed        | Same content of the L1B products 4.1.<br><br>This NetCDF group is missing for these breakpoints:<br><br>- BRK_LO_____ |   |                |      |           |
| Breakpoint variables                       |   |   |                |      |           |
| Breakpoint variables/L1B Corrections       |   |   |                |      |           |
|  | number_of_sl_in terp_spectral_pixels  | Number of samples of the interpolated spectrum used in SL processing. | 1430           |      |           |

| Group Name | Element Name                        | Description   | Range or Value   | Type | Dimension |
|------------|-------------------------------------|---|------------------|------|-----------|
|            |                                     | Note:<br>This NetCDF dimension is defined only for SL breakpoints and only in *.HRE1.NC file:<br><br>- BRK_LSTR01<br>- BRK_LSTR02   |                  |      |           |
|            | number_of_sl_along_track_samples    | Number of frames for which the SL correction coefficients have been estimated.<br><br>Note:<br>This NetCDF dimension is defined only for SL breakpoints and only in *.HRE1.NC file:<br><br>- BRK_LSTR01<br>- BRK_LSTR02 | 580              |      |           |
|            | number_of_sl_across_track_samples   | Number of across track samples used used in SL processing.<br><br>Note:<br>This NetCDF dimension is defined only for SL breakpoints and only in *.HRE1.NC file:<br><br>- BRK_LSTR01<br>- BRK_LSTR02                     | 530 <sup>1</sup> |      |           |
|            | number_of_hr1_sl_interp_band_limits | Number of indices indicating the position of the boundaries of the HR1 spectral bands in the interpolated spectrum, used in SL processing. Always an even number.<br><br>Note:  | 2                |      |           |

<sup>1</sup> 530 is the TBC size matching the ACT size of the SL Kernels provided by LDO.

| Group Name | Element Name                        | Description   | Range or Value | Type | Dimension |
|------------|-------------------------------------|---|----------------|------|-----------|
|            |                                     | <p>This NetCDF dimension is defined only for SL breakpoints and only in *.HRE1.NC file:</p> <ul style="list-style-type: none"> <li>- BRK_LSTR01</li> <li>- BRK_LSTR02</li> </ul>  |                |      |           |
|            | number_of_hr2_sl_interp_band_limits | <p>Number of indices indicating the position of the boundaries of the HR2 spectral bands in the interpolated spectrum, used in SL processing. Always an even number.</p> <p>Note:<br/>This NetCDF dimension is defined only for SL breakpoints and only in *.HRE1.NC file:</p> <ul style="list-style-type: none"> <li>- BRK_LSTR01</li> <li>- BRK_LSTR02</li> </ul> | 2              |      |           |
|            | number_of_lr_sl_interp_band_limits" | <p>Number of indices indicating the position of the boundaries of the LR spectral bands in the interpolated spectrum, used in SL processing. Always an even number.</p> <p>Note:<br/>This NetCDF dimension is defined only for SL breakpoints and only in *.LRE_.NC file:</p> <ul style="list-style-type: none"> <li>- BRK_LSTR01</li> <li>- BRK_LSTR02</li> </ul>  | 4              |      |           |
|            | sl_range                            | <p>Note:<br/>This NetCDF dimension is defined only for SL breakpoints and only in *.HRE1.NC file:</p> <ul style="list-style-type: none"> <li>- BRK_LSTR01</li> </ul>  | 2              |      |           |

| Group Name | Element Name             | Description  | Range or Value              | Type   | Dimension  |
|------------|--------------------------|--|-----------------------------|--------|--|
|            |                          | - BRK_LSTR02   |                             |        |  |
|            | offset_correction        | Offset correction (ofc).<br>$DN_{out} = D_{in} - ofc$<br><br>This NetCDF variable is present only for these breakpoints:<br><br>- BRLK_L1A____<br>- BRK_LOFC01                   |                             | double | number_of_spectral_channels<br>number_of_along_track_samples<br>number_of_across_track_samples |
|            | standard_name            | CF standard name   | non_linearity_gain          | string | 1  |
|            | long_name                | A long and more explicative name   | Non linearity gain factors. | string | 1  |
|            | non_linearity_gain       | Non linearity gain factors (nlg)<br><br>$DN_{out} = D_{in} * nlg + nlb$<br><br>This NetCDF variable is present only for these breakpoints:<br><br>- BRLK_L1A____<br>- BRK_LNLI01 |                             | double | number_of_spectral_channels<br>number_of_along_track_samples<br>number_of_across_track_samples |
|            | standard_name            | CF standard name   | non_linearity_gain          | string | 1  |
|            | long_name                | A long and more explicative name   | Non linearity gain factors. | string | 1  |
|            | non_linearity_biases     | Non linearity biases (nlb)<br><br>$DN_{out} = D_{in} * nlg + nlb$<br><br>This NetCDF variable is present only for these breakpoints:<br><br>- BRLK_L1A____<br>- BRK_LNLI01       |                             | double | number_of_spectral_channels<br>number_of_along_track_samples<br>number_of_across_track_samples |
|            | standard_name            | CF standard name   | non_linearity_biases        | string | 1  |
|            | long_name                | A long and more explicative name   | Non linearity biases.       | string | 1  |
|            | dark_offset_coefficients | Dark offset coefficients (dkc).  |                             | double | number_of_spectral_channels  |

