SMOS Near Real Time Processing Chain

SMOS NRT Product Format Specification

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Issue	Change description	Date	Approved
0.1	First draft issue of the document	29/08/2007	
1.0	Updated comments received during PM1	05/10/2007	
1.1	Updates for CDR: product specifications aligned with DPGS V2, included product reports, and other changes.	08/02/2008	
1.2	Added the reference to the BUFR specification in the Applicable Documents section Section “Product Reports” has been deleted. It is now in the NRTP ICD Updated section 5.7 headers to reflect product type directly Clarified instance site in section 4.1 for NRT case Removed references from operational processor in table 6 and added references to NRT case Updated table 6 , 20, 21, 22 and 23 with [-180, 180] convention for longitude Added Correlator Layer field and unified table with DPGS V2 format Corrected missing references in table 7, 24, 26 Unified table 7 with DPGS V2 format Added NRT CNF file to list of reference files in table 9 Unified table 12 with DPGS V2 format Corrected NIR Reference Data Set name in table 13 Clarified antenna boresight contents in sections 5.3.1.3.1 and 5.3.1.3.2 Unified table 14 with DPGS V2 format Updated table 15 with all Reference Data Sets from DPGS V2 format Updated L1c Reference Data Set with LSMASK to obtain water fraction Added clarification on section 5.5.1.3.2 and 5.5.1.3.3 about table contents differences in DPGS V2 format Added BUFR naming convention in section 5.5.3 Removed section 5.8 Clarified scope and mitigation action for open point in 5.8Updated AUX_CNFNRT with new values	06/05/2008	

Issue	Change description	Date	Approved
1.3	Section 4.1 changed according to comment IDR-45: REPR file class has been removed Section 4.2 changed according to comment from INDRA to version 1.2 of this document, in which they indicate a contradiction with NRT ICD concerning the distribution of NRT files. References to such distribution have been removed Section 5.5.3 changed according to comment from INDRA to version 1.2 of this document, in which they asked for a better specification of the BUFR product file name. The source for the change is the BUFR specification from ECMWF (see AD.6), which has been updated to answer the comment. New fields "L1c_Generation_Switch" and "BrowseL1c_Generation_Switch" added in the "Level1C" section of the AUX_CNFNRT file added (see Table 22: NRT Configuration File data block)	03/06/2008	
1.4	Format of fields "Start_Time_ANX_T" and "Stop_Time_ANX_T" changed from "%011.6f" to "%013.6f", following the indications from INDRA in email of 12/06/2008 Correction of references to inexistent sections 4.1.1 and 4.1.2 Corrections of some errors in the AUX_CNFNRT specification: - Format of *Validity_Period* of field *PMS_Calibration* changed to *%04f* - Completed the description of the field *Max_Sky_Rms* of *NIR_Calibration* - Units and format of the field *RMS_Threshold_for_FTT* of *Quality_Configuration* have been changed to *K* and *%06f* respectively The format of the fields *N_Invalid_Blocks* and *N_Missing_Packets* of the *SPH Quality Information* have been changed to *%09d* due to an update of the same fields in NRT L0 products, needed to be able to store the information from a long pass Reference documents RD.01, RD.02, RD.05-08 have been moved to Applicable Documents BUFR spec. version updated to 1.4	13/08/2008	

Issue	Change description	Date	Approved
1.5	Section 4.1 (from comments from ESA in email of 20/08/2008): TBD removed, since the number '6' has been agreed with INDRA for NRTP (see email from INDRA the 26/05/2008) Section 4.3.1 (from comments from ESA in email of 20/08/2008): - Added an explanation of how the field "Notes" is filled by NRTP - Added an explanation of the "Creation_Date" field - Description of AUX_CNFNRT slightly modified - Removed the "u" character at the end of the "Validity_Stop" field value in the example - "File_Version" field value changed to "0ccc" - "Creator_Version" field value changed to "vvv" - Removed the "u" character at the end of the "Creation_Date" field value in the example "Mask" field added in AUX_NRTMSK specification. In addition, explanation of the NRT mask has been added in the section 5.6.1 Small changes in AUX_CNFNRT in section 5.6.3(units, default values specified). Moreover, a column called "Internal Structure" has been added in the table, to clarify the mapping with the data structure used in the NRTP	19/09/2008	

Issue	Change description	Date	Approved
1.6	New BUFR spec. version applicable (delivered by ECMWF after testing of examples of BUFR files). Removed the discrepancy between sections 4.1 and 5.4.3 regarding the BUFR products and naming. There are no BUFR file types, so the description in section 5.4.3 prevails. Modifications of AUX_CNFNRT in section 5.6.3: - Minor changes in the format of some parameters - Addition of field Copolar_Processing (previously hard coded) - Addition of structures PMS_Sens_Calibration and FWF_Sens_Calibration, part of Calibration_Sequences (previously hard coded) - Addition of some fields not used by the system, in some Calibration_Sequences structures, only to allow a correct validation of the file using the applicable schemas Newline removed at the beginning of section **Error! Reference source not found.**	04/11/2008	
2.0	Updates required for DPGS V3 format evolution: - Generic quality information in section 5.1.2.2 - Reference Data Sets for HKTM L1a in Table 11 - Reference Data Sets for Science L1a in Table 13 - Clarification of contents in NRT Science L1a in section 5.3.1.3 - Update on L1b SPH contents in table 14 - Reference Data Sets for Science L1b in Table 15 - Reference Data Sets for Science L1c in Table 16 - Specific Quality information added to table 18 - Update of BT_Counter from byte to short in tables 19 and 20 - Removed geometric correction field from browse SPH in table 21 - Reference Data Sets for Unoise L1a in Table 24 - Reference Data Sets for Cnoise L1a in Table 26 - Reference Data Sets for NIR L1a in Table 27 - Update to NRT CNF in section 5.7.3, removed obsolete fields, clarified calibration sequences - Clarified RFI flag in section 6.2.3 for L1b and L1c data	07/11/2008	

Issue	Change description	Date	Approved
2.1	Some cross-references and references to tables in other documents fixed Correction of number of bytes of 'Start_Time_ANX_T' and 'Stop_Time_ANX_T' fields of the SPH (13 for NRT) Correction of number of bytes of 'N_Missing_Packets' and 'N_Invalid_Fields' fields of the SPH (9 for NRT) Fields 'Semiorbit_Start' and 'Semiorbit_Stop' added to the 'Time_Info' of SPH for compatibility issues with L1OP products Removed the sign '+' from the format of 'Percentage_of_Mixed_Pixels' in page 77 Missing field 'Grid_Point_Altitude' added to the spec. of Browse data block page 80 Field 'BrowseL1c_Generation_Switch' from AUX_CNFNRT spec. has been removed. The reason is that the Browse products will be triggered by Orchestrator rules Corrections of some field units	28/01/2009	
2.2	The origin of the SPH fields "Semiorbit_Start", "Semiorbit_Stop" and "Ascending_Flag" has been updated. In addition, it is clarified the meaning of "Ascending_Flag" field. The meaning of the SPH field "Percentage_of_mixed_pixels" in Browse products has been updated. The same meaning is applicable to L1C products, but in this case the description is as in the document [AD-7] "SMOS Level 1 and Auxiliary Data Products Specifications", although the version referenced v5.8 does not yet have this clarification (agreed in email of 27/04/2008 from Miguel Zapata). AUX_CNFNRT Data Block updated: ❑ New flag added to request the processor to stop after L1A or L1B processing ❑ New fields added to control the generation of intermediate products (L1A, L1B) ❑ Redundant parameters removed (Backlobes_Earth_Temperature and Backlobes_Sky_Temperature) NIR Calibration configuration removed, since NRTP does not perform NIR calibration	11/05/2009	

Issue	Change description	Date	Approved
2.3	"Open Points" section updated, since there are no open points. Name of Reference Data Set for the AUX_CNFNRT file corrected in Table 9. Tables of List of Data Sets for L1A, L1B and L1C products have been corrected. Clarifications added in some parameters of AUX_CNFNRT file: L1a/L1b/L1c_Generation_Switch, and PMS_LINEARITY_CORRECTION.	02/07/2009	
2.4	Table 4 "Logical File Names of SMOS L1 NRT Products" updated, since no telemetry or ANIR L1A files are generated by NRTP. Modifications according to alignment with L1PP 2.2 algorithms: - New values in Reflected_Sun_Correction_Type field of AUX_CNFNRT - New field Max_Sunglint_Threshold added in AUX_CNFNRT - Updated the description of Relected_Sun_Correction_Type SPH field of L1B files	06/10/2009	
2.5	Section 5.7.3 modified, Reference_Temperature_Level parameter added to AUX_CNFNRT file.	23/02/2009	
2.6	Section 5.7.3: Description of Sun Removal configuration (Direct_Sun_Correction_Type and Reflected_Sun_Correction_Type parameters of AUX_CNF_NRT) has been improved, according to NRTP-PR-116 (so this document version closes that PR)	15/03/2010	
2.7	Section 5.7.3 modified: - New parameter "RFI_Filter_u-noise_threshold" added, belonging to the Level1A section of Algorithm Configuration. - The fields "Max_Separation_Within_Step", "Max_Gap_Within_Sequence" and "Max_Sequence_Duration" have the precision increased from 4 to 5 digits. - Values of parameters updated based on AUX_CNFNRT provided by INDRA for version 340 of NRTP	07/05/2010	
2.8	Table 19, Faraday_Rotation_Angle field computation modified.	18/06/2010	
2.9	Table 20, Faraday_Rotation_Angle field computation modified.	09/08/2010	

Issue	Change description	Date	Approved
3.0	Section 5.7.3. NRTP Configuration Data Block: AUX_CNFNRT modified.	17/11/2010	
3.1	Modifications in the frame of IDEAS contract. New section created: 5.7.4 NRT Converter Configuration Data Block: AUX_CNVNRT	17/01/2011	
3.2	5.7.3 Section modified to introduce usage of AUX_CNFL1P configuration file.	28/07/2011	
3.3	New Section 5.5.4 describing light BUFR product Section 5.7.3 modified to reflect changes in AUX_NRTCNF file. New section 5.7.5 describing AUX_N256__ file Tables 19, 20 and 22: Updated reference to section 6.2.3.3 (it was wrongly referring to 5.2.3.3)	06/10/2011	
3.4	Major upgrades in all the document so as to adapt it to the current status. Section 5.2 “HKTM Data: TLM_MIRA1A” suppressed as no Telemetry data is generated by NRTP. This was planned in the past but got discontinued. Section 5.2 ”L1a Data: MIR_SCND1A, MIR_SCNF1A” now point to AD7 Section 5.5.3 “Consolidated NIR Calibration Data: MIR_ANIR1A” suppressed as no Telemetry data is generated by NRTP. This was planned in the past but got discontinued. Section 6, reworded to reflect the current situation.	21/10/2011	
3.5	Section 5.4.3 Bufre Data modified, included additional explanations on the $datatype field. Section 5.4.4 Light BUFR data modified, altering the naming convention used for the lighBUFR.	21/10/2011	
3.6	Section 5.4.4 Light BUFR data modified, small modification in the naming convention used for the lightBUFR. Fields SensingTime1 and SensingTime2 description modified so it is clearer.	21/02/2012	

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1. INTRODUCTION

1.1. Purpose and Scope

This document describes the format of the SMOS NRTP products, and is intended for NRT product users.

The document starts with a brief introduction to the SMOS L1 Near Real Time Processor in chapter 2, and then provides the generic baseline for NRT L1 Products in chapter 3.

Section 4 describes the format of the L1 Products, grouping them into sub-levels and applicability (nominal and calibration L1), but making emphasis on the final L1c formatting rather than in the intermediate outputs.

Finally, an annex in chapter 5 provides a discussion of some specific aspects of the processing, and the strategies adopted in the products contents to deal with them.

1.2. Acronyms and Abbreviations

The acronyms and abbreviations used in this document are the following ones:

Acronym	Description
AD	Aplicable Document
ADF	Auxiliary Data File
API	Application Programming Interface
BT	Brightness Temperature
BUFR	Binary Universal Form for the Representation of Meteorological data
CDR	Critical Design Review
CEC	Calibration and Expertise Centre
CFI	Customer Furnished Item
DMS	DEIMOS Space
DPGS	Data Processing Ground Segment
ECMWF	European Centre for Medium-Range Weather Forecasts
ESA	European Space Agency
HKTM	Housekeeping Telemetry
HW	Hardware
ICD	Interface Control Document
L1OP	SMOS Level 1 Operational Processor
L1PP	SMOS Level 1 Prototype Processor
NIR	Noise Injection Radiometers
NRT	Near Real Time

Acronym	Description
NRTP	Near Real Time Processor
PMS	Power Measurement System
RD	Referente Document
SMOS	Soil Moisture and Ocean Salinity
SW	Software
TBC	To Be Confirmed
TBD	To Be Defined / Decided
TN	Technical Note

2. RELATED DOCUMENTS

2.1. Applicable Documents

The following table specifies the applicable documents that shall be complied with during project development.

Table 1: Applicable documents

Ref.	Code	Title	Issue
AD.1	XSMS-GSEG-EOPG-SW-07-2002	SMOS Near Real Time Processor Statement of Work	1.0
AD.2	SO-RS-ESA-SYS-0555	SMOS Systems Requirements Document	4.2
AD.3	ECSS-E-40B	ECSS E-40 Software Engineering Standards	1B
AD.4	PE-TN-ESA-GS-001	Earth Explorer Ground Segment File Format Standard	1.4
AD.5	XSMS-GSEG-EOPG-TN-05-0006	SMOS Tailoring of the Earth Explorer File Format Standard for the SMOS Ground Segment	1.0
AD.6	SMOS_NRT_BUFR_ECMWF	SMOS NRT BUFR specification	1.9
AD.7	SO-TN-IDR-GS-0005	SMOS Level 1 and Auxiliary Data Products Specifications	5.21
AD.8	XSMS-GSEG-EOPG-SW-09-0023	Maintenance and Evolution of SMOS Instrument Processing Facilities and Data Quality Control Tools Statement f Work.	0.7
AD.9	SO-MA-IDR-GS-0004	SMOS DPGS XML Guidelines	2.0
AD.10	SO-DS-DME-L1PP-0007	SMOS L1PP Detail Processing Model L0 to L1a	2.14
AD.11	SO-DS-DME-L1PP-0008	SMOS L1PP Detail Processing Model L1a to L1b	2.14
AD.12	SO-DS-DME-L1PP-0009	SMOS L1PP Detail Processing Model L1b to L1c	2.9
AD.13	XSMS-GSEG-EOPG-TN-08-0016	SMOS L1OP-V3 Product Quality Flag Format Definition	3.0

2.2. Reference Documents

The following table specifies the reference documents that have been taken into account during project development.

Table 2: Reference documents

Ref.	Code	Title	Issue
RD.01	SO-IS-DME-L1PP-0003	SMOS L1PP Auxiliary Data File Format	*2.2*
RD.02	SMOS-DMS-TN-5200	SMOS L1 Processor Discrete Global Grids Document	*1.4*
RD.03	SO-TN-IDR-GS-0004	Technical Note on SMOS DPGS Products Consolidation	*1.0*
RD.04	SMOS-DMS-TN-5100	SMOS L1 Strip Adaptive Results	*1.2*
RD.05	SO-DS-DMS-GS-0001	SMOS NRT Detailed Processing Model	*1.3*

Table 3: Reference articles

Ref.	Article
RA.01	*Sun Effects in 2-D Aperture Synthesis Radiometry Imaging and Their Cancellation* (A. Camps, M. Vall-llossera, N. Duffo, M. Zapata, I. Corbella, F. Torres, and V. Barrena), IEEE Transactions on Geoscience and Remote Sensing, 42 (6): 1161-1167. ISSN: 0196-2892, 2004
RA.02	*Introduction to Two-dimensional Aperture Synthesis Microwave Radiometry for Earth Observation: Polarimetric Formulation of the Visibility Function* (M. Martín-Neira, A. Martín-Polegre, S. Ribó), Internal ESTEC Working Paper nº 2130, October 2001

3. SMOS L1 NEAR REAL TIME PROCESSOR

The SMOS Level 1 NRT Processor converts the extracted Level 0 data or raw data into brightness temperatures swaths. This data is used as input for weather models (e.g. ECMWF, UK Metoffice), and to be useful for them, it has to be delivered under strong time constraints. The data must be delivered to the users within three hours from sensing time. To achieve this, the SMOS NRT processing chain has to process 100 minutes of L0 data into NRT product in no more than 33 minutes.

The NRT Processing Chain takes SMOS L0 products and auxiliary data files as input, and perform on this data a processing similar to the L1 processor.

There are three output NRT products, named ESA NRT product, ECMWF NRT product and the UK Metoffice product (i.e. light BUFR).

- The ESA NRT product follows the Earth Explorer File Format Standards and the tailoring for the SMOS ground segment. It is also similar in structure and contents to L1C products. This eases the comparisons between them.
- The ECMWF NRT and the UK Metoffice products do not follow the EE standards. They are BUFR formatted product, derived from the contents of the ESA NRT product. they are intended to be delivered to external users, such as the ECMWF or UK Metoffice, and the BUFR format is more suitable for meteorological data, it is designed to optimise the assimilation of the SMOS data in the weather systems.

Since for each recipient (ECMWF or UK Metoffice) there is a single NRT product – the BUFR product can be considered as a reformatted product-, it contains all the grid points. There is no separation between land and sea pixels, as happens with the L1C products generated by the L1 processor. As a result, a single apodisation window shall be used.