| Group Name | Element Name              | Description   | Range or Value            | Type   | Dimension   |
|------------|---------------------------|---|---------------------------|--------|---|
|            |                           | <p>DNout = Din – dkc</p> <p>This NetCDF variable is present only for these breakpoints:</p> <ul style="list-style-type: none"> <li>- BRLK_L1A___</li> <li>- BRK_LDRK01</li> </ul>   |                           |        | <p>number_of_along_track_samples</p> <p>number_of_across_track_samples</p>                                    |
|            | standard_name             | CF standard name  | dark_offset_coefficients  | string | 1   |
|            | long_name                 | A long and more explicative name  | Dark offset coefficients. | string | 1   |
|            | smear_offset_coefficients | <p>Smearing signal correction coefficients (smc)</p> <p>DNout = DNin – smc</p> <p>This NetCDF variable is present only for these breakpoints:</p> <ul style="list-style-type: none"> <li>- BRLK_L1A___</li> <li>- BRK_LSME01</li> </ul>   |                           | double | <p>number_of_spectral_channels</p> <p>number_of_along_track_samples</p> <p>number_of_across_track_samples</p> |
|            | standard_name             | CF standard name  | smear_offset_coefficients | string | 1   |
|            | wvl_sl_interp             | <p>Wavelengths of the interpolated spectrum used in SL processing.</p> <p>Note:<br/>This NetCDF variable is defined only in *.HRE1.NC file and only for these breakpoints:</p> <ul style="list-style-type: none"> <li>- BRK_L1A___</li> <li>- BRK_LSTR01</li> <li>- BRK_LSTR02</li> </ul> |                           | float  | number_of_sl_interp_spectral_pixels   |
|            | standard_name             | CF standard name  | wvl_sl_interp             | string | 1   |
|            | long_name                 | A long and more explicative name  | Interpolated wavelengths  | string | 1   |
|            | wvl_sl_interp_hr1_limits  | <p>0-relative indices in wvl_sl_interp array. They are a list of pairs pointing the boundaries of HR1 bands.</p> <p>Note:</p>   |                           | uint   | number_of_hr1_sl_interp_band_limits   |

| Group Name | Element Name             | Description   | Range or Value                                    | Type   | Dimension                           |
|------------|--------------------------|---|---|--------|-------------------------------------|
|            |                          | This NetCDF variable is defined only in *.HRE1.NC file and only for these breakpoints:<br><br>- BRK_L1A____<br>- BRK_LSTR01<br>- BRK_LSTR02   |   |        |                                     |
|            | standard_name            | CF standard name  | wvl_sl_interp_hr1_limits                          | string | 1                                   |
|            | long_name                | A long and more explicative name  | Indices in wvl_sl_interp bounding HR1 wavelengths | string | 1                                   |
|            | wvl_sl_interp_hr2_limits | 0-relative indices in wvl_sl_interp array. They are a list of pairs pointing the boundaries of HR2 bands.<br><br>Note:<br>This NetCDF variable is defined only in *.HRE1.NC file and only for these breakpoints:<br><br>- BRK_L1A____<br>- BRK_LSTR01<br>- BRK_LSTR02 |   | uint   | number_of_hr1_sl_interp_band_limits |
|            | standard_name            | CF standard name  | wvl_sl_interp_hr2_limits                          | string | 1                                   |
|            | long_name                | A long and more explicative name  | Indices in wvl_sl_interp bounding HR2 wavelengths | string | 1                                   |
|            | processed_frames_limits  | 0-relative indices of first and last frame that have been corrected for Straylight signal.<br><br>Note:<br>This NetCDF variable is defined only in *.HRE1.NC file and only for these breakpoints:<br><br>- BRK_L1A____<br>- BRK_LSTR01<br>- BRK_LSTR02                |   | uint   | sl_range                            |

| Group Name | Element Name            | Description   | Range or Value   | Type   | Dimension  |
|------------|-------------------------|---|--|--------|--|
|            | standard_name           | CF standard name  | processed_frames_limits  | string | 1  |
|            | long_name               | A long and more explicative name  | Indices (0-relative) of first and last frames corrected for Straylight | string | 1  |
|            | wvl_sl_interp_lr_limits | 0-relative indices in wvl_sl_interp array. They are a list of pairs pointing the boundaries of LR bands.<br><br>Note:<br>This NetCDF variable is defined only in *.HRE1.NC file and only for these breakpoints:<br><br>- BRK_L1A___<br>- BRK_LSTR01<br>- BRK_LSTR02 |  | uint   | number_of_lr_sl_interp_band_limits   |
|            | standard_name           | CF standard name  | wvl_sl_interp_lr_limits  | string | 1  |
|            | long_name               | A long and more explicative name  | Indices in wvl_sl_interp bounding LR wavelengths                       | string | 1  |
|            | hrspe_sl_in             | Spectrally un-binned and interpolated data cube in input to the SL HRSPE processing stage.<br><br>Note:<br>This NetCDF variable is defined only in *.HRE1.NC file and only for these breakpoints:<br><br>- BRK_L1A___<br>- BRK_LSTR01                               |  | float  | number_of_sl_along_track_samples<br>number_of_sl_across_track_samples<br>number_of_sl_interp_spectral_pixels |
|            | standard_name           | CF standard name  | hrspe_sl_in  | string | 1  |
|            | long_name               | A long and more explicative name  | Input to the straylight HRSPE signal correction (spectrally unbinned)  | string | 1  |
|            | tel_sl_in               | Spectrally un-binned  |  | float  | number_of_   |