4. LEVEL 1 GENERAL FORMAT DESCRIPTION

The format is in accordance to Earth Explorer standards, including ASCII and binary data in the XML (eXtensible Markup Language) standard.

The format information is an inherent part of the XML Schemas, so the product files are auto-contained. This means that any API used to read them will not need any a priori information on their possible contents, but would be able to know it by using the schemas.

4.1. File Name

According to [AD.5], the ESA Earth Explorer File Format Standard, *files shall be named using a fixed set of elements, each of fixed size, separated by underscores "_"*. The maximum size for any given file name shall be 64 characters.

The Logical File Name for SMOS NRTP has the following structure, following the same convention as in [AD.7]:

MM_CCCC_TTTTTTTTTT_yyyymmddThhmmss_YYYYMMDDTHHMMSS_vvv_ccc_s

Where each of the elements is described in [AD.7], but is repeated here for completeness:

- MM: is the Mission identifier, for the SMOS case it shall be always SM
- CCCC: is the File Class, which has three alternatives:
  - TEST: for internal testing purposes only (e.g. products generated as input to or output from acceptance testing, GSOV, etc.)
  - OPER: for all files generated in automated processing during mission operation phases
- TTTTTTTTTT : is the File Type, consisting of two sub-fields:

  TTTTTTTTTT=FFFFDDDDDD

  Where:
  - FFFF: is the File Category.
    - For the L1 HKTM product, this shall be always TLM_.
    - For all other MIRAS measurement product, this shall be always MIR_.
    - For auxiliary data products, this shall be always AUX_.
  - DDDDDD: is the Semantic Descriptor, described in the Table below for L1 NRT measurements products.
- yyyymmddThhmmss:
  - in case of MIRAS measurements products (including calibration ones) it is the SMOS sensing start time of the data contained in the product, in CCSDS compact format. As SMOS sensing time values will typically have greater precision than a second, the sensing start time is rounded up (this way the period specified in the filename is completely covered by the time period of the data actually contained in it). The origin for this time is the Precise_Validity_Start_time specified in the Specific Product Header.

- in case of auxiliary data products it is the start time of the period in which the product is valid – i.e. it can be used as supporting product in the processing of a SMOS measurement product to an upper level-. As possibly the values will typically have greater precision than a second, the start time is rounded up (this way the period specified in the filename is completely covered by the time period of the data actually contained in it)

- YYYYMMDDTHHMMSS:
  - in case of MIRAS measurements products (including calibration ones) it is the SMOS sensing stop time of the data contained in the product, in CCSDS compact format. As SMOS sensing time values will typically have greater precision than a second, the sensing stop time is rounded down (this way the period specified in the filename is completely covered by the time period of the data actually contained in it). The origin for this time is the Precise_Validity_Stop_time specified in the Specific Product Header.
  - in case of auxiliary data products it is the stop time of the period in which the product is valid – i.e. it can be used as supporting product in the processing of a SMOS measurement product to an upper level-. As possibly the values will typically have greater precision than a second, the stop time is rounded down (this way the period specified in the filename is completely covered by the time period of the data actually contained in it).
- vvv: is the version number of the processor generating the product.
- ccc: is the file counter (used to make distinction among products having all other filename identifiers identical). The counter shall start at 001 and not 000.
- s: is the site instance ID, where
  - 0: test data generated outside the SMOS operational ground segment (e.g. test data)
  - 1: SMOS DPGS Fast Processing Centre / Fast Reprocessing Centre @ESAC
  - 2: SMOS DPGS LTA @ ESRANGE in Kiruna
  - 3: SMOS DPGS Calibration & Expertise Centre @ ESAC
  - 6: SMOS DPGS Near Real Time Processing Centre

The File Types of the SMOS L1 NRT Products are listed in the following table. In this table, a distinction has been made between truly L1 NRT Products, and L1 Calibration Products (in bold). L1 Calibration Products contain data produced by processing of instrument data, but whose purpose is to provide calibration parameters used in the generation of the L1 Products. As such, their use is that of auxiliary products, but as they are generated as a by-product of the nominal processing chain, they have been included here with the different naming convention.

Table 4: Logical File Names of SMOS L1 NRT Products

Type of Data				File Type
Level 1a	Measurement Mode	Science Data	Dual-Pol	MIR_SCND1A
			Full-Pol	MIR_SCNF1A
	Consolidated Calibration Mode	Consolidated Uncorrelated Noise Injection Calibration		**MIR_UAVD1A**
		Consolidated Correlated Noise Injection Calibration		**MIR_CRSD1A**
Level 1b	Measurement Mode	Science Data	Dual-Pol	MIR_SCND1B
			Full-Pol	MIR_SCNF1B
Level 1c	Measurement Mode	Science Data	Dual-Pol	MIR_SCND1C
			Full-Pol	MIR_SCNF1C
		Browse Data	Dual-Pol	MIR_BWND1C
			Full-Pol	MIR_BWNF1C
BUFR	Measurement Mode	Science Data (there is no distinction between Dual and Full in BUFR products		Not applicable (see file naming in section 5.4.3)
Light BUFR	Measurement Mode	Science Data (there is no distinction between Dual and Full in BUFR products		Not applicable (see file naming in section 5.4.4)

In NRT processing, as opposed to the full L1 processing available in the DPGS, there are no products produced for non-nominal pointing (i.e. external target mode).

Moreover, the type of in-orbit calibration data that is produced is limited to the consolidated products of Correlated and Uncorrelated Noise Injection.

The final products of the NRT processing are the BUFR products (see section 5.4.3 for the BUFR and 5.4.4 for the light BUFR), which are delivered to the end users. The L1C products (for ECMWF products only) allow the comparison of the NRT outputs with the nominal L1 processing, and the L1A and L1B products are intended as breakpoints only. There is no L1C nominal product generation for the light BUFR product.

4.2. Logical files vs. Physical files

A SMOS Level 1 Product Logical File is compliant with [AD.3] and [AD.4]; its structure, shown in the next figure, comprises

- An ASCII XML Fixed Header, whose structure is identical for all file types.
- An ASCII XML Variable Header, which allows to define and structure different information for each file type, and is split into:

- a Main Product Header (MPH)
- a Specific Product Header (SPH).

It must be noticed that SMOS measurements products' headers (i.e. those specified in Chapter 4 of this document) follow the structure described above, while the auxiliary data products (specified in Chapter 5) do not have MPH, as most of that information does not make sense in these products. Whenever a field is still needed, it has been moved to the SPH.

- A Data Block, containing one or more Data Sets. Each Data Set contains a number of identical Data Set Records.

In terms of computer 'Physical Files', the L1 Logical File can be structured in one of the following two ways:

- when Data Block is binary, it is structured as two separate Physical Files:
  - a Header file (XML ASCII), with .HDR extension
  - a Data Block file (binary), with .DBL extension
- when Data Block is XML, it is structured as one unique Physical File, all in XML ASCII format following EEF convention, with .EEF extension.

All Physical Files related to the same Logical File share the same file name, changing only the extension. A single file merging Header and Data Block should have the extension .EEF. If the files are distributed separately, the Header File should bear the extension .HDR and the Data Block File the extension .DBL.

The Logical file composition shall follow the Earth Explorer Standard, as shown in the following figure:

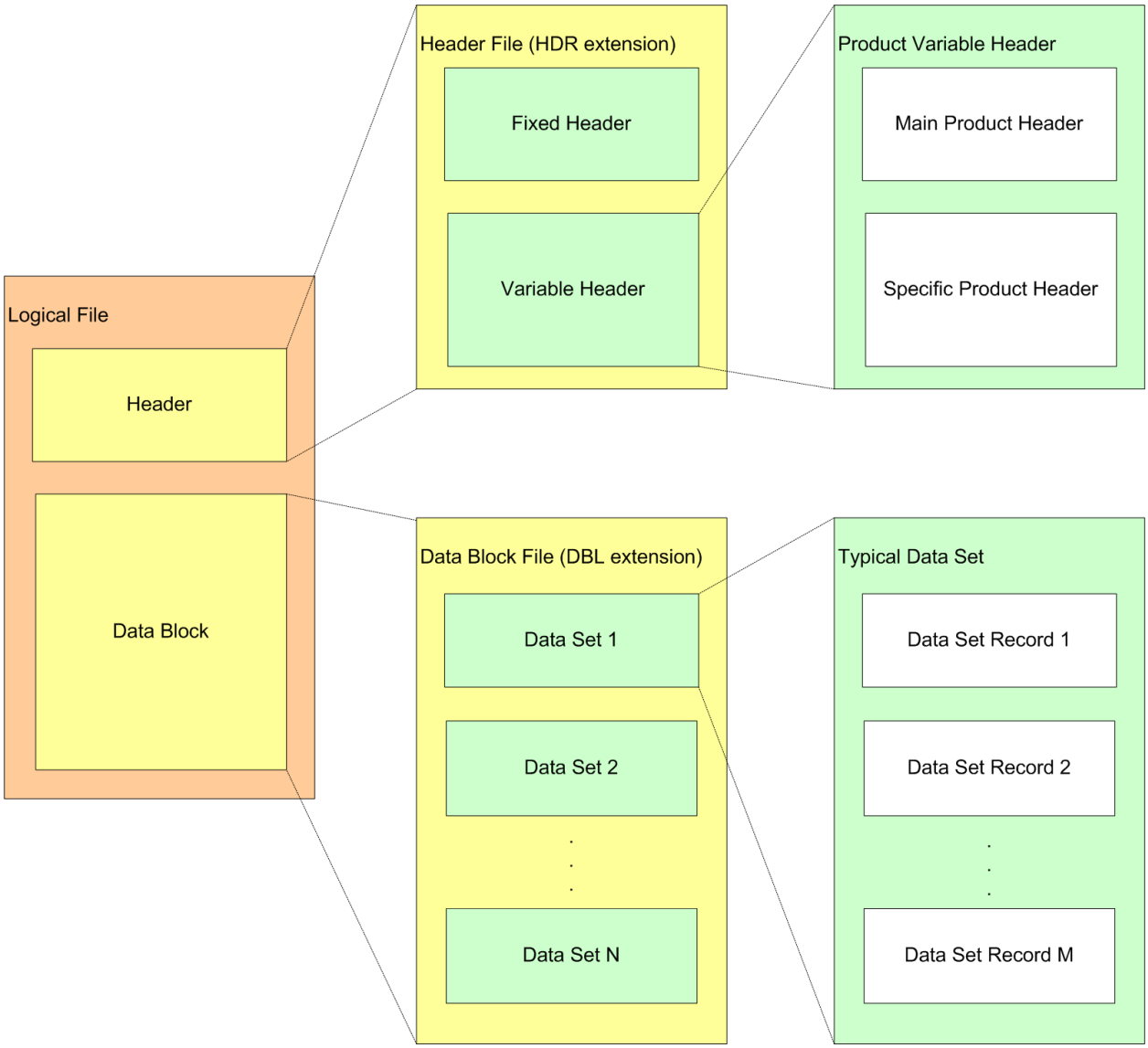

Figure 1: Logical File Decomposition

In the L1 NRT Processor, binary DBL shall never be concatenated with the HDR XML header. Instead, the approach used in the DPGS shall be adopted, where the two files are used as a single logical file.

4.3. Header File

The Header File is constituted by two parts, a **Fixed Header** and a **Variable Header**.

4.3.1. Fixed Header

Fixed header is common to all Earth Explorer missions and is defined in Table 3-1 of [AD.7].

The following considerations are considered on top of the referred table.

The NRTP generates no notes, but due to constraints in the R/W API the field Notes can not be empty, for that reason a "X" character or an space will be written. Functionally the field "Notes" shall be considered as empty.

The “Creation_Date” corresponds to the beginning of the processing.

The “File_Description” for the NRTP products are described in the following table that complements Table 3-2 of [AD.7].:

Table 5: File Descriptions

File Type	File_Description
MIR_SCND1C	Level 1C Dual Polarization NRT Science measurements product
MIR_SCNF1C	Level 1C Full Polarization NRT Science measurements product
MIR_BWND1C	Level 1C Dual Polarization NRT Browse measurements product
MIR_BWNF1C	Level 1C Full Polarization NRT Browse measurements product
AUX_NRTMSK	NRT Discrete Global Grid Pixel ID Mask used to filter only the pixels required in NRT products
AUX_APDNRT	NRT Apodisation Window
AUX_CNFNRT	Processor Algorithm Configuration Parameters and Constants for NRTP
AUX_N256	N256 Gaussian Grid used in NRTP Light BUFR generation

4.3.2. Variable Header

The Variable Header is specific to each SMOS file and is listed in detail in the following chapters. It is constituted by the Main Product Header (MPH) and Specific Product Header (SPH) of the Product File to which the Header File is univocally attached.

5. PRODUCT FILES

5.1. Generic Guidelines

Each Product File is composed by the following components:

- XML Header
- XML/Binary Data Block

The first block is written in XML ASCII format, while the last one contains the ASCII/Binary data, which is the bulk of the product.

The XML Header, as described in section 3.2 is formed by a Fixed Header and a Variable Header. The Variable Header for SMOS products is formed by the Main Product Header and the Specific Product Header. These two headers are detailed in the following sections.

These following conventions have been used in these specifications:

- The tables for headers start and end with a Fixed_Header, Main_Product_Header and Specific_Product_Header tags to make clear which are the fields enclosed within. The same applies for datablocks, which are enclosed within Data_Block tags.
- Binary data blocks are specified following the XML syntax, although obviously they are not in XML format. The Field#, Type, Unit, Precision and Format columns for the pseudo-XML tags are in gray colour, so as to make clear that they are not fields contained in the product. A note has been added in any case in the Comments column highlighting this issue.
- A wider line specifies which is the beginning and the end of a dataset. Adjacent datasets are then separated by this wider line, but this also applies to Header/DataBlock tags that are separated from datasets by this wider line.

The tables shown throughout the document have the following columns:

- Field #: numbering applied to each field appearing in the table.
- Tag Name: tag used in the schemas to identify the field
- Description: clarifications on the meaning of the product's field.
- Type: variable type, this is the concept of the variable instead of its actual implementation in the product. It can be either Tag (enclosing XML structures), string, integer, identifier, real value, matrix of complex values, etc.
- Unit: specification of the unit type according to EEF convention. N/A is applied to unitless fields.
- Bytes: specification of the size in bytes of the variable
  - For binary data this column specifies the implementation of an element of the field, in C-like specification (float, unsigned integer, etc.), specifying also the element's size in bytes.
  - For ASCII data, it specifies number of bytes in which the field value is written
- Format: specification of the field formatting:

- For ASCII data it specifies in C language fwrite function the format in which field is written to a file. Note that %+08.3f means that the number has always 8 digits, one of which is the sign, another is the dot and 3 of them are decimals, being the remaining digits at the left of the dot.
- For binary data it specifies the format of the variable from the elements defined in the previous column (number of elements, sorting, etc.).

❑ Origin: specification of the source of the information in the field. It takes the following values:

- INT: NRTP internal processing
- ICNF: NRTP internal configuration
- AUX: value is assigned by internal processing, but the real origin is from an ADF of the indicated file type
- MIR: extracted from lower level (L0, L1A or L1B) science input product
- TLM: extracted from lower level (L0) telemetry input product
- JobOrder: extracted from the job order that triggered this execution
- Hardcoded

5.1.1. Main Product Header

The Main Product Header of any SMOS Product Level 1 will be written in XML ASCII. It contains the information about:

❑ Product and Creator identification

❑ Orbit information

❑ Product Confidence Data (PCD)

The Main Product Header is fully described in section 4.1 of [AD.7] and will not be repeated here. It is noted that the values of the fields Processing_Centre and Logical_Proc_Centre (fields 4 and 5) are given the fixed values of ESAC and NRTP.

5.1.2. Specific Product Header

The Specific Product Header of any SMOS Product Level 1 is written in XML ASCII. The SPH is composed of several structures depending on the product type. The following two sub-elements are common to all Level 1 Measurement products:

- XML Specific Product Header Product Main Info
- XML Specific Product Header Data Sets

While the SPH Product Main Info contains generic information about the Product, the SPH Data Sets contains the list of names of Data Sets either of Reference or of Measurement.

The Reference Data Sets contain the reference to any file containing relevant information for the Product. The Measurement Data Sets contain relevant information about the binary information linked directly to the product.

In all cases, the SPH will be enclosed between the Specific_Product_Header Tag.

5.1.2.1. SPH Product Info

The XML SPH Product Main Info described in the following table contains the information about:

- Product Description and Identification Information
- Product Time Information
- Schema, Size and Checksum information
- Identifier of HW generating the product

Table 6: L1 Data Main_Info SPH

Field #	Tag name	Description	Type	Units	Bytes	Format	Origin
#01	Main_Info	Tag starting a Main_Info structure	Tag				
#02	SPH_Descriptor	Name describing SPH.See Table 8.	String	N/A	14	%14s	Hardcoded
#03	Time_Info	Tag starting a Time Information. XML structure	Tag				
#04	Precise_Validity_Start	UTC Validity Start Time, coherent with the Validity time in the FileName, but in CCSDS ASCII format with time reference and microseconds.	String	UTC	30	UTC=yyyy-mm-ddThh:mm:ss.uuuuuu	INT
#05	Precise_Validity_Stop	UTC Validity Stop Time, coherent with the Validity time in the FileName, but in CCSDS ASCII format with time reference and microseconds.	String	UTC	30	UTC=yyyy-mm-ddThh:mm:ss.uuuuuu	INT
#06	Abs_Orbit_Start	Absolute orbit of the Precise_Validity_Start	Integer	N/A	6	%+06d	INT
#07	Start_Time_ANX_T	Time in seconds between Precise_Validity_Start and closest previous crossing of the ascending node	Real	s	13	%013.6f	INT
#08	Abs_Orbit_Stop	Absolute orbit of the Precise_Validity_Stop	Integer	N/A	6	%+06d	INT
#09	Stop_Time_ANX_T	Time in seconds between Precise_Validity_Stop and closest previous crossing of the ascending node	Real	s	13	%013.6f	INT
#10	UTC_at_ANX	UTC time of the ascending node of the orbit containing the Precise_Validity_Start	String	UTC	30	UTC=yyyy-mm-ddThh:mm:ss.uuuuuu	INT

Field #	Tag name	Description	Type	Units	Bytes	Format	Origin
#11	Long_at_ANX	Longitude of the ascending node crossing at Equator of the Precise_Validity_Start time referred to WGS84 [-180,+180] (+ to East, from Greenwich)	Real	deg	12	%+012.6f	INT
#12	Ascending_Flag	Not used for NRT. Added for compatibility issues with L1OP	String	N/A	1	%c	Copied from same field in input product
#13	Semiorbit_Start	Not used in NRT. Added for compatibility issues with L1OP	String	UTC	30	UTC=yyyy-mm-ddThh:mm:ss.uuuuuu	Copied from same field in input product
#14	Semiorbit_Stop	Not used in NRT. Added for compatibility issues with L1OP	String	UTC	30	UTC=yyyy-mm-ddThh:mm:ss.uuuuuu	Copied from same field in input product
#15	Time_Info	Tag ending a Time Information. XML structure	Tag				
#15b	Correlator_Layer	Field reporting the layer of correlators used in the averages, taken from the first DSR with valid Correlator_Layer value. It shall be N for Nominal, R for Redundant	String	N/A	1	%1c	INT
#16	Checksum	Checksum of the datablock, obtained from the algorithm in the IEEE Std 1003.1.2004 , using function cksum in POSIX.	Integer	N/A	10	%010d	INT

Field #	Tag name	Description	Type	Units	Bytes	Format	Origin
#17	Header_Schema	Name of the XSD to be used for the validation of the product header. The format is as specified in [AD.9]. The value will be provided by an XML R/W API method at the time of writing the file.	String	N/A	31	%31s	ICNF
#18	Datablock_Schema	Name of the validation xml schema for the binary product's datablock Name of the binX schema for the validation of the product datablock. The format is as specified in [AD.9]. The value will be provided by an XML R/W API method at the time of writing the file.	String	N/A	42	%42s	ICNF
#19	Header_Size	Size of the Header of the product	Integer	bytes	6	%06d	INT
#20	Datablock_Size	Size of the product Datablock	Integer	bytes	11	%011d	INT
#21	HW_Identifier	Unique identifier of the hardware involved in the processing. "nnnn" where n are digits or characters	String	N/A	4	%4s	ICNF
#22	Main_Info						

5.1.2.2. SPH Quality Information

This structure contains the statistics on the quality checks performed during processing on the generated L1 data. The following table specifies the contents for this structure, which is common to all MIRAS products, and specific information on each product type can be found in [AD.13].

Table 7: L1 Quality Information SPH

Field #	Tag name	Description	Type	Units	Bytes	Format	Origin
#01	Quality_Information	Tag starting of a Quality_Information structure	Tag				
#02	Software_Error_Counter	Number of snapshot used to generate the product affected by software error. The error in NRT is always accumulated from L0 to L1c (incremental counter).	Integer	N/A	5	%05d	INT
#03	Instrument_Error_Counter	Number of snapshot used to generate the product affected by instrument error. The error in NRT is always accumulated from L0 to L1c (incremental counter).	Integer	N/A	5	%05d	INT

Field #	Tag name	Description	Type	Units	Bytes	Format	Origin
#04	ADF_Error_Counter	Number of snapshot used to generate the product affected by ADF error. ADF error occurs when the snapshot is processed by using an ADF with a validity time outside the acquisition time of the snapshot or when the ADF is missing (e.g. usage of the IRI model in the L1c processing instead of the VTEC auxiliary file.) The error in NRT is always accumulated from L0 to L1c (incremental counter).	Integer	N/A	5	%05d	INT
#05	Calibration_Error_Counter	Number of snapshot used to generate the product affected by calibration file error. Calibration file error occurs when the snapshot is processed by using a calibration file with a validity time outside the acquisition time of the snapshot or when the calibration file is missing (e.g. usage of the on-ground NIR characterization processing instead of the on-flight NIR data from MIR_ANIR calibration file).	Integer	N/A	5	%05d	INT
#06	N_Discarded_Scenes	Number of scenes discarded from the corresponding L0 up to this product..	Integer	scenes	5	%05d	INT

Field #	Tag name	Description	Type	Units	Bytes	Format	Origin
#07	N_Invalid_Blocks	Copied from the SPH of the corresponding L0 input product. Number of blocks in the L0 product with at least 1 missing packet.	Integer	blocks	9	%09d	MIR/TLM
#08	N_Missing_Packets	Copied from the SPH of the corresponding L0 input product. Number of missing packets inserted in the L0 product (not including 24-packet blocks missing in the pass).	Integer	packets	9	%09d	MIR/TLM
#09	Quality_Information	Tag ending of a Quality_Information structure	Tag				

5.1.2.3. SPH Data Sets

The fields in the SPH Data Sets table are present in all Level 1 products. They present the data sets that are related to the content of the product, either they are physically contained in it or they are referenced from other product used as input to the generation of this product.

Some other fields are included before the SPH Data Sets fields, i.e. the SPH Data Sets structures shall be the last ones in the product's header.

The Data Block content for L1 Products consists of a Measurement Data Sets (containing binary contents as described in its associated XML schema) and a Reference Data Set (containing filename linking the product to a reference supporting file used as input to generate this product). The SPH Data Sets are fully described in Table 4-5 of [AD.7] and will not be repeated here.

SPH names accepted shall make reference to the type of product that contains the SPH. The following table provides a summary of NRT SPH names not included in table 4-2 of [AD.7]:

Table 8: SPH names

SPH NAME	Description
MIR_SCND1C_SPH	SPH for Nominal NRT L1c product generated from MIRAS output in Dual polarisation mode
MIR_SCNF1C_SPH	SPH for Nominal NRT L1c product generated from MIRAS output in Full polarisation mode
MIR_BWND1C_SPH	SPH for Browse NRT L1c product generated from MIRAS output in Dual polarisation mode
MIR_BWNF1C_SPH	SPH for Browse NRT L1c product generated from MIRAS output in Full polarisation mode
AUX_NRTMSK_SPH	SPH for NRT processor Discrete Global Grid Pixel ID Mask
AUX_APDNRT_SPH	SPH for NRT processor Apodisation Window
AUX_CNFNRT_SPH	SPH for NRTP Auxiliary configuration file.
AUX_CNVNRT_SPH	SPH for BUFR Converter Auxiliary configuration file.
AUX_N256___SPH	SPH for N256 Gaussian Grid used in NRTP Light BUFR generation

5.1.3. Data Sets Specification

The Reference Data Sets shall contain a filename linking the product to a reference auxiliary file, to the originating sub-product and even to the ancillary calibration data. The values accepted are presented in table 4.6 of [AD.7].

The Measurement Data Sets shall contain binary contents as described in its associated XML schema, ranging from calibrated correlations to reconstructed Brightness Temperatures in the Earth Fixed Grid. The names for all Measurement DS for NRT products appear on [AD.7], no new ones are needed.

The list of possible Reference Data_Set names for NRT, which are not contemplated in table 4.6 of [AD.7] is shown in the following table:

Table 9: Reference Data_Set names

Data_Set Name	Type	Description
APODISATION_FILE	AUX_APDNRT	Apodisation window definition filename used in the current L1c product. This Reference data set is contemplated in [AD.7] but the file type needs to be different in NRT
AUX_NRT_MASK_FILE	AUX_NRTMSK	Auxiliary file with definition of pixel assignment to NRT processing
NRT_CONFIG_FILE	AUX_CNFNRT	Auxiliary file with definition of configuration values to be used in NRT processing

5.2. L1a Data: MIR_SCND1A, MIR_SCNF1A

L1a Data are formed by the calibration of measurement science data, in both dual and full polarisation. Observation type may be also nominal or an external target (i.e. deep Sky, Moon…), but this is not processed in NRTP

There is a unique type of product, as it shall contain the calibrated visibilities between receivers, before any reconstruction is applied. These products present these calibrated visibilities in a known array, so that the reconstruction process may re-order and apply the reconstruction algorithm as needed.

5.2.1. Calibrated visibilities

Calibrated visibilities products contain reformatted, unpacked and calibrated complex correlations coming from L0 data, combined per integration time and including all redundant visibilities. This is the information needed prior to the reconstruction process, along with the receivers' and NIR temperatures, as well as S/C position and attitude.

These L1a products are generated depending on the type of L0 product, arranged on a pole-to-pole time interval according to ascending and descending passes.

Product Files hold the Variable Header, specific to each SMOS file and constituted by a Main Product Header (MPH) and a Specific Product Header (SPH). MPH is common to all Product files and SPH depends on the product itself and includes the references to measurement data and descriptors of external input files.

Due to the fact that there are dual and full polarisation products, there is a different Measurement Data Set specified for each type. Their format is exactly the same, but they have been separated for clarification purposes.

Thus, the only difference in Dual or Full polarisation L1a science products is the structure of the Data Block, the MPH and SPH shall be common to both.

L1a Data is fully described in section 4.2.3 of [AD.7] and will not be repeated here.

NRTP processor only generates this kind of data upon specific request for validation purposes. Nominally this product is not generated as part of the NRTP chain and it is not distributed in any case to the DPGS.

5.3. L1b Data: MIR_SCND1B, MIR_SCNF1B

5.3.1. Reconstructed $\hat{T}_B$ Brightness Temperatures Fourier Components

L1b products are the output of the image reconstruction algorithm applied to the Calibrated visibilities. They are composed by a vector of Fourier Domain components obtained after reconstruction. This information is presented on a snapshot basis, ordered by time stamp.

The data used for L1c processing are the Fourier Domain components of each snapshot, which has no apodisation applied at this level.

Different L1b products are generated depending on the polarisation mode of the instrument (dual or full polarimetric), and their contents change from mode to mode. In dual-pol, one data set record is generated per integration time (1.2s), containing H or V polarisation measurements. In full-pol every alternate integration time generates a data set record (H or V), and the next one generates two data set records (HV and V or HV and H).

Products are arranged on a pole-to-pole time interval according to ascending and descending passes and grouped according to multiples of the integration time (time sorted and arranged with respect to the originating L1a product).

L1b Data is fully described in section 4.2.4 of [AD.7] and will not be repeated here.

NRTP processor only generates this kind of data upon specific request for validation purposes. Nominally this product is not generated as part of the NRTP chain and it is not distributed in any case to the DPGS.

5.4. L1c Data

5.4.1. Reconstructed T_B swath: MIR_SCND1C, MIR_SCNF1C

L1c products are reprocessed L1b products that have been geographically sorted into swath based brightness temperature maps. If no overlap is inserted at the beginning of the L1b product, then two L1b products at ground level would be needed for the generation of one L1c product, in order to properly process the data near both orbit ends. In NRTP, the same consolidation strategy as DPGS is applied, which includes a sufficient overlap to use only one L1b product.

Files include info on geographical coordinates of the pixel including elevation, and its geometrical properties (area, orientation. Type of surface, etc). Different L1c products are generated depending on the polarisation mode of the instrument (dual or full polarimetric). NRT L1c products are not separated into Land or Sea products.

Products are arranged in swaths on a full orbit time interval according to ascending and descending passes. The product contents will be organised in a way as to remove all unnecessary information related to geo-location of overlapping pixels.

It shall be remarked that in full polarimetric mode, one of the measurements is the complex cross-polarisation brightness temperature (HV), from which the third and fourth Stokes parameters are represented in the L1c (real and imaginary components). This means that the values represented for each

incidence angle are always real valued, instead of separating temperatures in real and complex, which would add to the complexity of the product structure.

5.4.1.1. Main Product Header

See section 5.1.1. All fields in the MPH are applicable to this type of product.

5.4.1.2. Specific Product Header

The Specific Product Header Format for Science L1C products follows the format described in section 5.1.2, including:

- Level 1 SPH Main Info (see section 5.1.2.1)
- Quality Information structure (see section 5.1.2.2)
- Product Location (Start, Stop and Mid-product Lat-Lon coordinates)
- Radiometric Accuracy Scale
- Pixel Footprint Scale
- Geolocation Information (percentage of mixed pixels, apodisation window, number of grid points)
- Level 1SPH Data Sets (see section 5.1.2.3).

The Specific Product Header is fully described in section 4.2.5.1.1 of [AD.7] and will be not repeated here.

For this type of product, the Data Set structure consist of two Measurement data sets and several Reference data sets. The possible Reference data sets are the following:

Table 10: L1c Reference Data Sets

Data_Set Name	Type	Description
L0_CORRELATIONS_FILE	MIR_SC_D0, MIR_SC_F0	L0 Product filename from which the current L1C was created. Only when L1C is not created starting from a L1A or L1B file.
L0_HKTM_FILE	TLM_MIRA0	L0 HKTM product from which it is obtained the telemetry data (note that NRT processors do not use HKTM L1A files, as it is computed internally).
L1A_AVER_OFFSET_FILE	MIR_UAVD1A	Consolidated L1a Offset filename used to calibrate the L1a visibilities. Only when L1C is created starting from a L0 file.
L1A_ORBIT_AMPL_PHASE_FILE	MIR_CRSD1A	Consolidated L1a Calibration filename used to calibrate the L1a visibilities (PMS and Fringe wash at the origin). Only when L1C is created starting from a L0 file
L1A_AVER_NIR_CAL_FILE	MIR_ANIR1A	NIR calibrated parameters filename used to calibrate L1a visibilities. Only when L1C is created starting from a L0 file
L1A_G_MATRIX_FILE	AUX_GMAT__	G Matrix filename used in the Image reconstruction process of the current L1b product to subtract foreign sources. Only when L1C is created starting from a L0 or L1A file. This DS is not mandatory, as it depends on processor configuration parameters.
L1A_J_MATRIX_FILE	AUX_JMAT__	J Matrix filename used in the purely mathematical Image reconstruction process of the current L1b product. Only when L1C is created starting from a L0 or L1A file. This DS is not mandatory, as it depends on processor configuration parameters.
L1A_FLAT_TARGET_FILE	AUX_FTTD_, AUX_FTTF_	Auxiliary file with Flat Target Transformation coefficients to be taken into account during L1b processing. Only when L1C is created directly from L0 or L1A. This DS is not mandatory, as it depends on processor configuration parameters.
L1A_FILE	MIR_SCND1A, MIR_SCNF1A,	L1a Calibrated Visibilities filename used to create the current L1b product. Only when L1C is created directly from L1A.

Data_Set Name	Type	Description
L1B_FILE	MIR_SCND1B, MIR_SCNF1B	L1b Product filename used to create the current L1c product. Only when L1C is created directly from L1B.
DGG_FILE	AUX_DGG___	Fixed Earth Grid filename used in the current L1c product.
GALAXY_FILE	AUX_GALAXY	Galaxy Map used for reconstruction. Only when L1C is created starting from a L0 or L1A file. This DS is not mandatory, as it depends on processor configuration parameters.
PMS_FILE	AUX_PMS___	Auxiliary file with external PMS characterisation. Only when L1C is created directly from L0 file.
NIR_FILE	AUX_NIR____	Auxiliary file with external NIR characterisation. Only when L1C is created directly from L0 file.
S_PARAM_FILE	AUX_SPAR__	Auxiliary file with S-parameters characterisation used for plane translation of L1a calibration data. Only when L1C is created directly from L0 file.
LICEF_FILE	AUX_LCF__	Auxiliary file with absolute phase characterisation used for plane translation of L1a calibration data. Only when L1C is created directly from L0 file.
RFI_FILE	AUX_RFI___	Auxiliary file with RFI flagged pixels in the same grid as the DGG
SUN_BT_FILE	AUX_SUNT__	Auxiliary file with definition of Sun Brightness Temperatures used for correction before L1b processing. Only when L1C is created directly from L0 or L1A file. This DS is not mandatory, as it depends on processor configuration parameters.
MOON_BT_FILE	AUX_MOONT_	Auxiliary file with definition of Moon Brightness Temperatures used for correction before L1b processing. Only when L1C is created directly from L0 or L1A file. This DS is not mandatory, as it depends on processor configuration parameters.