| Group Name | Element Name      | Description   | Range or Value  | Type   | Dimension  |
|------------|-------------------|---|---|--------|--|
|            |                   | and interpolated data cube in input to the SL TEL processing stage.<br><br>Note:<br>This NetCDF variable is defined only in *.HRE1.NC file and only for these breakpoints:<br><br>- BRK_L1A____<br>- BRK_LSTR02             |   |        | sl_along_track_samples<br>number_of_sl_across_track_samples<br>number_of_sl_interp_spectral_pixels           |
|            | standard_name     | CF standard name  | tel_sl_in   | string | 1  |
|            | long_name         | A long and more explicative name  | Input to the straylight TEL signal correction (spectrally unbinned) | string | 1  |
|            | hrspe_sl_cor      | HRSPE straylight signal correction coefficients (smc)<br><br>DNout = DNin – smc<br><br>Note:<br>This NetCDF variable is defined only in *.HRE1.NC file and only for these breakpoints:<br><br>- BRK_L1A____<br>- BRK_LSTR01 |   | float  | number_of_sl_along_track_samples<br>number_of_sl_across_track_samples<br>number_of_sl_interp_spectral_pixels |
|            | standard_name     | CF standard name  | hrspe_sl_cor  | string | 1  |
|            | long_name         | A long and more explicative name  | HRSPE straylight signal correction coefficients                     | string | 1  |
|            | tel_sl_outfld_cor | TEL Out-field straylight signal correction coefficients (smc)<br><br>DNout = DNin – smc<br><br>Note:<br>This NetCDF variable is defined only in *.HRE1.NC file and only for these breakpoints:                              |   | float  | number_of_sl_along_track_samples<br>number_of_sl_across_track_samples<br>number_of_sl_interp_spectral_pixels |

| Group Name | Element Name           | Description   | Range or Value  | Type   | Dimension  |
|------------|------------------------|---|---|--------|--|
|            |                        | - BRK_L1A____<br>- BRK_LSTR01<br>- BRK_LSTR02   |   |        |  |
|            | standard_name          | CF standard name  | tel_sl_outfld_c<br>or   | string | 1  |
|            | long_name              | A long and more<br>explicative name   | TEL out-field<br>straylight<br>signal<br>correction<br>coefficients | string | 1  |
|            | tel_sl_infld_cor       | TEL In-field straylight<br>signal correction<br>coefficients (smc)<br><br>DNout = DNin – smc<br><br>Note:<br>This NetCDF variable is<br>defined only in<br>*.HRE1.NC file and only<br>for these breakpoints:<br><br>- BRK_L1A____<br>- BRK_LSTR02 |   | float  | number_of_<br>sl_along_tra<br>ck_samples<br>number_of_<br>sl_across_tr<br>ack_samples<br>number_of_<br>sl_interp_sp<br>ectral_pixels |
|            | standard_name          | CF standard name  |   | string | 1  |
|            | long_name              | A long and more<br>explicative name   | TEL in-field<br>straylight<br>signal<br>correction<br>coefficients  | string | 1  |
|            | long_name              | A long and more<br>explicative name   | Smearing<br>signal<br>correction<br>coefficients                    | string | 1  |
|            | ff_offset_coefficients | Flat Field correction<br>coefficients (ffc)<br><br>DNout = DNin/ffc<br><br>This NetCDF variable is<br>present only for these<br>breakpoints:<br><br>- BRLK_L1A____<br>- BRK_LFFC01  |   | double | number_of_<br>spectral_cha<br>nnels<br>number_of_<br>across_track<br>_samples  |
|            | standard_name          | CF standard name  | smear_offset_c<br>oefficients                                       | string | 1  |
|            | long_name              | A long and more<br>explicative name   | Flat Field<br>correction  | string | 1  |

| Group Name | Element Name  | Description   | Range or Value                          | Type   | Dimension                   |
|------------|---------------|---|---|--------|-----------------------------|
|            |               |   | coefficients                            |        |                             |
|            | abs_cal_gains | <p>Absolute Radiometric calibration gains (gain)</p> <p><math>DN_{out} = DN_{in} * gain</math></p> <p>This NetCDF variable is present only for these breakpoints:</p> <ul style="list-style-type: none"> <li>- BRLK_L1A___</li> <li>- BRK_LABS01</li> </ul> |   | double | number_of_spectral_channels |
|            | standard_name | CF standard name  | abs_cal_gains                           | string | 1                           |
|            | long_name     | A long and more explicative name  | Absolute Radiometric calibration gains. | string | 1                           |

## 4.6.2 RSCM break-point products

The next table reports the list and a brief description of the semantic descriptors of each RSCM break-point:

**Table 4-21: RSCM BRK semantic descriptors**

| Semantic Descriptor<br><XXXXXX> | Description   |
|---------------------------------|---|
| <b>BRK_SUN_01</b>               | Break-point file generated when the RSCM receives in input an L0_SUN___ product and apply the SUN ARG Radiometric Calibration processing [GPP-ATBD]. It includes several parameters usefull for debugging, computed during the processing and not included in the RAC product.                |
| <b>BRK_DARK01</b>               | Break-point file generated when the RSCM receives in input an L0_DARK* or L0_DRK* products and apply the Dark Signal Radiometric Calibration processing [GPP-ATBD]. It includes several parameters usefull for debugging, computed during the processing and not included in the RAC product. |

### 4.6.2.1 BRK\_SUN\_01

The overall structure of this breakpoint product generated by the RSCM module follows the FLEX FIPS/GPP L1 product specification [PDS-L1]:

- 1 XML header
- 3 data blocks corresponding to the 3 detectors LR, HR1 and HR2

As specified in [PDS-L1] the data blocks of the FLEX ancillary products are NetCDF files.

Example:

```
- FLX_GPP_BRK_SUN_01_20190926T103613_20190926T103618_20211112T171326_18431
/--> FLX_GPP_BRK_SUN_01_20190926T103613_20190926T103618_20211112T171326_18431.XML
/--> FLX_GPP_BRK_SUN_01_20190926T103613_20190926T103618_20211112T171326_18431.LRE.NC
/--> FLX_GPP_BRK_SUN_01_20190926T103613_20190926T103618_20211112T171326_18431.HRE1.NC
/--> FLX_GPP_BRK_SUN_01_20190926T103613_20190926T103618_20211112T171326_18431.HRE2.NC
```

Here after the table reporting the detailed content of the NetCDF data block (valid for all the 3 detectors LR, HR1 and HR2).

| Group Name           | Element Name                    | Description  | Range or Value   | Type   | Dimension  |
|----------------------|---------------------------------|--|--|--------|--|
|                      | number_of_spectral_channels     | Number of spectral channels (binned)   | HR1: 140<br>HR2: 269<br>LR: 235  |        |  |
|                      | number_of_along_track_samples   | Number of rows in the product image  |  |        |  |
|                      | number_of_across_track_samples  | Number of columns in the product image   | 536  |        |  |
| Breakpoint variables |                                 |  |  |        |  |
|                      | Earth_Sun_Distance              |  |  | double | number_of_along_track_samples  |
|                      | standard_name                   | CF standard name   | Earth_Sun_Distance   | string | 1  |
|                      | long_name                       | A long and more explicative name   | Earth-Sun Distance   | string | 1  |
|                      | units                           | units name   | meters   | string | 1  |
|                      | SI_seasonal_factor              | SI's correction seasonal factor ( $(SI\_Reference\_Earth\_Sun\_Distance/Earth\_Sun\_Distance)^2$ ) |  | double | number_of_along_track_samples  |
|                      | standard_name                   | CF standard name   | SI_seasonal_factor   | string | 1  |
|                      | long_name                       | A long and more explicative name   | SI's correction seasonal factor ( $(SI\_Reference\_Earth\_Sun\_Distance/Earth\_Sun\_Distance)^2$ ) | string | 1  |
|                      | SI_Reference_Earth_Sun_Distance | SI's Reference Eart-Sun distance.  |  | string | 1  |
|                      | L_cal                           | Radiance from the solar diffuser   |  | double | number_of_along_track_samples<br>number_of_across_track_samples<br>number_of_spectral_channels |

| Group Name | Element Name  | Description  | Range or Value                                      | Type   | Dimension  |
|------------|---------------|--|---|--------|--|
|            |               |  |   |        | nnels  |
|            | standard_name | CF standard name   | L_cal   | string | 1  |
|            | long_name     | A long and more explicative name                                   | Radiance from the solar diffuser                    | string | 1  |
|            | units         | units name   | mW.m-2.nm-1.sr-1                                    | string | 1  |
|            | BRDF          | Sun Bidirectional Reflectance Distribution Function                |   | double | number_of_along_track_samples<br>number_of_across_track_samples<br>number_of_spectral_channels |
|            | standard_name | CF standard name   | BRDF  | string | 1  |
|            | long_name     | A long and more explicative name                                   | Sun Bidirectional Reflectance Distribution Function | string | 1  |
|            | units         | units name   | sr-1  | string | 1  |
|            | DN_L0         | DNs read from L0   |   | float  | number_of_along_track_samples<br>number_of_across_track_samples<br>number_of_spectral_channels |
|            | standard_name | CF standard name   | DN_L0   | string | 1  |
|            | long_name     | A long and more explicative name                                   | DNs read from L0                                    | string | 1  |
|            | units         | units name   | DN  | string | 1  |
|            | DN_corr       | DN corrected radiometrically, input to the SUN ARG core algorithm. |   | float  | number_of_along_track_samples<br>number_of_across_track_samples                                |
|            | standard_name | CF standard name   | DN_corr   | string | 1  |
|            | long_name     | A long and more explicative name                                   | DNs radiometrically corrected                       | string | 1  |
|            | units         | units name   | DN  | string | 1  |

#### 4.6.2.2 BRK\_DARK01

The overall structure of this breakpoint product generated by the RSCM module follows the FLEX FIPS/GPP L1 product specification [PDS-L1]:

- 1 XML header
- 3 data blocks corresponding to the 3 detectors LR, HR1 and HR2

As specified in [PDS-L1] the data blocks of the FLEX ancillary products are NetCDF files.

Example:

```
- FLX_GPP_BRK_DARK01_20190926T103613_20190926T103618_20211111T163038_18431
|--> FLX_GPP_BRK_DARK01_20190926T103613_20190926T103618_20211111T163038_18431.XML
|--> FLX_GPP_BRK_DARK01_20190926T103613_20190926T103618_20211111T163038_18431.NC
|--> FLX_GPP_BRK_DARK01_20190926T103613_20190926T103618_20211111T163038_18431.HRE1.NC
|--> FLX_GPP_BRK_DARK01_20190926T103613_20190926T103618_20211111T163038_18431.HRE2.NC
```

Here after the table reporting the detailed content of the NetCDF data block (valid for all the 3 detectors LR, HR1 and HR2).

| Group Name           | Element Name                   | Description                            | Range or Value                  | Type   | Dimension  |
|----------------------|--------------------------------|--|---------------------------------|--------|--|
|                      | number_of_spectral_channels    | Number of spectral channels (binned)   | HR1: 140<br>HR2: 269<br>LR: 235 |        |  |
|                      | number_of_along_track_samples  | Number of rows in the product image    |                                 |        |  |
|                      | number_of_across_track_samples | Number of columns in the product image | 536                             |        |  |
| Breakpoint variables |                                |  |                                 |        |  |
|                      | DN_L0                          | DNs read from L0                       |                                 | float  | number_of_spectral_channels<br>number_of_along_track_samples<br>number_of_across_track_samples |
|                      | standard_name                  | CF standard name                       | DN_L0                           | string | 1  |
|                      | long_name                      | A long and more explicative name       | DNs read from L0                | string | 1  |
|                      | units                          | units name                             | DN                              | string | 1  |
|                      | DN_L0_MEAN                     | DNs read from L0                       |                                 | float  | number_of_across_track_samples<br>number_of_spectral_channels                                  |
|                      | standard_name                  | CF standard name                       | DN_L0_MEAN                      | string | 1  |
|                      | long_name                      | A long and more explicative name       | DNs read from L0 MEAN in        | string | 1  |

| Group Name | Element Name         | Description                      | Range or Value              | Type   | Dimension   |
|------------|----------------------|----------------------------------|-----------------------------|--------|---|
|            |                      |                                  | ALT direction               |        |   |
|            | units                | units name                       | DN                          | string | 1   |
|            | offset_correction    | Offset correction biases         |                             | double | number_of_across_track_samples<br>number_of_spectral_channels |
|            | standard_name        | CF standard name                 | offset_correction           | string | 1   |
|            | long_name            | A long and more explicative name | Offset correction biases    | string | 1   |
|            | non_linearity_gain   | NL Transfer function gains       |                             | double | number_of_across_track_samples<br>number_of_spectral_channels |
|            | standard_name        | CF standard name                 | non_linearity_gain          | string | 1   |
|            | long_name            | A long and more explicative name | NL Transfer function gains  | string | 1   |
|            | non_linearity_biases | NL Transfer function biases      |                             | double | number_of_across_track_samples<br>number_of_spectral_channels |
|            | standard_name        | CF standard name                 | non_linearity_biases        | string | 1   |
|            | long_name            | A long and more explicative name | NL Transfer function biases | string | 1   |

Note:

Other metadata and/or break-point semantic descriptors could be added.

### 4.6.3 GCM break-point products

TBW

### 4.6.4 OSPC break-points products

The overall structure of this breakpoint product generated by the OSPC module follows the FLEX FIPS/GPP L1 product specification [PDS-L1]:

- 1 XML header

- 3 data blocks corresponding to the 3 detectors LR, HR1 and HR2

As specified in [PDS-L1] the data blocks of the FLEX ancillary products are NetCDF files.

Example:

```
- FLX_GPP_BRK_OSPCEO_20190926T103613_20190926T103618_20211111T163038_18431
/--> FLX_GPP_BRK_OSPCEO_20190926T103613_20190926T103618_20211111T163038_18431.XML
/--> FLX_GPP_BRK_OSPCEO_20190926T103613_20190926T103618_20211111T163038_18431.HRE1.NC
/--> FLX_GPP_BRK_OSPCEO_20190926T103613_20190926T103618_20211111T163038_18431.HRE2.NC
/--> FLX_GPP_BRK_OSPCEO_20190926T103613_20190926T103618_20211111T163038_18431.LRE.NC
```

Here after the table reporting the detailed content of the NetCDF data block (valid for all the 3 detectors LR, HR1 and HR2).