Data_Set Name	Type	Description
BISTATIC_SCAT_FILE	AUX_BSCAT	Auxiliary file with Bistatic Scattering Coefficients (only used in nominal pointing processing).
WEIGHT_VECTOR_FILE	AUX_BWGHT_	Auxiliary file with definition of baseline weights. Only when L1C is created directly from L0 or L1A file.
LAND_SEA_MASK_FILE	AUX_LSMASK	Auxiliary file with pixel LandSea mask and water fraction content.
AUX_NRT_MASK_FILE	AUX_NRTMSK	Auxiliary file with definition of pixel assignment to NRT processing
TEC_FILE	AUX_VTEC_P, AUX_VTEC_R, AUX_VTEC_C	TEC filename used in the current L1b and L1c products. This DS is not mandatory, as it depends on the availability of a TEC file when starting the processing.
ANTENNA_PATTERNS_FILE	AUX_PATT__	Auxiliary file with antenna patterns.
PLM_FILE	AUX_PLM___	Auxiliary file with Payload Module characterisation
FAILURES_FILE	AUX_FAIL__	Auxiliary file with failure of components to be taken into account during L1 processing
BEST_FIT_PLANE_FILE	AUX_BFP___	Auxiliary file with definition of Best Fit Plane to be used during geolocation in L1c
MISPOINTING_ANGLES_FILE	AUX_MISP__	Auxiliary product containing the mispointing angles between the Body Frame referenced in the Proteus quaternions and the Antenna Plane defined by the MIRAS instrument
APODISATION_FILE	AUX_APDNRT	Auxiliary file with definition and coefficients of the apodisation applied from L1b to L1c
ORBIT_SCENARIO_FILE	MPL_ORBSCT	Mission planning file used to initialise the EE CFI orbit_id and/or time_id. It is read and used by the EECFI.
BULLETIN_B_FILE	AUX_BULL_B	IERS Bulletin B file used by the EE CFI to get very precise computations of geolocation.
RFI_LIST_FILE	AUX_RFILIST	Global RFI position list used in the RFI mitigation algorithms

Data_Set Name	Type	Description
ALGORITHM_CONFIG_FILE	AUX_CNFL1P	Algorithms Configuration File.
NRT_CONFIG_FILE	AUX_CNFNRT	NRT Processor Configuration File

5.4.1.3. Data Block

The binary Data Block of the MIR_SCND1C/MIR_SCNF1C product consists of two Measurement datasets, the first one containing the list of snapshots and associated information in the swath, and the second one containing the list of brightness temperature samples and associated geophysical information for each grid points sensed by the MIRAS instrument.

The first Measurement data set for L1c products shall be a list of the snapshots contained within the L1c product, along with the parameters that characterise them. The second Measurement data set contain a list of Brightness Temperatures and their incidence angles for every point in the Earth Fixed grid covered by the product. As part of the information provided on a "per pixel" basis, the originating snapshot ID and the pixel size and orientation are provided.

The structure follows the one indicated in the following table:

Table 11: L1c Data Set structure

Field #	Tag name	Description	Type	Units	Bytes	Size
	Data_Block	Init of binary Data Block in the product.	Tag			
#01-24	Swath_Snapshot_List	Measurement Data Set containing the Snapshot_Information records.	Struct			
#25-40	Temp_Swath_Dual	Measurement Data Set containing the pixel records in Dual polarisation (only in Dual pol L1c products)	Struct			
#25-40	Temp_Swath_Full	Measurement Data Set containing the pixel records in Full polarisation (only in Full pol L1c products).	Struct			
	Data_Block	End of binary Data Block in the product.	Tag			

There are two different Data Set structures for this last type, depending on the operation mode that generates the L1c product (dual or full). This approach has been followed, in order to provide the complex BT measurement for HV cross-polarisation with a reduced product size.

In the Temp_Swath_Dual structure, a single 4-byte value is presented for each BT measurement, while in the Temp_Swath_Full structure two 4-byte values are presented for each BT measurement. Setting the two values for the HV in full-pol is needed for its real and imaginary components, as they share the rest of the pixel parameters (shape, incidence angle…). For pure polarisation measurements (HH or VV) while in full-pol, the second 4-byte value may be useful to present the imaginary term (it should be null, but the imaginary residue from the reconstruction may be useful) or even the First and Second Stokes parameters (BT in HH or VV polarisation are always real valued)

5.4.1.3.1. Swath_Snapshot_List

This Data Set shall serve as a summary of the snapshots that form the L1c product, together with influential values that they may have on the pixel measurements retrieved from each snapshot.

There is a complete Data Set Record (DSR) for each integration time. The following table describes the XML schema used to decode the binary contents of this type of record. The tag element used to describe the DSR structure name in the XML schema is Swath_Snapshot_List.

This Data Set contains as many Data Set Records as snapshots measured by the instrument in the validity period, plus the initial counter. The first field in the dataset, Counter, specifies the number of DSR contained in it, while the following fields are Counter repetitions of the Snapshot_Information dataset record structure. The size of each MDR is fixed and equal to 123 bytes.

Table 12: L1c Data Set Record containing snapshot info list

Field #	Tag name	Description	Type	Units	Bytes	Size	Origin
	Swath_Snapshot_List	Init of binary Data Set containing the Snapshot_Information records.	Tag				
#01	Snapshot_Counter	Number of Snapshot_Information data set record structures.	Integer	N/A	4	unsigned int	INT
	List_of_Snapshot_Informations	Init of list of Snapshot_Information data set record structures, and repeated Counter times. There are as many DSR as integration periods in the product.	Tag				
	Snapshot_Information	Init of Snapshot_Information data set record structure.	Tag				
#02	Snapshot_Time	UTC Time at which the scene was taken. Middle of integration time period, propagated from UTC at start of integration provided in ancillary packet. Expressed in EE CFI transport time format (Array of 3 integer elements)	Integer	Days,secs, µsecs	12	Int[3]	MIR (L1B)
#03	Snapshot_ID	Unique identifier for the snapshot. Formed by aggregation of orbit and time within orbit. Contents of this field are formed by: Absolute_orbit_number*10000 + Seconds_from_ANX	Integer	N/A	4	Unsigned int	MIR (L1B)

Field #	Tag name	Description	Type	Units	Bytes	Size	Origin
#04	Snapshot_OBET	Unique identifier for the snapshot. Formed by the OBET at T_SYNC extracted from L0. Represents start of integration time in OBET format	Integer	N/A	8	Unsigned long long	MIR (L1B)
#05	X_Position	Orbit State Vector X Position in Earth Fixed Reference at Snapshot_Time (field #1)	Real	m	8	double	MIR (L1B)
#06	Y_Position	Orbit State Vector Y Position in Earth Fixed Reference at Snapshot_Time (field #1)	Real	m	8	double	MIR (L1B)
#07	Z_Position	Orbit State Vector Z Position in Earth Fixed Reference at Snapshot_Time (field #1)	Real	m	8	double	MIR (L1B)
#08	X_Velocity	Orbit State Vector X Velocity in Earth Fixed Reference at Snapshot_Time (field #1)	Real	m/s	8	double	MIR (L1B)
#09	Y_Velocity	Orbit State Vector Y Velocity in Earth Fixed Reference at Snapshot_Time (field #1)	Real	m/s	8	double	MIR (L1B)
#10	Z_Velocity	Orbit State Vector Z Velocity in Earth Fixed Reference at Snapshot_Time (field #1)	Real	m/s	8	double	MIR (L1B)
#11	Vector_Source	Source of the Orbit State Vector record. Enumerated value	Integer	N/A	1	char	MIR (L1B)

Field #	Tag name	Description	Type	Units	Bytes	Size	Origin
#12	Q0	Real number component of quaternion obtained rotating from the J2000 inertial reference frame to the satellite body frame	Real	N/A	8	double	MIR (L1B)
#13	Q1	First component of quaternion obtained rotating from the J2000 inertial reference frame to the satellite body frame	Real	N/A	8	double	MIR (L1B)
#14	Q2	Second component of quaternion obtained rotating from the J2000 inertial reference frame to the satellite body frame	Real	N/A	8	double	MIR (L1B)
#15	Q3	Third component of quaternion obtained rotating from the J2000 inertial reference frame to the satellite body frame	Real	N/A	8	double	MIR (L1B)
#16	TEC	Total Electron Count content applicable to snapshot data.	Real	TECU (10^{16} electron/$m^{2)}$	8	double	INT
#17	Geomag_F	Full or Total Intensity (F) of Geomagnetic field vector applicable to snapshot data, obtained mixing PVT and IGRF model.	Real	nT	8	double	INT

Field #	Tag name	Description	Type	Units	Bytes	Size	Origin
#18	Geomag_D	Declination (D) of Geomagnetic field vector applicable to snapshot data, obtained mixing PVT and IGRF model. Magnetic declination is the angle between magnetic north and true north. D is considered positive when the angle measured is east of true north and negative when west. Positive in eastward direction.	Real	deg	8	double	INT
#19	Geomag_I	Inclination (I) of Geomagnetic field vector applicable to snapshot data, obtained mixing PVT and IGRF model. Magnetic inclination is the angle between the horizontal plane and the total field vector, measured positive into Earth. Positive in downward (towards Earth Surface) direction.	Real	deg	8	double	INT
#20	Sun_RA	Right Ascension of Sun illumination direction in Earth Fixed Reference	Real	deg	4	float	INT
#21	Sun_DEC	Declination of Sun illumination direction in Earth Fixed Reference	Real	deg	4	float	INT
#22	Sun_BT	Direct Sun estimated Brightness Temperature that has been removed from snapshot	Real	K	4	float	INT

Field #	Tag name	Description	Type	Units	Bytes	Size	Origin
#23	Accuracy	Snapshot overall accuracy measurement, based on Corbella equation and computed as the difference of the mean snapshot Brightness Temperature and the averaged physical temperature of the LICEF receivers	Real	K	4	float	INT
#24	Radiometric_Accuracy	Error accuracy measurement in the Brightness Temperature value at boresight. Vector array of 2 float elements, the second element is only used to store the boresight accuracy for full pol snapshots, set to zero in all other cases	Real	K	8	Float[2]	INT
#25	X-Band	0 if X-Band Transmitter OFF 1 if X-Band Transmitter ON (Nominal side) if X-Band Transmitter ON (Redundant side) 3 if X-Band Transmitter ON (Nominal and Redundant side)	Integer	N/A	1	char	MIR(L1B)
	Quality_Information	Start of Quality Information structure					

Field #	Tag name	Description	Type	Units	Bytes	Size	Origin
#26	Software_Error_Flag	0 if no software errors were detected during the processing of the snapshot 1 if a software error was detected in the corresponding L1b snapshot OR/AND a software error was detected during the L1c scientific processing.	Flag	N/A	1	Char	INT
#27	Instrument_Error_Flag	0 if no instrument errors were detected during the processing of the snapshot 1 if an instrument error was inherited from the corresponding L1b snapshot. Currently there is no identification of instrument error in the processing of L1b science data.	Flag	N/A	1	Char	MIR(L1B)
#28	ADF_Error_Flag	0 if no ADF error occurs when the snapshot is processed 1 if ADF_error_flag set in the L1b data AND/OR one or more ADF used to process the L1c scientific snapshot had a validity time outside the acquisition time of the snapshot or the ADF is missing (e.g. VTEC)	Flag	N/A	1	Char	INT
#29	Calibration_Error_Flag	0 if no Calibration file error occurs when the snapshot is processed 1 if Calibration_Error_Flag is set in the corresponding L1b snapshot.	Flag	N/A	1	Char	MIR(L1B)

Field #	Tag name	Description	Type	Units	Bytes	Size	Origin
	Quality_Information	End of Quality Information structure					
	Snapshot_Information	End of Snapshot_Information data set record structure.	Tag				
	List_of_Snapshot_Informations	End of list of Snapshot_Information data set record structures, and repeated Counter times. There are as many DSR as integration periods in the product.	Tag				
	Swath_Snapshot_List	End of binary Data Set containing the Snapshot_Information records					

All data is referenced to the time described in the field SNAPSHOT_TIME expressed in UTC format. SNAPSHOT_OBET is still referred to the start of the integration time, but it is kept as it provides an extra unique reference to the snapshot.

Sun illumination is provided as Right Ascension and Declination, which can be applicable to the S/C or to the geographical point, due to the long distance to the Sun. Computation of the illumination angle for any geolocated point is a simple computation based on the geographical coordinates of the point, transforming them to RA and DEC, and comparing to the Sun position values.

5.4.1.3.2. Temp_Swath_Dual

This Data Set contains the pixel measurements for dual polarisation. It is formed by Data Set Records, each of them containing data for one single pixel defined by its grid identifier in the Earth Fixed Grid ADF. The data within the DSR is a list of measurements (BT, accuracy, angles), which by nature changes in size depending on the pixel across-track distance (i.e. pixels near the orbit track will have more measurements than those far from the orbit track)

There is a complete Data Set Record (DSR) for each pixel within the product. The following table describes the XML schema used to decode the binary contents of this type of record. The tag element used to describe the DSR structure name in the XML schema is Temp_Swath_Dual. The size of each MDR is variable and depends on the number of BT measurements available for each pixel.

This Data Set contains as many Data Set Records as pixels observed by the instrument in the validity period. The first field in the dataset, Counter, specifies the number of pixels structures Grid_Point_Data contained in it. This dataset differs with the rest of the datasets in L1 in that it contains an intermediate hierarchical level, consisting Grid_Point_Data in a variable list of brightness temperature samples BT_Data, falling over the same DGG pixel. The size of each BT_Data is fixed and equal to 24 bytes, while the size of Grid_Point_Data is variable and depends on the number of BT_Data actually contained in it (14+Nx24 bytes; where N is the number of BT_Data over that grid point, specified by field # 30 BT_Data_Counter). This concept is referred to as variable array of variable array.

The table presented below is almost identical to the L1c structure presented in Table 4-44 of [AD.7], with the exception of field #6 that represents the Water Fraction content instead of the LandSea Mask.

Table 13: L1c Data Set Record for Dual polarisation products

Field #	Tag name	Description	Type	Units	Bytes	Size	Origin
	Temp_Swath_Dual	Init of binary Data Set containing the Grid_Point_Data records.	Tag				
#01	Grid_Point_Counter	Number of Grid_Point_Data data set record structures.	Integer	N/A	4	unsigned int	INT
	List_of_Grid_Point_Datas	Init of list of Grid_Point_Data data set record structures, and repeated Counter times. There are as many DSR as integration periods in the product.	Tag				
	Grid_Point_Data	Init of Grid_Point_Data data set record structure.	Tag				
#02	Grid_Point_ID	Unique identifier for Earth fixed grid point, linking it to Auxiliary Earth Grid file.	Integer	N/A	4	int	AUX (DGG)
#03	Grid_Point_Latitude	Latitude of the DGG cell centre identified by the Grid_Point_ID	Real	deg	4	float	AUX (DGG)
#04	Grid_Point_Longitude	Longitude of the DGG cell centre identified by the Grid_Point_ID [-180,+180]	Real	deg	4	float	AUX (DGG)
#05	Grid_Point_Altitude	Altitude of the DGG cell centre identified by the Grid_Point_ID	Real	m	4	float	AUX (DGG)
#06	Water_Fraction	Percentage of Water content in the DGG cell, expressed in 0,5% units. Range is [0 to 200]	Percentage	N/A	1	Unsigned char	AUX (LSMSK)

Field #	Tag name	Description	Type	Units	Bytes	Size	Origin
#07	BT_Data_Counter	Number of BT_Data data set record structures within Grid_Point_Data.	Integer	N/A	2	unsigned short	INT
	List_of_BT_Datas	Init of list of BT_Data data set record structures, and repeated Counter times. There are as many DSR as integration periods in the product.	Tag				
	BT_Data	Init of BT_Data data set record structure.	Tag				
#08	Flags	L1c flags applicable to the pixel for this particular integration time. Its detailed description is presented in section 6.2.3.3	Flag	N/A	2	Unsigned short	INT
#09	BT_Value	Brightness temperature value over current Earth fixed grid point, obtained by DFT interpolation from L1b data.	Real	K	4	float	INT
#10	Pixel_Radiometric_Accuracy	Error accuracy measurement in the Brightness Temperature presented in the previous field, extracted in the direction of the pixel. Coded as an unsigned short. LSB= (SPH Table 24 field #11)/2^{16}. Meaning that value=(value coded as unsigned short)* (SPH Table 24 field #11)/2^{16}K	Real	K	2	Unsigned short	INT

Field #	Tag name	Description	Type	Units	Bytes	Size	Origin
#11	Incidence_Angle	Incidence angle value corresponding to the measured BT value over current Earth fixed grid point. Measured as angle from pixel to S/C with respect to the pixel local normal (0º if vertical) Coded as an unsigned short. LSB=$90/2^{16}$. Meaning that value=(value coded as unsigned short)*$90/2^{16}$degrees	Real	deg	2	Unsigned short	INT
#12	Azimuth_Angle	Azimuth angle value corresponding to the measured BT value over current Earth fixed grid point. Measured as angle in pixel local tangent plane from projected pixel to S/C direction with respect to the local North (0º if local North) Coded as an unsigned short. LSB=$360/2^{16}$. Meaning that value=(value coded as unsigned short)*$360/2^{16}$ degrees	Real	deg	2	Unsigned short	INT
#13	Faraday_Rotation_Angle	Faraday rotation angle value corresponding to the measured BT value over current Earth fixed grid point. It is computed as the rotation from surface to antenna (i.e. direct angle) Coded as an unsigned short. LSB=$360/2^{16}$. Meaning that value=(value coded as unsigned short)*$360/2^{16}$ degrees	Real	deg	2	Unsigned short	INT

Field #	Tag name	Description	Type	Units	Bytes	Size	Origin
#14	Geometric_Rotation_Angle	Geometric rotation angle value corresponding to the measured BT value over current Earth fixed grid point. It is computed as the rotation from surface to antenna (i.e. direct angle) Coded as an unsigned short. LSB=360/2^{16}. Meaning that value=(value coded as unsigned short)*360/2^{16} degrees	Real	deg	2	Unsigned short	INT
#15	Snapshot_ID_of_Pixel	Unique identifier for the snapshot. Formed by aggregation of orbit and time within orbit. Contents of this field are formed by: Absolute_orbit_number*10000 + Seconds_from_ANX	Integer	N/A	4	Unsigned int	MIR (L1B)
#16	Footprint_Axis1	Elliptical footprint major semi-axis value. Coded as an unsigned short. LSB=(SPH Table 24 field #12)/2^{16}. Meaning that value=(value coded as unsigned short)* (SPH Table 24 field #12)/2^{16} km	Real	km	2	Unsigned short	INT
#17	Footprint_Axis2	Elliptical footprint minor semi-axis value. Coded as an unsigned short. LSB=(SPH Table 24 field #12)/2^{16}. Meaning that value=(value coded as unsigned short)* (SPH Table 24 field #12)/2^{16} km	Real	km	2	Unsigned short	INT
	BT_Data	End of BT_Data data set record structure.	Tag				

Field #	Tag name	Description	Type	Units	Bytes	Size	Origin
	List_of_BT_Datas	End of list of BT_Data data set record structures, and repeated Counter times. There are as many DSR as integration periods in the product.	Tag				
	Grid_Point_Data	End of Grid_Point_Data data set record structure.	Tag				
	List_of_Grid_Point_Datas	End of list of Grid_Point_Data data set record structures, and repeated Counter times. There are as many DSR as integration periods in the product.	Tag				
	Temp_Swath_Dual	End of binary Data Set containing the Grid_Point_Data records					

Being this DSR a variable size DSR, it means that the information contained in the fields #7to #16 is repeated the number of times defined in field #6.