| Group Name       | Element Name                   | Description  | Range or Value   | Type   | Dimension  |
|------------------|--------------------------------|--|--|--------|--|
|                  | number_of_across_track_samples | Number of across track samples   | 524  |        |  |
|                  | number_of_spectral_features    |  | HR1: 1<br>HR2: 1<br>LR: 1  |        |  |
|                  | number_of_inputs               |  |  |        |  |
|                  | number_of_coefficients         |  | 6  |        |  |
|                  | number_of_fitting_parameters   |  | 3  |        |  |
| Measurement data |                                |  |  |        |  |
|                  | number_of_DSL_polynomial_coeff | Number of DSL-dependent coefficients                                     | 2  |        | 1  |
|                  | number_of_TOE_coeff            | Number of TOE-dependent coefficients                                     | 2  |        | 1  |
|                  | number_of_DOY_coeff            | Number of DOY-dependent coefficients                                     | 2  |        | 1  |
|                  | model_coeff                    | The coefficients computed from fitting the model to the input SPCEO data |  | float  | number_of_across_track_samples<br>number_of_coefficients |
|                  | standard_name                  | CF standard name   | model_coeff  | string | 1  |
|                  | long_name                      | A long and more explicative name   | The (number_of_coefficients = number_of_DSL_polynomial_coeff + number_of_TOE_coeff + number_of_DOY_coeff) model's coefficients for | string | 1  |

| Group Name                       | Element Name                          | Description  | Range or Value  | Type   | Dimension  |
|----------------------------------|---------------------------------------|--|---|--------|--|
|                                  |                                       |  | each across track pixel   |        |  |
| Model coefficients               |                                       |  |   |        |  |
|                                  | X_first_parameter                     | DSL values for polynomial (linear) term for the fitting model  | DSL   |        | 1  |
|                                  | X_second_parameter (units == degrees) | sin and cos DOY (3 <sup>rd</sup> term) fitting model parameter values converted to degrees                         | DOY   |        | 1  |
|                                  | X_third_parameter (units == degrees)  | sin and cos TOE (2 <sup>nd</sup> term) fitting model parameter values converted to degrees                         | TOE   |        | 1  |
|                                  | X                                     | X LS3GFit fitting coefficients used for calculation, according to X <sub>ith</sub> parameter meanings listed above |   | float  | number_of_across_track_samples<br>number_of_inputs<br>number_of_fitting_parameters |
|                                  | standard_name                         | CF standard name   | offset_correction   | string | 1  |
|                                  | long_name                             | A long and more explicative name   | X LS3GFit fitting coefficients used for calculation   | string | 1  |
|                                  | measured_shifts                       | Measured spectral shifts   |   | double | number_of_inputs<br>number_of_across_track_samples                                 |
|                                  | standard_name                         | CF standard name   | measured_shifts   | string | 1  |
|                                  | long_name                             | A long and more explicative name   | The measured shifts from input SPCEO products (misleadingly named predicted in the ATBD) used for model fitting calculation | string | 1  |
| Annotation data/Time coordinates |                                       |  |   |        |  |
|                                  | time_stamp                            | Measurement Time   |   | int64  | number_of_   |

| Group Name                          | Element Name     | Description   | Range or Value  | Type   | Dimension           |
|-------------------------------------|------------------|---|---|--------|---------------------|
|                                     |                  | Stamp for each measurement  |   |        | along_track_samples |
|                                     | standard_name    | CF standard name  | time  | string | 1                   |
|                                     | long_name        | A long and more explicative name  | Elapsed time since 01 Jan 2000 0h   | string | 1                   |
|                                     | units            |   | microseconds since 2000-01-01 00:00:00  | string | 1                   |
|                                     | _FillValue       | Default value for missing data  | -1  | int64  | 1                   |
| Annotation data/Processing executed |                  |   |   |        |                     |
|                                     | flag_dim         |   | 1   |        | 1                   |
|                                     | number_of_inputs | The number of inputs  |   |        |                     |
|                                     | input_names      | Name of the inputs used in the processing   |   | string | number_of_inputs    |
|                                     | standard_name    | CF standard name  | Input_names   | string | 1                   |
|                                     | long_name        | A long and more explicative name  | Name of the inputs used in the processing   | string | 1                   |
|                                     | shifts_smoothed  | Flag indicating if the smoothing of the measured shifts has been applied (1) or not (0) |   | ubyte  | flag_dim            |
|                                     | standard_name    | CF standard name  | shifts_smoothed   | string | 1                   |
|                                     | long_name        | A long and more explicative name  | Flag indicating if the smoothing of the measured shifts has been applied (1) or not (0) | ubyte  | 1                   |

## 4.7 L1A PRODUCTS

L1A are scientific EO data with corresponding radiometric, spectral and geometric correction and calibration computed and appended, but not applied. So L1A can be seen as an EO Level 0 plus RAD/GEO metadata.

FLEX L1A is a breakpoint of the L1B processing and not a product on its own automatically generated by the L1B.

Example:

- FLX\_GPP\_BRK\_L1A\_\_\_\_20190305T133000\_20190305T133009\_20190927T091740\_\_00015



```
/--> FLX_GPP_BRK_L1A_20190305T133000_20190305T133009_20190927T091740_00015.XML  
/--> FLX_GPP_BRK_L1A_20190305T133000_20190305T133009_20190927T091740_00015.LRE_.NC  
/--> FLX_GPP_BRK_L1A_20190305T133000_20190305T133009_20190927T091740_00015.HRE1.NC  
/--> FLX_GPP_BRK_L1A_20190305T133000_20190305T133009_20190927T091740_00015.HRE2.NC
```

As specified in [PDS-L1] the data blocks of the FLEX L1A products are NetCDF files.

The format content is that described for break-point files (see 4.6.1).



## 4.8 L1 EO/CAL DATA VOLUME

Table 4-22. L1 EO/CAL data volume

| L1 Product<br>(File Type) | Data Volume (not compressed)<br><i>Fixed + Rate*Duration ~ Size</i> |                  |                  |                   | Calibration's specs |                  |     |
|---------------------------|---|------------------|------------------|-------------------|---------------------|------------------|-----|
|                           | Fixed<br>[MB]   | Rate<br>[MB/sec] | Size<br>[MB]     | Duration<br>[sec] | Nacq                | Int.Time<br>[ms] | WOI |
| L1B_OBS                   | 3.95067   | 31.79155         | 5726.52603       | 180.003           | 4138                | 0.0428           | 1   |
| RAC_DARKNP                | 6.58387   | 8.06848          | 420.98130        | 51.36             | 1200                | 0.0428           | 1   |
| RAC_DARKOC                | 6.58387   | 8.06848          | 420.98130        | 51.36             | 1200                | 0.0428           | 1   |
| RAC_DARKSR                | 6.58387   | 8.06848          | 420.98130        | 51.36             | 1200                | 0.0428           | 1   |
| RAC_DRKMTF                | 6.58387   | 8.06848          | 41.11699         | 4.278             | 100                 | 0.0428           | 1   |
| RAC_DRKSTR                | 6.58387   | 0.71943          | 13.49049         | 9.6               | 20                  | 0.48             | 1   |
| RAC_MOON                  | 5.60386   | 15.79574         | 208.42120        | 12.84             | 300                 | 0.0428           | 1   |
| RAC_MOONSL                | 7.90688   | 6.20599          | 67.48441         | 9.6               | 20                  | 0.48             | 1   |
| RAC_SUN                   | 6.58878   | 131.70460        | 15790.06885      | 119.84            | 2800                | 0.0428           | 1   |
| RAC_DEFSUN                | 19.33447  | 0.62875          | 94.68466         | 119.84            | 700                 | 0.0428           | 4   |
| RAC_DEFDAR                | 19.33447  | 0.62875          | 94.68466         | 119.84            | 700                 | 0.0428           | 4   |
| RAC_DEFRTS                | 607.7112<br>1   | 0.00067          | 627.08697        | 28800             | 360<br>(10 x 36)    | 40000            | 2   |
| RAC_CLOUD                 | 3.96506   | 186.85323        | 467135.3224<br>0 | 2499.99080        | 58411               | 0.0214           | 2   |
| RAC_NLCAL                 | 28.96900  | 5.27084          | 2031.88991       | 380               | 4800                | variable         |     |
|                           | <i>From:</i>  |                  |                  |                   |                     |                  |     |
|                           | <i>LINDAR</i>   |                  |                  | 240               | 40 x 5              |                  | 1   |
|                           | <i>LINDES</i>   |                  |                  | 60                | 40 x 10             |                  | 2   |
|                           | <i>LINSEA</i>   |                  |                  | 20                | 40 x 5              |                  | 4   |
|                           | <i>LINSUN</i>   |                  |                  | 60                | 40 x 100            |                  | 1   |
| RAC_CTE                   | 9.23832   | 11.51169         | 1388.79993       | 119.84            | 2800                | 0.0428           | 1   |
| SPC_SPECEO                | 4.15765   | 9.20139          | 21732.37797      | 2361.40440        | 55173               | 0.0428           | 1   |
| SPC_SPECSO                | 4.15721   | 8.06848          | 966.92733        | 120               | 2800                | 0.0428           | 1   |
| GEC_SCNVAL                | 0.049   | 0                | 0.049            | Any               |                     |                  |     |
| ANC_ROTLOS                | 0.049   | 0                | 0.049            | Any               |                     |                  |     |
| ANC_ATTRES                | 0   | 0.0051           | 0.9              | 180               |                     |                  |     |
| ANC_ORBRES                | 0   | 0.0108           | 1.9              | 180               |                     |                  |     |
|                           |   |                  |                  |                   |                     |                  |     |
|                           |   |                  |                  |                   |                     |                  |     |
|                           |   |                  |                  |                   |                     |                  |     |