5.4.1.3.3. Temp_Swath_Full

This Data Set contains the pixel measurements for full polarisation. It is formed by Data Set Records, each of them containing data for one single pixel defined by its grid identifier in the Earth Fixed Grid ADF. The data within the DSR consist on a list of measurements (BT, accuracy, angles), which by nature changes in size depending on the pixel across-track distance (i.e. pixels near the orbit track will have more measurements than those far from the orbit track).

The difference between this Data Set and the previous one for dual polarisation is that the measurements in this Data Set contains complex measurements, so there is an extra field to contain the imaginary term of the cross-polarisation Brightness Temperature. This field, when the measurement is H or V polarisation Brightness Temperature is set to zero.

There is a complete Data Set Record (DSR) for each pixel within the product. The following table describes the XML schema used to decode the binary contents of this type of record. The tag element used to describe the DSR structure name in the XML schema is Temp_Swath_Full. The size of each MDR is variable and depends on the number of BT measurements available for each pixel.

This Data Set contains as many Data Set Records as pixels observed by the instrument in the validity period. The size of each DSR, as it has been mentioned varies, so one field in the DSR serves to indicate the number of measurements available per pixel, in the same approach as has been described for the previous Data Set.

The table presented below is almost identical to the L1c structure presented in Table 4-46 of [AD.7], with the exception of field #6 that represents the Water Fraction content instead of the LandSea Mask.

Table 14: L1c Data Set Record for Full polarisation products

Field #	Tag name	Description	Type	Units	Bytes	Size	Origin
	Temp_Swath_Fulll	Init of binary Data Set containing the Grid_Point_Data records.	Tag				
#01	Grid_Point_Counter	Number of Grid_Point_Data data set record structures.	Integer	N/A	4	unsigned int	INT
	List_of_Grid_Point_Datas	Init of list of Grid_Point_Data data set record structures, and repeated Counter times. There are as many DSR as integration periods in the product.	Tag				
	Grid_Point_Data	Init of Grid_Point_Data data set record structure.	Tag				
#02	Grid_Point_ID	Unique identifier for Earth fixed grid point, linking it to Auxiliary Earth Grid file.	Integer	N/A	4	int	AUX (DGG)
#03	Grid_Point_Latitude	Latitude of the DGG cell centre identified by the Grid_Point_ID	Real	deg	4	float	AUX (DGG)
#04	Grid_Point_Longitude	Longitude of the DGG cell centre identified by the Grid_Point_ID [-180,+180]	Real	deg	4	float	AUX (DGG)
#05	Grid_Point_Altitude	Altitude of the DGG cell centre identified by the Grid_Point_ID	Real	m	4	float	AUX (DGG)
#06	Water_Fraction	Percentage of Water content in the DGG cell, expressed in 0,5% units. Range is [0 to 200]	Percentage	N/A	1	Unsigned char	AUX (LSMSK)
#07	BT_Data_Counter	Number of BT_Data data set record structures within Grid_Point_Data.	Integer	N/A	2	unsigned short	INT

Field #	Tag name	Description	Type	Units	Bytes	Size	Origin
	List_of_BT_Datas	Init of list of BT_Data data set record structures, and repeated Counter times. There are as many DSR as integration periods in the product.	Tag				
	BT_Data	Init of BT_Data data set record structure.	Tag				
#08	Flags	L1c flags applicable to the pixel for this particular integration time. Its detailed description is presented in section 6.2.3.3	Flag	N/A	2	Unsigned short	INT
#09	BT_Value_Real	Brightness temperature value over current Earth fixed grid point, obtained by interpolation from L1b data. Contains real components of HH, HV or VV polarisation measurements.	Real	K	4	float	INT
#09b	BT_Value_Imag	Brightness temperature value over current Earth fixed grid point, obtained by interpolation from L1b data. Contains imaginary components of HH, HV or VV polarisation measurements. For dual polarisation measurements, this value will always be zero.	Real	K	4	float	INT
#10	Pixel_Radiometric_Accuracy	Error accuracy measurement in the Brightness Temperature presented in the previous field, extracted in the direction of the pixel. Coded as an unsigned short. LSB= (SPH Table 24 field #11)/2^{16}. Meaning that value=(value coded as unsigned short)* (SPH Table 24 field #11)/2^{16}K	Real	K	2	Unsigned short	INT

Field #	Tag name	Description	Type	Units	Bytes	Size	Origin
#11	Incidence_Angle	Incidence angle value corresponding to the measured BT value over current Earth fixed grid point. Measured as angle from pixel to S/C with respect to the pixel local normal (0º if vertical) Coded as an unsigned short. LSB=$90/2^{16}$. Meaning that value=(value coded as unsigned short)*$90/2^{16}$degrees	Real	deg	2	Unsigned short	INT
#12	Azimuth_Angle	Azimuth angle value corresponding to the measured BT value over current Earth fixed grid point. Measured as angle in pixel local tangent plane from projected pixel to S/C direction with respect to the local North (0º if local North) Coded as an unsigned short. LSB=$360/2^{16}$. Meaning that value=(value coded as unsigned short)*$360/2^{16}$ degrees	Real	deg	2	Unsigned short	INT
#13	Faraday_Rotation_Angle	Faraday rotation angle value corresponding to the measured BT value over current Earth fixed grid point. It is computed as the rotation from surface to antenna (i.e. direct angle) Coded as an unsigned short. LSB=$360/2^{16}$. Meaning that value=(value coded as unsigned short)*$360/2^{16}$ degrees	Real	deg	2	Unsigned short	INT

Field #	Tag name	Description	Type	Units	Bytes	Size	Origin
#14	Geometric_Rotation_Angle	Geometric rotation angle value corresponding to the measured BT value over current Earth fixed grid point. It is computed as the rotation from surface to antenna (i.e. direct angle) Coded as an unsigned short. LSB=360/2^{16}. Meaning that value=(value coded as unsigned short)*360/2^{16} degrees	Real	deg	2	Unsigned short	INT
#15	Snapshot_ID_of_Pixel	Unique identifier for the snapshot. Formed by aggregation of orbit and time within orbit. Contents of this field are formed by: Absolute_orbit_number*10000 + Seconds_from_ANX	Integer	N/A	4	Unsigned int	MIR (L1B)
#16	Footprint_Axis1	Elliptical footprint major semi-axis value. Coded as an unsigned short. LSB=(SPH Table 24 field #12)/2^{16}. Meaning that value=(value coded as unsigned short)* (SPH Table 24 field #12)/2^{16} km	Real	km	2	Unsigned short	INT
#17	Footprint_Axis2	Elliptical footprint minor semi-axis value. Coded as an unsigned short. LSB=(SPH Table 24 field #12)/2^{16}. Meaning that value=(value coded as unsigned short)* (SPH Table 24 field #12)/2^{16} km	Real	km	2	Unsigned short	INT
	BT_Data	End of BT_Data data set record structure.	Tag				

Field #	Tag name	Description	Type	Units	Bytes	Size	Origin
	List_of_BT_Datas	End of list of BT_Data data set record structures, and repeated Counter times. There are as many DSR as integration periods in the product.	Tag				
	Grid_Point_Data	End of Grid_Point_Data data set record structure.	Tag				
	List_of_Grid_Point_Datas	End of list of Grid_Point_Data data set record structures, and repeated Counter times. There are as many DSR as integration periods in the product.	Tag				
	Temp_Swath_Full	End of binary Data Set containing the Grid_Point_Data records					

5.4.2. Browse T_B swath: MIR_BWND1C, MIR_BWNF1C

There are browse L1c products comprising all the grid points expressed in the nominal L1c, but containing only data for one incidence angle (42.5º) in each polarisation available.

Data includes info on geographical coordinates of the pixel including elevation, and its geometrical properties (area, orientation. Type of surface, etc). Different L1c browse products are generated depending on the polarisation mode of the instrument (dual or full polarimetric)

Products are arranged in swaths on a pole-to-pole time interval according to ascending and descending passes.

5.4.2.1. Main Product Header

See section 5.1.1. All fields in the MPH are applicable to this type of product.

5.4.2.2. Specific Product Header

The Specific Product Header Format for Science L1C Browse products follows the format described in section 5.1.2, including:

- Level 1 SPH Main Info (see section 5.1.2.1)
- Quality Information structure (see section 5.1.2.2)
- Product Location
- Browse Incidence Angle
- Radiometric Accuracy Scale
- Pixel Footprint Scale
- Geolocation Information
- Level 1SPH Data Sets (see section 5.1.2.3).

Table 15: L1C Browse Data Sets SPH

Field #	Tag name	Description	Type	Units	Bytes	Format	Origin
#01	Specific_Product_Header	Tag starting the Specific Product Header structure	Tag				
#02-19	Main_Info	Structure described in Table 6	Struct	N/A			
#20-26	Quality_Information	Structure described in Table 7	Struct	N/A			
#27	Product_Location	Tag starting the Product Location structure	Tag				
#28	Start_Lat	WGS84 latitude of the subsatellite point at Sensing Start time in the product (positive towards North direction)	Real	deg	11	%+011.6f	INT
#29	Start_Lon	WGS84 longitude of the subsatellite point at Sensing Start time in the product [-180,+180] (positive to East, from Greenwich)	Real	deg	11	%+011.6f	INT
#30	Stop_Lat	WGS84 latitude of the subsatellite point at Sensing Stop time in the product (positive towards North direction)	Real	deg	11	%+011.6f	INT
#31	Stop_Lon	WGS84 longitude of the subsatellite point at Sensing Stop time in the product [-180,+180] (positive to East, from Greenwich)	Real	deg	11	%+011.6f	INT
#32	Mid_Lat	WGS84 latitude of the subsatellite point at half the time between Sensing Start and Sensing Stop time in the product (positive towards North direction)	Real	deg	11	%+011.6f	INT

Field #	Tag name	Description	Type	Units	Bytes	Format	Origin
#33	Mid_Lon	WGS84 longitude of the subsatellite point at half the time between Sensing Start and Sensing Stop time in the product [-180,+180] (positive to East, from Greenwich)	Real	deg	11	%+011.6f	INT
#34	Product_Location	Tag ending the Product Location structure	Tag				
#35	Incidence_Angle	Incidence angle of Brightness Temperature measurements presented in Browse product. Set to 42.500	Real	deg	7	%+07.3f	ICNF
#36	Radiometric_Accuracy_Scale	Scale used in the normalisation to 2s complement of the Pixel Radiometric Accuracy (default 50K)	Integer	K	3	%03d	ICNF
#37	Pixel_Footprint_Scale	Scale used in the normalisation to 2s complement of the Pixel Footprint size (100km)	Integer	km	3	%03d	ICNF
#38	Geolocation_Information	Tag starting the geolocation structure	Tag				
#39	Percentage_of_Mixed_Pixels	Percentage of grid point defined as mixed in the USGS classification. Generated by NRT Processor based on AUX_LSMASK.	Real	N/A	7	%07.3f	INT

Field #	Tag name	Description	Type	Units	Bytes	Format	Origin
#40	Apodisation_Window	Constant Apodisattion function used to generate the product. Numerical value representing the apodisation function applied (coherent with the filename Reference Data Set) 000=Rectangular window 001=Blackman window 002=Barlett window 003=Hamming window 004=Hanning window … 100=Kaiser window with alpha 1.20 101=Kaiser window with alpha 1.21 …(user defined and agreed windows) 999=Strip Adaptive window	Integer	N/A	3	%03d	Joborder
#41	Total_Num_Grid_Points	Total number of grid points covered by L1C product	Integer	N/A	6	%06d	INT
#42	Geolocation_Information	Tag ending the geolocation structure	Tag				
#43-54	Data_Sets	Structure described in Table 9, using Data Sets from **Error! Reference source not found.**	Struct	N/A			
#55	Specific_Product_Header	Tag ending the Specific Product Header structure	Tag				

The same reference Data Sets are used as for the nominal L1c products. See section 4.5.1.2 for the complete list.

5.4.2.3. Data Block

The Data Block for L1c Browse Data products consists of a single Measurement data set comprised of a number of data records, and the same Reference data sets as defined for the nominal L1c product (see Table 15).

The Measurement data set contains a list of Brightness Temperatures at a fixed incidence angle (42.5º) for every point in the Earth Fixed grid covered by the product.

As mentioned before, there is no need to report now the incidence angle as in nominal L1c products, as the angle is fixed. Also, it is needed to interpolate not only BT values, but also the elliptical footprints variation, as a best fit to the position under 42.5º.

5.4.2.3.1. Temp_Browse

This Data Set contains the pixel measurements at the above mentioned incidence angle. It is formed by a list of Data Set Records, each of them containing data for one single pixel defined by its grid identifier in the Earth Fixed Grid ADF and two or four measurements depending on whether it is dual or full polarisation. The data within each DSR consist on a list of measurements (BT, accuracy, angles), which in this case **does not** change in size depending on the pixel across-track distance, as we only report the values for a given incidence angle.

There is a complete Data Set Record (DSR) for each pixel within the product. The following table describes the XML schema used to decode the binary contents of this type of record. The tag element used to describe the DSR structure name in the XML schema is Temp_Browse. The size of each DSR is variable and depends on the number of BT measurements available for each pixel. In this case of Browse products, there can only be two possible values: 33 bytes for dual pol and 61 bytes for full pol.

This Data Set will contain as many Data Set Records as pixels observed by the instrument in the validity period. The size of each DSR, as it has been mentioned, varies depending on the data (dual or full), so one field in the DSR serves to indicate the number of measurements available per pixel.

The table presented below is almost identical to the L1c structure presented in Table 4-49 of [AD.7], with the exception of field #5 that represents the Water Fraction content instead of the LandSea Mask.

Table 16: Browse L1c Data Set Record for Dual and Full polarisation products

Field #	Tag name	Description	Type	Units	Bytes	Size	Origin
	Data_Block	Init of binary Data Block in the product.	Tag				
	Temp_Browse	Init of binary Data Set containing the Grid_Point_Data records.	Tag				
#01	Grid_Point_Counter	Number of Grid_Point_Data data set record structures.	Integer	N/A	4	unsigned int	INT
	List_of_Grid_Point_Datas	Init of list of Grid_Point_Data data set record structures, and repeated Counter times. There are as many DSR as integration periods in the product.	Tag				
	Grid_Point_Data	Init of Grid_Point_Data data set record structure.	Tag				
#02	Grid_Point_ID	Unique identifier for Earth fixed grid point, linking it to Auxiliary Earth Grid file.	Integer	N/A	4	int	AUX (DGG)
#03	Grid_Point_Latitude	Latitude of the DGG cell centre identified by the Grid_Point_ID	Real	deg	4	float	AUX (DGG)
#04	Grid_Point_Longitude	Longitude of the DGG cell centre identified by the Grid_Point_ID [-180,+180]	Real	deg	4	float	AUX (DGG)
#05	Grid_Point_Altitude	Altitude of the DGG cell centre identified by the Grid_Point_ID	Real	m	4	Float	AUX (DGG)
#06	Water_Fraction	Percentage of Water content in the DGG cell, expressed in 0,5% units. Range is [0 to 200]	Percentage	N/A	1	Unsigned char	AUX (DGG)

Field #	Tag name	Description	Type	Units	Bytes	Size	Origin
#07	BT_Data_Counter	Number of BT_Data data set record structures within Grid_Point_Data (fixed number in Browse products, 2 for dual polarisation products, 4 for full polarisation products)	Integer	N/A	1	unsigned char	INT
	List_of_BT_Datas	Init of list of BT_Data data set record structures, and repeated Counter times. There are as many DSR as integration periods in the product.	Tag				
	BT_Data	Init of BT_Data data set record structure.	Tag				
#08	Flags	L1c flags applicable to the pixel for this particular integration time. Its detailed description is presented in section 6.2.3.3	Flag	N/A	2	Unsigned short	INT
#09	BT_Value	Brightness temperature value over current Earth fixed grid point, obtained by interpolation from L1b data. Contains real components of HH, HV or VV polarisation measurements.	Real	K	4	float	INT
#10	Radiometric_Accuracy_of_Pixel	Error accuracy measurement in the Brightness Temperature presented in the previous field, extracted in the direction of the pixel. Coded as an unsigned short. LSB= (SPH Table 24 field #11)/2^{16}. Meaning that value=(value coded as unsigned short)* (SPH Table 24 field #11)/2^{16}K	Real	K	2	Unsigned short	INT

Field #	Tag name	Description	Type	Units	Bytes	Size	Origin
#11	Azimuth_Angle	Azimuth angle value corresponding to the measured BT value over current Earth fixed grid point. Measured as angle in pixel local tangent plane from projected pixel to S/C direction with respect to the local North (0º if local North) Coded as an unsigned short. LSB=360/2^{16}. Meaning that value=(value coded as unsigned short)*360/2^{16} degrees	Real	deg	2	Unsigned short	INT
#12	Footprint_Axis1	Elliptical footprint major semi-axis value. Coded as an unsigned short. LSB=(SPH Table 24 field #12)/2^{16}. Meaning that value=(value coded as unsigned short)* (SPH Table 24 field #12)/2^{16} km	Real	km	2	Unsigned short	INT
#13	Footprint_Axis2	Elliptical footprint minor semi-axis value. Coded as an unsigned short. LSB=(SPH Table 24 field #12)/2^{16}. Meaning that value=(value coded as unsigned short)* (SPH Table 24 field #12)/2^{16} km	Real	km	2	Unsigned short	INT
	BT_Data	End of BT_Data data set record structure.	Tag				
	List_of_BT_Datas	End of list of BT_Data data set record structures, and repeated Counter times. There are as many DSR as integration periods in the product.	Tag				
	Grid_Point_Data	End of Grid_Point_Data data set record structure.	Tag				
	List_of_Grid_Point_Datas	End of list of Grid_Point_Data data set record structures, and repeated Counter times. There are as many DSR as integration periods in the product.	Tag				

Field #	Tag name	Description	Type	Units	Bytes	Size	Origin
	Temp_Browse	End of binary Data Set containing the Grid_Point_Data records					
	Data_Block	End of binary Data Block in the product.	Tag				

5.4.3. BUFR data

SMOS L1c data is also be formatted, according to ECMWF specifications into BUFR format.