## ANNEX A – HEADER FILE XML AND XSD

Here after an example of Level 1 XML header

**Table 4-23. Example of a L1 XML header file**

```
<?xml version="1.0" encoding="UTF-8"?>
<Earth_Observation_File>
  <Earth_Observation_Header>
    <Fixed_Header>

<File_Name>FLX_GPP_L1B_OBS____20190914T103613_20190914T103623_20241121T114832__18260.XML</File_Name>
    <File_Description>FLEX Level L1B OBS Product</File_Description>
    <Notes></Notes>
    <Mission>FLEX</Mission>
    <File_Class>GPP_</File_Class>
    <File_Type>L1B_OBS__</File_Type>
    <Validity_Period>
      <Validity_Start>UTC=2019-09-14T10:36:13</Validity_Start>
      <Validity_Stop>UTC=2019-09-14T10:36:23</Validity_Stop>
    </Validity_Period>
    <File_Version>0001</File_Version>
    <EOFFS_Version>3.0</EOFFS_Version>
    <Source>
      <System>FLORIS</System>
      <Creator>GPP-L1BPP</Creator>
      <Creator_Version>4.0.0</Creator_Version>
      <Creation_Date>UTC=2024-11-21T11:48:32</Creation_Date>
    </Source>
  </Fixed_Header>
  <Variable_Header>
    <List_of_Data_Block_Files count="3">
      <Data_Block_File>

<File_Name>FLX_GPP_L1B_OBS____20190914T103613_20190914T103623_20241121T114832__18260.HRE1.NC
</File_Name>
      <Format>NetCDF</Format>
      <Format_Version></Format_Version>
      <Schema_Reference>N/A</Schema_Reference>
      <Byte_Order>3210</Byte_Order>
    </Data_Block_File>
      <Data_Block_File>

<File_Name>FLX_GPP_L1B_OBS____20190914T103613_20190914T103623_20241121T114832__18260.HRE2.NC
</File_Name>
      <Format>NetCDF</Format>
      <Format_Version></Format_Version>
      <Schema_Reference>N/A</Schema_Reference>
      <Byte_Order>3210</Byte_Order>
    </Data_Block_File>
      <Data_Block_File>

<File_Name>FLX_GPP_L1B_OBS____20190914T103613_20190914T103623_20241121T114832__18260.LRE_.NC
```

```

</File_Name>
  <Format>NetCDF</Format>
  <Format_Version></Format_Version>
  <Schema_Reference>N/A</Schema_Reference>
  <Byte_Order>3210</Byte_Order>
</Data_Block_File>
</List_of_Data_Block_Files>
</Variable_Header>
</Earth_Observation_Header>
</Earth_Observation_File>

```

Hereafter a possible implementation of an XSD schema valid for the FLEX L1 product header file

**Table 4-24. L1 header file XSD schema**

```

<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified">
  <xs:element name="Earth_Observation_File">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="Earth_Observation_Header">
          <xs:complexType>
            <xs:sequence>
              <xs:element name="Fixed_Header">
                <xs:complexType>
                  <xs:sequence>
                    <xs:element name="File_Name" type="xs:string"/>
                    <xs:element name="File_Description" type="xs:string"/>
                    <xs:element name="Notes" type="xs:string" minOccurs="0"/>
                    <xs:element name="Mission" type="xs:string"/>
                    <xs:element name="File_Class" type="xs:string"/>
                    <xs:element name="File_Type">
                      <xs:simpleType>
                        <xs:restriction base="xs:string">
                          <xs:length value="10"/>
                        </xs:restriction>
                      </xs:simpleType>
                    </xs:element>
                    <xs:element name="Validity_Period">
                      <xs:complexType>
                        <xs:sequence>
                          <xs:element name="Validity_Start">
                            <xs:simpleType>
                              <xs:restriction base="xs:string">
                                <xs:pattern value=".{23}"/>
                              </xs:restriction>
                            </xs:simpleType>
                          </xs:element>
                          <xs:element name="Validity_Stop">
                            <xs:simpleType>
                              <xs:restriction base="xs:string">
                                <xs:pattern value=".{23}"/>
                              </xs:restriction>
                            </xs:simpleType>
                          </xs:element>
                        </xs:sequence>
                      </xs:complexType>
                    </xs:element>
                  </xs:sequence>
                </xs:complexType>
              </xs:element>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>

```

```

</xs:complexType>
</xs:element>
<xs:element name="File_Version">
  <xs:simpleType>
    <xs:restriction base="xs:string">
      <xs:pattern value="\d{4}"/>
    </xs:restriction>
  </xs:simpleType>
</xs:element>
<xs:element name="EOFFS_Version" type="xs:string"/>
<xs:element name="Source">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="System" type="xs:string"/>
      <xs:element name="Creator" type="xs:string"/>
      <xs:element name="Creator_Version" type="xs:string"/>
      <xs:element name="Creation_Date">
        <xs:simpleType>
          <xs:restriction base="xs:string">
            <xs:pattern value=".{23}"/>
          </xs:restriction>
        </xs:simpleType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
<xs:element name="Variable_Header">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="List_of_Data_Block_Files">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="Data_Block_File" maxOccurs="unbounded">
              <xs:complexType>
                <xs:sequence>
                  <xs:element name="File_Name" type="xs:string"/>
                  <xs:element name="Format" type="xs:string"/>
                  <xs:element name="Format_Version" type="xs:string" minOccurs="0"/>
                  <xs:element name="Schema_Reference" type="xs:string"/>
                  <xs:element name="Byte_Order" type="xs:string"/>
                </xs:sequence>
              </xs:complexType>
            </xs:element>
          </xs:sequence>
          <xs:attribute name="count" type="xs:integer" use="required"/>
        </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>

```



```
</xs:element>  
</xs:sequence>  
</xs:complexType>  
</xs:element>  
</xs:schema>
```

END OF DOCUMENT