BUFR is an acronym for **B**inary **U**niversal **F**orm for the **R**epresentation of meteorological data. BUFR is a World Meteorological Organization (WMO) standard binary code for the exchange and storage of data. The format is documented in The WMO Manual on Codes; WMO Publication No. 306; Volume I, Part B; 1995 Edition, plus Supplement 1. For further information about BUFR formats please reference 'A GUIDE TO THE CODE FORM FM-94 BUFR'.

SMOS L1c data is reordered by snapshots instead of pixels, and each complete snapshot forms one BUFR message. Then, each NRT acquisition yields one BUFR file, with as many BUFR messages inside as snapshots inside the acquisition. Nevertheless, BUFR files never contain more than one orbit of sensing data, meaning that if more data is acquired in one pass, NRTP splits it into separate BUFR files.

The file naming convention to be used for this BUFR file is the following one:

$Instrument_$SensingTime1_$SensingTime2_$Satellite_$orbit_$datatype_$GeneratingTime_$datalevel.bufr

Where:

- $Instrument is the name of the instrument in 5 characters. It is fixed to 'miras'
- $SensingTime1 = $YYYYMMDD_$HHMMSS is the first MIRAS integration time within the product
- $SensingTime2 = $YYYYMMDD_$HHMMSS is the last MIRAS integration time within the product
- $YYYYMMDD is a 8 digit number to depict the year month day
- $HHMMSS is a 6 digit number for hour minute second
- $Satellite is the name of the satellite in 4 characters. It is fixed to: 'smos'
- $orbit is the 5 digits orbit number
- $datatype : is 1 character, The allowed values are:
    - 't' will be written in the following cases:
        - In case of TEST data.
        - Product is delayed (i.e. it is not produced in NRT) The fact that a product is delayed is decided by the orchestrator based in the orchestrator configuration parameter "NRT_Delay" and is when writing this version set to 130 minutes. Sensing times older than 130 min would be considered delayed.
        - Data is degraded.
    - 'o' operational data. "OPER" that do not fall in the 't' classification described above.
    - 'r' for reprocessed "REPR" data. This value will be obtained by using the BUFR Converter tool. Any output of the BUFR Converter tool will be marked as "r" regardless of any other consideration. This value is not generated by the NRTP but it is explained here for clarity.
- $GeneratingTime = $YYYYMMDD_$HHMMSS is the time stamp of the BUFR generation date time

- $datalevel : 3 characters fixed for level1c to 'l1c'

The character '_' is the separator character. The extension '.bufr' indicates that the file is a bufr file.

For SMOS NRT Level 1c products, this naming convention leads for example to:

miras_20081031_152532_20081031_170532_smos_00100_o_20081031_181500_l1c.bufr

More details on the BUFR file and in specific information on the fields contained inside each BUFR message and their encoding can be found in [AD.6].

5.4.4. Light BUFR data

SMOS L1c **light** data is also formatted, according to ECMWF specifications into BUFR format.

The file naming convention to be used for this Light BUFR file is the following one:

$pflag_$productidentifier_$oflag_$originator_$GeneratingTime_$freeformat.bin

Where:

- $pFlag is a character indicating how to decode the product identifier field. The value is fixed to 'W' (WMO Product Identifier)
- $productidentifier is a field containing information that describes the nature of the data in the file. In our case, it shall be decoded as follows:

  $location_indicator,$data_designator,$free_description

  - $location_indicator defines thes producer: Country_organization and the production centre. It is fixed to 'es-esa-esac'.
  - $data_designator specifies the type of data. It is fixed to 'SMOS'.
  - $free_description. It is fixed to 'N256'.
- $oflag = is a character indicating how to decode the originator field. The value is fixed to C (standard CCCC country code).
- $originator containing information that the states where the file originated from. It should follow standard CCCC country code. It is fixed to 'LEMM'.
- $GeneratingTime = $YYYYMMDD$HHMMSS is the time stamp of the BUFR generation date time
- $freeformat will contain the following information **$SensingTime1_$SensingTime2_bufr_vXXX where**
  - $SensingTime1 = $YYYYMMDDHHMMSS set to the same time of the nominal BUFR data. The first light-BUFR MIRAS integration time might be slightly different due to differences in the grid between BUFR and light-BUFR products.
  - $SensingTime2 = $YYYYMMDDHHMMSS set to the same time of the nominal BUFR data. The last light-BUFR MIRAS integration time might be slightly different due to differences in the grid between BUFR and light-BUFR products.
  - XXX is the processor version.

The character '_' is the separator character. The extension '.bin' indicates that the file is a binary file.

For SMOS NRT Light Level 1c products, this naming convention leads for example to:

W_es-esa-esac,SMOS,N256_C_LEMM_20110923093913_20100119204540_20100119205553_bufr_v505.bin

More details on the Light BUFR file and in specific information on the fields contained inside each BUFR message and their encoding can be found in [AD.6].

5.5. L1 Calibration Data

L1a Calibration Data is formed by the calibration parameters and offsets extracted after noise injection and the NIR calibration parameters.

This data is only needed for processing (calibrating) of the nominal L1 data, due to the fact that it is needed for this purpose, it is called "calibration". Due to the fact that it is produced within the L1 nominal processing chain, it is also called L1 data, hence the double name "L1 Calibration" data.

The NRT Processor generates its own L1 Calibration data. The format is the same as DPGS products, albeit with some minor differences. NIR calibration is received from DPGS.

Only **two types** of L1 calibration data are generated at NRTP, and only the consolidated products for each of the two different types. Intermediate products are useful for periodic analysis at CEC or MF, but they are not really needed to generate a consolidated product.

5.5.1. Consolidated Uncorrelated Noise Injection Calibration Data: MIR_UAVD1A

This file presents the mean of the offsets aggregated per continuous operation time in Uncorrelated Noise Injection. They are used during L1a science processing, in order to remove existing offsets inherent to the instrument.

The average shall be performed by combining the previously existing consolidated product (if any) with any additional measurements produced from a L0 Unoise product. The average values are presented along with the number of measurements used and the time period where the samples were gathered. This time is used to further consolidate additional data in an existing average, or to discard the previous average and recompute a new one.

5.5.1.1. Main Product Header

See section 5.1.1. All fields in the MPH are applicable to this type of product.

5.5.1.2. Specific Product Header

The Specific Product Header Format for MIR_UAVD1A products follows the format described in section 5.1.2, including:

- Level 1 SPH Main Info (see section 5.1.2.1)
- Quality Information structure (see section 5.1.2.2)
- Level 1SPH Data Sets (see section 5.1.2.3)

Table 17: Consolidated Unoise L1A Data Sets SPH

Field #	Tag name	Description	Type	Units	Bytes	Format
#01	Specific_Product_Header	Tag starting the Specific Product Header structure	Tag			
#02-19	Main_Info	Structure described in Table 6	Struct	N/A		
#20-26	Quality_Information	Structure described in Table 7	Struct	N/A		
#27	Uncorrelated_Quality_Information	Tag starting the Unoise Quality structure	Tag			
#28	N_Averaged_Measurements	Number of averaged uncorrelated noise injection measurements	Integer	N/A	6	%06d
#29	Uncorrelated_ Quality	Flag indicating that the average contained in the product as used less epochs than the number specified as threshold in the configuration file. The possible values are: 1 if number of averaged measurements is under the threshold 0 if it is greater	Integer	N/A	1	%01d
#30	Uncorrelated_Quality Information	Tag ending the Unoise Quality structure	Tag			
#31-42	Data_Sets	Structure described in Table 8, using Data Sets from Table 13	Struct	N/A		
#43	Specific_Product_Header	Tag ending the Specific Product Header structure	Tag			

For this type of product, the Data Set structure consists of one Measurement data set and several Reference data sets. The possible Reference data sets are the following:

Table 18: Uncorrelated L1a Calibration Product Reference Data Sets

Reference Data_Set Name	Type	Description
L0_CORRELATIONS_FILE	MIR_UNCD0_	L1a Offset filename with measurements to be consolidated
L1A_AVER_OFFSET_FILE	MIR_UAVD1A	Consolidated L1a Offset filename previously available
L1A_ORBIT_AMPL_PHASE_FILE	MIR_CRSD1A	Consolidated L1a Calibration filename used to calibrate the L1a visibilities (PMS and Fringe wash at the origin)
L1A_HKTM_FILE	TLM_MIRA1A	HKTM filename containing the S/C position and attitude for the snapshots in the current product
PMS_FILE	AUX_PMS___	Auxiliary file with external PMS characterisation
NIR_FILE	AUX_NIR___	Auxiliary file with external NIR characterisation
S_PARAM_FILE	AUX_SPAR__	Auxiliary file with S-parameters characterisation used for plane translation of L1a calibration data
LICEF_FILE	AUX_LCF__	Auxiliary file with absolute phase characterisation used for plane translation of L1a calibration data
FAILURES_FILE	AUX_FAIL__	Auxiliary file with failure of components to be taken into account during L1 processing
ORBIT_SCENARIO_FILE	MPL_ORBSCT	Mission planning file used to initialise the EE CFI orbit_id and/or time_id. It is read and used by the EECFI.
ALGORITHM_CONFIG_FILE	AUX_CNFL1P	Algorithms Configuration File.

5.5.1.3. Data Block

A single data record containing the averages comprises the Measurement data set for Consolidated L1a Uncorrelated Noise Injection Calibration Data products. This data record contains the complete set of averaged offsets for every pair of receivers, expressed as a visibility offset, together with the number of samples used for the average. The sequence in which the data is presented is the same as for nominal L1a Products, and can be seen in **Error! Reference source not found.**. Total amount of offsets is then 72*71/2, as the LICEF_NIR are correlated in both polarisations during the integration time.

The Data Block is fully described in section 4.2.2.2.2 of [AD.7] and will not be repeated here.

5.5.2. Consolidated Correlated Noise Injection Calibration Data: MIR_CRSD1A

Consolidated Correlated Noise Injection (CNI) Calibration data is produced by combining a CNI product with its array of calibration sequences, with a previously existing (if any) consolidated product.

The objective is to establish a continuous baseline of in-orbit calibration data (FWF at the origin and PMS Gain and Offset) that will be used to calibrate science data measured in those parts of the orbit.

Correlated noise injection (combined in odd and even sources) produces the calibration parameters (complex value of the FWF at the origin, representing the correction factors in amplitude and phase) that need to be applied to calibrate the instrument measurements, as well as the calibrated coefficients for the PMS. It is stored in a separated file from the Uncorrelated Noise Injection, as the data is generated separately, although used in conjunction for calibration of nominal measurements.

5.5.2.1. Main Product Header

See section 5.1.1. All fields in the MPH are applicable to this type of product.

5.5.2.2. Specific Product Header

The Specific Product Header Format for MIR_CRSD1A products follows the format described in section 5.1.2, including:

- Level 1 SPH Main Info (see section 5.1.2.1)
- Quality Information structure (see section 5.1.2.2)
- Level 1SPH Data Sets (see section 5.1.2.3)

Table 19: Consolidated Cnoise L1A Data Sets SPH

Field #	Tag name	Description	Type	Units	Bytes	Format
#01	Specific_Product_Header	Tag starting the Specific Product Header structure	Tag			
#02-19	Main_Info	Structure described in Table 6	Struct	N/A		
#20-26	Quality_Information	Structure described in Table 7	Struct	N/A		
#27	Cons_Long_PMS_DSR_New	Number of Cons_Long_PMS_Coefficients new data set added in the file during the processing.	Integer	N/A	2	%02d
#28	Cons_Long_PMS_DSR_Removed	Number of obsolete Cons_Long_PMS_Coefficients data set removed in the file during the processing.	Integer	N/A	2	%02d

Field #	Tag name	Description	Type	Units	Bytes	Format
#29	Cons_Phase_FWF_Origin_New	Number of Cons_Phase_FWF_Origin new data set added in the file during the processing.	Integer	N/A	2	%02d
#30	Cons_Phase_FWF_Origin_Removed	Number of Cons_Phase_FWF_Origin_coefficients data set removed in the file during the processing	Integer	N/A	2	%02d
#31	Cons_Long_Ampl_FWF_Origin_New	Number of Cons_Long_Ampl_FWF_Origin new data set added in the file during the processing.	Integer	N/A	2	%02d
#32	Cons_Long_Ampl_FWF_Origin_Removed	Number of obsolete Cons_Long_Ampl_FWF_Origin data set removed in the file during the processing.	Integer	N/A	2	%02d
#33	Cons_PMS_ Start	UTC Start Time of the Consolidated PMS Coefficients dataset, in CCSDS ASCII format with time reference and microseconds. "UTC=yyyy-mm-ddThh:mm:ss.uuuuuu" This time shall coincide with the start time of the older dataset record of this dataset in the binary datablock.	String	N/A	30 bytes	%30s
#34	Cons_PMS_ Stop	UTC Stop Time of the Consolidated PMS Coefficients dataset, in CCSDS ASCII format with time reference and microseconds. "UTC=yyyy-mm-ddThh:mm:ss.uuuuuu" This time shall coincide with the stop time of the most recent dataset record of this dataset in the binary datablock.	String	N/A	30 bytes	%30s

Field #	Tag name	Description	Type	Units	Bytes	Format
#35	Cons_Long_PMS_Start	UTC Start Time of the Consolidated Long PMS Coefficients dataset, in CCSDS ASCII format with time reference and microseconds. "UTC=yyyy-mm-ddThh:mm:ss.uuuuuu" This time shall coincide with the start time of the older dataset record of this dataset in the binary datablock.	String	N/A	30 bytes	%30s
#36	Cons_Long_PMS_Stop	UTC Stop Time of the Consolidated Long PMS Coefficients dataset, in CCSDS ASCII format with time reference and microseconds. "UTC=yyyy-mm-ddThh:mm:ss.uuuuuu" This time shall coincide with the stop time of the most recent dataset record of this dataset in the binary datablock.	String	N/A	30 bytes	%30s
#37	Cons_Ampl_FWF_Origin_Start	UTC Start Time of the Consolidated Amplitude of FWF Origin dataset, in CCSDS ASCII format with time reference and microseconds. "UTC=yyyy-mm-ddThh:mm:ss.uuuuuu" This time shall coincide with the start time of the older dataset record of this dataset in the binary datablock.	String	N/A	30 bytes	%30s
#38	Cons_Ampl_FWF_Origin_Stop	UTC Stop Time of the Consolidated Amplitude of FWF Origin dataset, in CCSDS ASCII format with time reference and microseconds. "UTC=yyyy-mm-ddThh:mm:ss.uuuuuu" This time shall coincide with the stop time of the most recent dataset record of this dataset in the binary datablock.	String	N/A	30 bytes	%30s

Field #	Tag name	Description	Type	Units	Bytes	Format
#39	Cons_Long_Ampl_FWF_Origin_Start	UTC Start Time of the Consolidated Long Amplitude of FWF Origin dataset, in CCSDS ASCII format with time reference and microseconds. "UTC=yyyy-mm-ddThh:mm:ss.uuuuuu" This time shall coincide with the start time of the older dataset record of this dataset in the binary datablock.	String	N/A	30 bytes	%30s
#40	Cons_Long_Ampl_FWF_Origin_Stop	UTC Stop Time of the Consolidated Long Amplitude of FWF Origin dataset, in CCSDS ASCII format with time reference and microseconds. "UTC=yyyy-mm-ddThh:mm:ss.uuuuuu" This time shall coincide with the stop time of the most recent dataset record of this dataset in the binary datablock.	String	N/A	30 bytes	%30s
#41	Cons_Phase_FWF_Origin_Start	UTC Start Time of the Consolidated Phase of FWF Origin dataset, in CCSDS ASCII format with time reference and microseconds. "UTC=yyyy-mm-ddThh:mm:ss.uuuuuu" This time shall coincide with the start time of the older dataset record of this dataset in the binary datablock.	String	N/A	30 bytes	%30s
#42	Cons_Phase_FWF_Origin_Stop	UTC Stop Time of the Consolidated Phase of FWF Origin dataset, in CCSDS ASCII format with time reference and microseconds. "UTC=yyyy-mm-ddThh:mm:ss.uuuuuu" This time shall coincide with the stop time of the most recent dataset record of this dataset in the binary datablock.	String	N/A	30 bytes	%30s
#43-54	Data_Sets	Structure described in Table 8, using Data Sets from Table 13	Struct	N/A		
#55	Specific_Product_Header	Tag ending the Specific Product Header structure	Tag			

For this type of product, the Data Set structure consists of one Measurement data set and several Reference data sets. The possible Reference data sets are the following:

Table 20: Correlated L1a Calibration Product Reference Data Sets

Reference Data_Set Name	Type	Description
L0_CORRELATIONS_FILE	MIR_CORD0_	L1a Offset filename with measurements to be consolidated
L1A_ORBIT_AMPL_PHASE_FILE	MIR_CRSD1A	Previous consolidated L1a Calibration filename
L1A_HKTM_FILE	TLM_MIRA1A	HKTM filename containing the S/C position and attitude for the snapshots in the current product
L1A_AVER_NIR_CAL_FILE	MIR_ANIR1A	NIR in-orbit calibration file
PMS_FILE	AUX_PMS___	Auxiliary file with external PMS characterisation
S_PARAM_FILE	AUX_SPAR__	Auxiliary file with S-parameters characterisation used for plane translation of L1a calibration data
LICEF_FILE	AUX_LCF__	Auxiliary file with absolute phase characterisation used for plane translation of L1a calibration data
NIR_FILE	AUX_NIR___	Auxiliary file with on-ground NIR characterisation
FAILURES_FILE	AUX_FAIL__	Auxiliary file with failure of components to be taken into account during L1 processing
ORBIT_SCENARIO_FILE	MPL_ORBSCT	Mission planning file used to initialise the EE CFI orbit_id and/or time_id. It is read and used by the EECFI.
ALGORITHM_CONFIG_FILE	AUX_CNFL1P	Algorithms Configuration File.

5.5.2.3. Data Block

The Data Block is fully described in section 4.2.2.3.2 of [AD.7] and will not be repeated here.

5.6. Auxiliary Data

Almost all of the ADF used in NRTP are exactly the same as the ones used in DPGS. The different ones are described in this subsection. The headers of these ADF follow the same formatting as indicated in section 5.1 of [AD.7]. The descriptions below are applicable to the Data Blocks of those ADF.

5.6.1. NRT DGG Pixel Mask Data Block: AUX_NRTMSK

This Data Block contains a unique data set that contains the Pixel identifiers from the DPGS DGG ADF used in NRT L1c processing.

The data block is formed by 10 Data Set Records, each one containing a list of points within a zone. These zones are used to allow a fast indexing of the data for search algorithms. They come from the natural decomposition of the icosahedron used in the ISEA projection.

In NRTMSK, each zone contains the same number of points as the DGG ADF. For each point, an individual mask identifies that point as to be processed in NRT (1) or not (0).

The formatting is the following one:

Table 21: NRT Discrete Global Grid Pixel Mask Measurement Data Set Record

Field #	Tag name	Description	Type	Units	Bytes	Size
	Data_Block	Init of binary Data Block in the product.	Tag			
	Discrete_Global_Grid	Init of binary Data Set containing the Zone records.	Tag			
#01	Zone_Counter	Number of Zone data set record structures. Set to 10.	Integer	N/A	4	unsigned int
	List_of_ Zones	Init of list of Zone data set record structures, and repeated Counter times.	Tag			
	Zone	Init of Zone data set record structure.	Tag			
#02	Zone_ID	Unique ID defining the zone where the points are contained. An initial approach has 10 zones formed by two adjacent triangles of the main ISEA decomposition	Integer	N/A	4	Unsigned int
#03	Grid_Point_Counter	Number of points contained within the zone (if not used, refer to whole file). (For ISEA 4-9, maximum of 2.7M pixels)	Integer	N/A	4	Unsigned int
	List_of_Grid_Point_Datas	Init of list of Grid_Point_Data data set record structures, and repeated Counter times.	Tag			
	Grid_Point_Data	Init of Grid_Point_Data data set record structure.	Tag			
#04	Grid_Point _ID	Unique identifier for Earth fixed grid point.	Integer	N/A	4	Unsigned int
#05	Mask	Mask identifying pixel to be processed in NRT	Byte	N/A	1	Unsigned char
	Grid_Point_Data	End of Grid_Point_Data data set record structure.	Tag			
	List_of_Grid_Point_Datas	End of list of Grid_Point_Data data set record structures	Tag			
	Zone	End of Zone data set record structure.	Tag			

Field #	Tag name	Description	Type	Units	Bytes	Size
	List_of_ Zones	End of list of Zone data set record structures	Tag			
	Discrete_Global_Grid	End of binary Data Set containing the Zone records.	Tag			
	Data_Block	End of binary Data Block in the product.	Tag			

5.6.2. NRT Apodisation Window Data Block: AUX_APDNRT

The contents and format of the NRT Apodisation window are exactly the same ones as described in section 5.2.19 of [AD.7], and the only exception is that the file type does not refer to Land or Sea products (AUX_APDNRT).

5.6.3. NRT Configuration Data Block: AUX_CNFNRT

As per version v500 onwards the algorithm configuration is done through the file **AUX_CNFL1P** which is defined at DPGS level. Its format is shared with the L1OP processors. Please refer to the relevant DPGS documentation.

The specific configuration file for NRT will contain only information not covered by the AUX_CNFL1P configuration file.

The Data Block is formatted in XML, and shall be updated manually by NRT operators when a change is desired on any configuration item.

The NRTP will be able to read old configurations files but only the information referred in the following table will be used.

Table 22: NRT Configuration File data block

Field #	Tag name	Description	Type	Units	Bytes	Internal Structure	Format
	Data_Block	Init of Data Block in the product.	Tag				

Field #	Tag name	Description	Type	Units	Bytes	Internal Structure	Format
	Algorithm_Configuration	Init of Algorithm_Configuration structure.	Tag				
	Generic	Init of Generic configuration structure	Tag				
#01	Stop_Location_Switch	Indicates the processor where to stop processing: 1 means stop after L1A processing 2 means stop after L1B processing other values mean do not stop processing	Flag	N/A	1	Stop_Location_Switch = 0	%01d
	Generic	End of Generic configuration structure	Tag				
	Level1A	Init of Level1A configuration structure	Tag				
#02	L1a_Generation_Switch	Flag to switch between “on” and “off” the generation of the L1A product. When equal to zero, no L1A product is generated.	Flag	N/A	1	L1a_Generation_Switch = 0	%01d
	Level1A	End of Level1A configuration structure	Tag				
	Level1B	Init of Level1B configuration structure	Tag				
#03	L1b_Generation_Switch	Flag to switch between “on” and “off” the generation of the L1B product. When equal to zero, no L1B product is generated.	Flag	N/A	1	L1b_Generation_Switch = 0	%01d
	Level1B	End of Level1B configuration structure	Tag				
	Level1C	Init of Level1C configuration structure	Tag				

Field #	Tag name	Description	Type	Units	Bytes	Internal Structure	Format
#04	L1c_Generation_Switch	Flag to switch between "on" and "off" the generation of the L1c product. During the operational phase of the project, it might happen that the L1c product is not necessary, since the BUFR product will be generated directly by the NRTP. When equal to zero, no L1C product is generated (note that in NRTP BUFR product is always generated).	Flag	N/A	1	L1c_generation_switch = 1	%01d
#05	L1c_Light_Generation_Switch	Flag to switch between "on" and "off" the generation of the light L1c product. When equal to zero, no L1C light product is generated. This flag is not to be used except for future debugging tasks.	Flag	N/A	1	L1c_light_generation_switch = 0	%01d
#06	L1c_Light_Bufr_Generation_Switch	Flag to switch between "on" and "off" the generation of the Light buffer product. When equal to zero, no light Bufr product is generated	Flag	N/A	1	L1c_Light_bufr_generation_switch = 1	%01d
	Level1C	End of Level1C configuration structure	Tag				
	Debug_Options	Init of Debug_Options structure	Tag				
#07	Breakpoint_Dir	Path for the breakpoints directories.	String	N/A	Variable		%s
#08	Print_L1c_Flag	Flag to active intermediate L1c breakpoints. Not to use operationally.	Flag	N/A	1	Print_L1c_Flag = 0	%01d
	Debug_Options	End of Debug_Options structure	Tag				

Field #	Tag name	Description	Type	Units	Bytes	Internal Structure	Format
	Algorithm_Configuration	End of Algorithm_Configuration structure.	Tag				
	Data_Block	End of Data Block in the product.	Tag				

5.6.4. NRT Converter Configuration Data Block: AUX_CNVNRT

The configuration file for NRT Converter processing contains all information applicable to selectable flags and configuration parameters.

The Data Block is formatted in XML, and shall be updated manually by NRT operators when a change is desired on any configuration item.

Field #	Tag name	Description	Type	Units	Bytes	Internal Structure	Format
	Data_Block	Init of Data Block in the product.	Tag				
	Algorithm_Configuration	Init of Algorithm_Configuration structure.	Tag				
	Generic	Init of Generic configuration structure	Tag				
#01	L1c_Generation_Switch	Flag to switch between “on” and “off” the generation of the L1c product in NRT Format. This switch shall be used for validation and verification purpose, and it must be considered that the generation will consume non negligible (note that in NRTP BUFR product is always generated).	Flag	N/A	1	L1c_generation_switch = 0	%01d
	Generic	End of Generic configuration structure	Tag				

Field #	Tag name	Description	Type	Units	Bytes	Internal Structure	Format
	Algorithm_Configuration	End of Algorithm_Configuration structure.	Tag				
	Data_Block	End of Data Block in the product.	Tag				

5.6.5. NRT light Product Grid Data Block: AUX_N256__

This Data Block contains a unique data set that contains the Pixel identifiers from the N256 ADF used in NRT Light product processing.

The data block is formed by 512 Data Set Records, each one containing a list of points within a zone. These zones are used to allow a fast indexing of the data for search algorithms in the light product generation.

The formatting is the following one:

Field #	Tag name	Description	Type	Units	Bytes	Size
	Data_Block	Init of binary Data Block in the product.	Tag			
	Gaussian_Grid_N256	Init of binary Data Set containing the Zone records.	Tag			
	List_of_ Zones	Init of list of Zone data set record structures, and repeated Counter times.	Tag			
	Zone	Init of Zone data set record structure.	Tag			
#01	Zone_ID	Unique ID defining the zone where the points are contained.	Integer	N/A	8	Unsigned int
#02	Grid_Point_Counter	Number of points contained within the zone	Integer	N/A	4	Unsigned int

Field #	Tag name	Description	Type	Units	Bytes	Size
	List_of_Grid_Point_Datas	Init of list of Grid_Point_Data data set record structures, and repeated Counter times.	Tag			
	Grid_Point_Data	Init of Grid_Point_Data data set record structure.	Tag			
#03	Grid_Point _ID	Unique identifier for Earth fixed grid point.	Integer	N/A	4	Unsigned int
#04	Latitude	Latitude value of grid point over the ellipsoid.	Real	Deg	4	float
#05	Longitude	Longitude value of grid point over the ellipsoid.	Real	Deg	4	float
#06	Altitude	Local altitude of grid point	Real	m	4	float
#07	Mask	Mask identifying pixel to be processed in NRT	Byte	N/A	1	Unsigned char
#08	Water_Fraction	Percentage of Water content in the Grid cell, expressed in 0,5% units. Range is [0 to 200]	Percentage	N/A	1	Unsigned char
	Grid_Point_Data	End of Grid_Point_Data data set record structure.	Tag			
	List_of_Grid_Point_Datas	End of list of Grid_Point_Data data set record structures	Tag			
	Zone	End of Zone data set record structure.	Tag			
	List_of_ Zones	End of list of Zone data set record structures	Tag			
	Gaussian_Grid_N256	End of binary Data Set containing the Zone records.	Tag			
	Data_Block	End of binary Data Block in the product.	Tag			

5.7. Open Points

There are no current open points.

6. ANNEX: TECHNICAL POINTS ON SMOS NRT PROCESSING

6.1. Consolidation in NRT

By consolidation in this context, it is meant the task of separating the data at different processing levels (L0, L1a, L1b and L1c) into separate products, establishing the guidelines that are followed by the NRTP.

SMOS consolidation strategy states that all products shall cover half an orbit, in a pole-to-pole configuration [AD.2]. L0, L1a and L1b shall be consolidated on a pole-to-pole time segment basis approach, depending on the snapshot (also named as scene) time. Meanwhile, L1c products shall be consolidated on a pole-to-pole geographical segment approach, depending on the location of each geographical point.

The main objective of this consolidation in the Fast Processing Centre is to provide all measurements for any given pixel within only one L1c product, instead of spreading them among two products. In order to achieve this, a certain amount of overlap has to be introduced already at the L0 Processor, and must be later taken into account during L1c processing. Moreover, the last data received, as it does not contain a complete half-orbit, is withheld until the next downlink is received. See [RD.03] for more information on the DPGS strategy.

In the Near Real time chain, this consolidation is not considered at all, instead opting for producing as much L1c data as possible even if the information will only be completed in the following downlink.

Data in NRT arrives directly from a specific instance of the L0 Processor that does not apply the overlap described before and does not wait to have complete half orbits before sending the products to NRTP. These L0 products will typically cover the whole sensing period from the last acquisition, and is the data which will be converted into L1c.

Pixels within each swath shall be ordered from bottom to top and from left to right. This means that for ascending L1c products the main ordering shall be South to North, and for points with the same latitude from West to East. For descending L1c products, the ordering shall be North to South, then East to West.

6.2. Flagging of pixels

The “pixels” mentioned in the title above make reference to the fixed Earth grid points where the Brightness Temperature values are retrieved along with their observation incidence angles. These pixels are also known as “viewing directions”, as they represent the BT magnitude measured by synthesizing the antenna beam in that unique viewing direction. Thus, the BT values are retrieved over a footprint on the Earth’s surface formed by the intersection of the synthesized beam shape with the Earth’s surface. Depending on the apodisation window applied, which alters the beam shape, these footprints may have a circular or elliptical shape, so for a given pixel there may be different shapes, taken at separate times, covering slightly different areas. All this information shall be set in L1c products to assist L2 users in their processing. Throughout this document, any mention to the word “pixel” shall be understood as the particular viewing direction combined with the apodisation.

There are several different effects that may be corrected at L1 processing, which will have a definite impact on single pixels or all the pixels in a scene. Each of these effects is described in the next chapters, and a flag is defined to alert L2 users of the steps taken at L1 for their correction.

Additionally, pixels shall be flagged according to their position in the Field of View, to identify which pixel belongs to the strict alias-free FOV, which one to the extended alias-free FOV, and which one to the borders of the extended alias-free FOV.

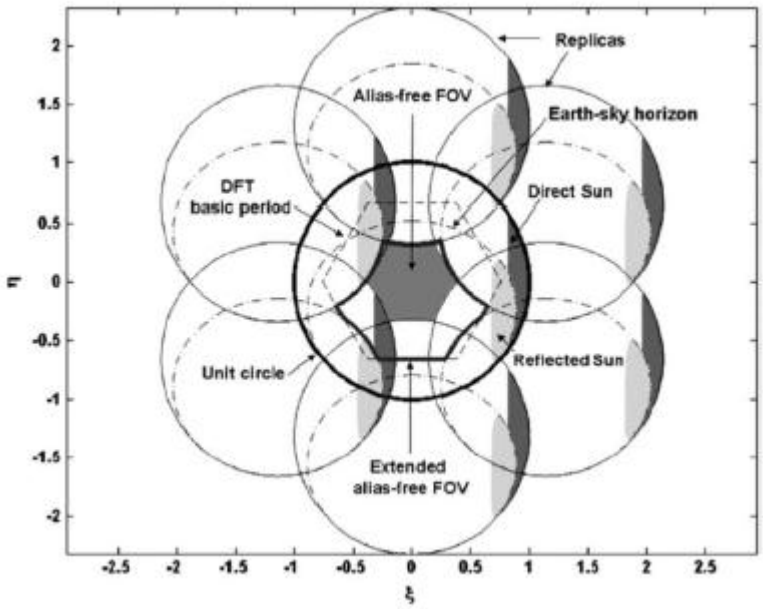

Figure 2: Areas in FOV for a 2-D aperture synthesis Y-shaped interferometric radiometer, with an antenna spacing of 0.875 wavelengths, 32º array tilt, 30º array steering and 755 km platform height [RA.01]

6.2.1. Flags due to pixel position in FOV

6.2.1.1. AF_FOV flag

Pixels with this flag set to TRUE will be contained inside the true alias free Field of View of the scene. This true alias free FOV is represented by the area of the scene not affected by the replication of the unit circles. Over this area, there shall be no overlapping of BT values from scene aliases.

6.2.1.2. EAF_FOV flag

Pixels with the flag set to TRUE will be contained inside the Extended alias-free FOV, obtained by subtracting the contribution of the Sky BT to the calibrated visibilities. In this case the reconstruction FOV is not limited by the unit circles, but by the repetition of the Earth-Sky border.

Sources not properly subtracted from the Sky may be present in the scene as part of the overlapping alias (e.g. Sun).

As they are defined, pixels with AF_FOV flag will always have the EAF_FOV flag, and pixels with the EAF_FOV flag may not necessarily have the AF_FOV flag.

6.2.1.3. BORDER_FOV flag

Pixels with this flag set to TRUE will be very close to the border of the extended alias-free FOV.

In the UPC Extended-CLEAN method, every iteration in the algorithm forces the BT field outside of the EAF-FOV to be zero. This artefact made ripples in the reconstructed image for all borders of the FOV

(Gibbs phenomena). It is not known if other reconstruction methods will have ripples in the border of the reconstructed image, but the pixels in that area shall be marked for reference.

Distance to the border shall be configurable, and is currently defined as 30km.

6.2.2. Flags due to foreign effects in FOV

As can be seen in the next figures, the Sun has a strong effect in the reconstruction process, and if not properly corrected, it may distort the recovered Brightness Temperature values beyond their usefulness.

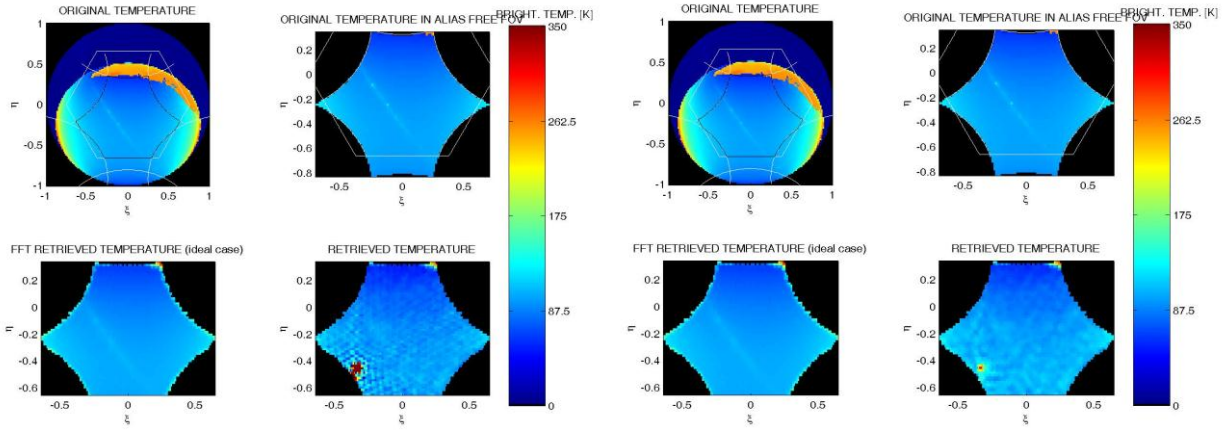

Figure 3: Uncorrected SUN effect (left) and Corrected SUN effect over sea (right)

In this image of an Ocean reconstructed scene, the effects of the bright point source presented by the Sun and the associated Gibbs phenomena may be observed in the left image. On the right image, during reconstruction an estimate of the Sun Brightness Temperature using the data from the scene itself has been used to correct the Sun effect, reducing the ripples.

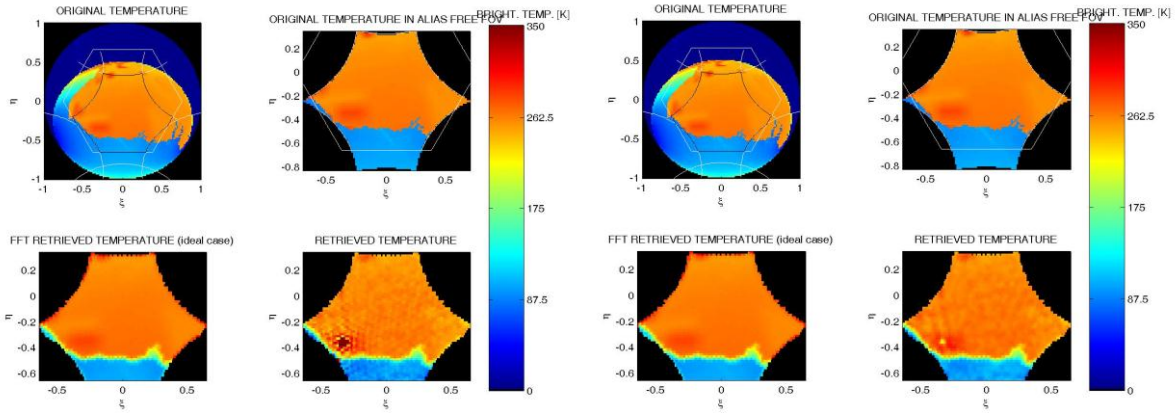

Figure 4: Uncorrected SUN effect (left) and Corrected SUN effect over land (right)

In this image the same approach as before is presented, but using a land scene to show the effects of inaccuracies in the Sun retrieval, that make necessary the definition of additional flags.

Both cases displayed were computed using the Blackman apodisation window, in case of reconstruction with a rectangular window, the effects of uncorrected Sun are more acute and spread over the image.

6.2.2.1. SUN_FOV flag

Whenever a scene is reconstructed with the Sun present as a direct source entering as an alias in the FOV, all pixels belonging to that scene shall be flagged with this value. The L1 Processor shall attempt a correction of the Sun influence of the scene, but as to the moment the accuracy attained may not be enough for L2 purposes, so the flagged pixels may be easily identified and discarded at L2 if desired.

Correction is based in a fast reconstruction of the scene (by means of FFT), retrieving the BT magnitude over the position where the Sun is entering the FOV. It may be possible to improve correction, by averaging the Sun BT value over previously obtained values. It is almost certain that its presence shall always be observed, with whatever degree of accuracy, by entering through the back lobes of the receivers.

6.2.2.2. SUN_POINT flag

In a scene affected by the direct Sun entering as an alias in the Extended alias-free FOV, the pixels of the Earth Fixed grid situated close to the exact position of the Sun alias shall be flagged with this value. In tests performed by UPC aiming to remove the direct Sun contribution, errors in the estimation of the Sun Brightness Temperature cause that the BT value for the overlapping pixels are computed with big biases.

This flag shall indicate these effects to the L2 users.

6.2.2.3. SUN_TAILS flag

In a scene affected by the direct Sun entering as an alias in the Extended alias-free FOV, the pixels situated over the hexagonal directions with respect to the position of the Sun alias shall be flagged with this value. In case the Sun has not been properly removed, these directions are the most prone to contain errors in the BT values, as they are privileged by the sidelobes of the reconstruction beam.

This figure shows the expected propagation path of the tails due to the Hexagonal Discrete Fourier Transform applied to L1b data:

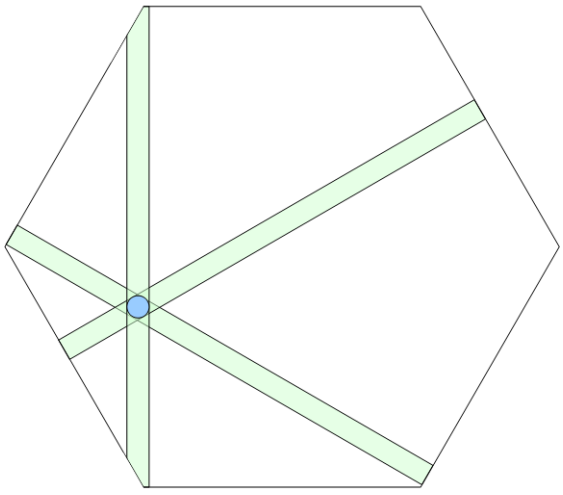

Figure 5: Sun tails areas

The blue circle represents the aliased Sun entering in the nominal reconstruction hexagon. The green areas represent the expected paths of ripple propagation due to a strong source in the blue circle. The

radius of the blue circle and the width of the green areas are the same as for the Direct Sun (0.01 units in xi-eta, equivalent to a 1º beam diameter).

6.2.2.4. SUN_GLINT_FOV flag

Same situation as with the previous flag, except this flag signifies that a reflection of the Sun entered the reconstruction, and could have influenced the results. The specular reflected Sun shall never enter the Extended alias-free FOV, but its effects due to sea roughness and Gibbs phenomena may, so the scene shall be flagged.

This flag indicates that the L1 Processor has attempted a correction of the reflected Sun influence in the scene. The correction strategy shall be based on obtaining the Sun BT magnitude at the specular reflection position (already attenuated) by means of a fast FFT reconstruction. It shall then compute an approximate Brightness temperature distribution based on this magnitude and several standard geophysical parameters (wind speed, SST…). The L1 Processor shall remove this contribution in term of visibilities (again using FFT or G matrix), and attempt a reconstruction with most of the Sun glint effects corrected.

6.2.2.5. SUN_GLINT_AREA flag

In a scene affected by the Sun entering as reflection in the Extended alias-free FOV, the pixels situated over the estimated area of the Sun reflection shall be flagged with this value. This area is where the L1 Processor estimated the reflected energy and corrected it in terms of visibilities.

This flag shall indicate to the L2 users that a correction has been performed over that area, using as a threshold a defined minimum bi-static scattering parameter to be compared against the obtained bi-static coefficient over that pixel. If the computed scattering coefficient surpasses the threshold, then the pixel measurement will be flagged with potential Sun Glint contamination (and its correction if it is activated in the configuration file).

6.2.2.6. RFI flag

For every pixel, there shall be an RFI flag defined in a specific Auxiliary File, which will be translated directly into a flag within the L1c products. No estimation of extraneous sources shall be made by comparing values retrieved in consecutive snapshots in the NRTP. Identification of RFI sources shall be done at L2 or CEC by spatial and temporal data analysis. The NRTP shall simply mark the pixels already identified for an easier discarding by L2.

6.2.3. Flag formatting in L1C products

These flags are represented in field #3 of Table 13 and Table 14. They shall be used to report polarisation of the pixel measurement data, as well as quality values applicable to the measurement.

The flags are contained in an 16-bit counter, each bit representing a status, and they shall be described using the following order convention: [MSB:X X X X:X X X X:X X X X:X X X X:LSB]

- Polarisation flags:
  - [X X X X:X X X X:X X X X:X X 0 0] represents HH polarisation (the BT_Value_Imag in the corresponding DSR should be equal to 0)
  - [X X X X:X X X X:X X X X:X X 0 1] represents VV polarisation (the BT_Value_Imag in the corresponding DSR should be equal to 0)
  - [X X X X:X X X X:X X X X:X X 1 0] represents the Real part and Imaginary part of the HV polarization when the instrument was in VHH+HVH+HHV arm configuration
  - [X X X X:X X X X:X X X X:X X 1 1] represents the Real part and Imaginary part of the HV polarization when the instrument was in HVV+VHV+VVH arm configuration
- SUN FOV flag:
  - [X X X X:X X X X:X X X X:X 0 X X] means that **no** Direct Sun correction has been performed during image reconstruction of this pixel
  - [X X X X:X X X X:X X X X:X 1 X X] means that Direct Sun correction has been performed during image reconstruction of this pixel
- SUN GLINT_FOV flag:
  - [X X X X:X X X X:X X X X:0 X X X] means that no Reflected Sun correction has been performed during image reconstruction of this pixel
  - [X X X X:X X X X:X X X X:1 X X X] means that Reflected Sun correction has been performed during image reconstruction of this pixel. Sun correction is based on the Sea bistatic coefficients defined in the AUX_BSCAT ADF and computed for a fixed wind speed of 7 m/s and wind direction of 0 deg North
- MOON FOV flag:
  - [X X X X:X X X X:X X X 0:X X X X] means that **no** Direct Moon correction has been performed during image reconstruction of this pixel
  - [X X X X:X X X X:X X X 1:X X X X] means that Direct Moon correction has been performed during image reconstruction of this pixel
- SINGLE_SNAPSHOT flag:
  - [X X X X:X X X X:X X 0 X:X X X X] means that this scene has been combined with an adjacent scene in opposite polarisation during image reconstruction to account for cross-polarisation leakage

- [X X X X:X X X X:X X 1 X:X X X X] means that this scene has **not** been combined with an adjacent scene in opposite polarisation during image reconstruction to account for cross-polarisation leakage (it has been processed with only co-polar antenna patterns information)

❑ RFI Mitigation flag:

- [X X X X:X X X X:X 0 X X:X X X X] means that no RFI Mitigation has been performed during image reconstruction of this pixel measurement
- [X X X X:X X X X:X 1 X X:X X X X] means that RFI Mitigation has been performed during image reconstruction of this pixel measurement

❑ SUN POINT flag:

- [X X X X:X X X X:0 X X X:X X X X] means that this pixel is not located in a zone (see below) where a Sun alias was reconstructed
- [X X X X:X X X X:1 X X X:X X X X] means that this pixel is located in a zone (circle around Sun alias position with radius configurable through Sun_Point_Flag_Size field in AUX CNFL1P) where a Sun alias was reconstructed (if Sun removal is active, measurement may be degraded)

❑ SUN GLINT_AREA flag:

- [X X X X:X X X 0:X X X X:X X X X] means that this pixel is located in a zone where no Sun reflection has been detected
- [X X X X:X X X 1:X X X X:X X X X] means that this pixel is located in a zone where Sun reflection has been detected using the bi-static scattering coefficient threshold defined in the configuration file.

❑ MOON POINT flag:

- [X X X X:X X 0 X:X X X X:X X X X] means that this pixel is located in a zone where **no** Moon alias was reconstructed
- [X X X X:X X 1 X:X X X X:X X X X] means that this pixel is located in a zone where a Moon alias was reconstructed (after Moon removal, measurement may be degraded)

❑ AF FOV flag:

- [X X X X:X 0 X X:X X X X:X X X X] means that the pixel **is not inside** the exclusive zone of Alias free (delimited by the six aliased unit circles)
- [X X X X:X 1 X X:X X X X:X X X X] means that the pixel **is inside** the exclusive zone of Alias free (delimited by the six aliased unit circles)

❑ BORDER FOV flag:

- [X X X 0:X X X X:X X X X:X X X X] means that the pixel is far from the border delimiting the Extended Alias free zone and from the unit circle replicas borders (also known as “suspenders and belts”)
- [X X X 1:X X X X:X X X X:X X X X] means that the pixel is close to the border delimiting the Extended Alias free zone or to the unit circle replicas borders (also known as “suspenders and belts”). Distance threshold is configurable through FOV_Border_Flag_Size field in AUX CNFL1P

- SUN TAILS flag:
  - [X X 0 X:X X X X:X X X X:X X X X] means that this pixel is located in a zone with no potential problems with Sun aliases
  - [X X 1 X:X X X X:X X X X:X X X X] means that this pixel is located in the hexagonal alias directions centred on a Sun alias (if Sun is not removed, measurement may be degraded in these directions)
- RFI flag:
  - [X 0 X X:X X X X:X X X X:X X X X] means that the measurement is not affected by strong RFI as detected in the L1b processing
  - o [X 1 X X:X X X X:X X X X:X X X X] means that the measurement is affected by strong RFI as detected in the L1b processing (max RFI self estimated BT above a defined threshold)
  - [0 X X X:X X X X:X X X X:X X X X] means that the measurement is not affected by any point source RFI as identified in the AUX RFI list and it does not exceed the threshold defined in BT_Dual/Full_RFI_Pixel_Flag_Threshold fields in AUX CNFL1P
  - [1 X X X:X X X X:X X X X:X X X X] means that the measurement is affected by point source RFI as identified in the AUX RFI list (flag is set in a circle around the RFI position, with a radius dependant on the RFI expected BT defined in the AUX RFILST), or it has exceeded the threshold defined in BT_Dual/Full_RFI_Pixel_Flag_Threshold fields in AUX CNFL1P, or is negative for Dual Polarisation values
  - [X X X X:0 X X X:X X X X:X X X X] means that the pixel is not affected by any tails from point source RFI as identified in the AUX RFILST ADF
  - [X X X X:1 X X X:X X X X:X X X X] means that the measurement is affected by the tails of a point source RFI as identified in the AUX RFI list (tail width is dependant on the RFI expected BT defined in the AUX RFILST)

6.3. Reference Frames

Throughout the products, 4 quaternion components are used to represent the pointing of the spacecraft. These quaternions are first decoded from the ancillary data packet together with the angular velocity, and are later propagated to the middle of the integration time of each snapshot. This propagation is needed because Proteus produces the attitude information on a regular time basis that is not coordinated with the instrument's integration time.

These quaternions represent the rotation angles from the J2000 Inertial Reference Frame to the Spacecraft Body Frame.

Reference coordinate frame J2000 inertial reference system is represented by the following axes:

- +Z2000 is normal to the Mean Earth Equator of Epoch J2000
- +X2000 is parallel to the Mean Earth Vernal Equinox of Epoch J2000
- +Y2000 completes the right-handed system, where the Epoch of J2000 is the Julian Ephemeris Date 2451545.0.

Spacecraft Body Frame is defined in [AD.6] as:

- +XS: Longitudinal axis; perpendicular to the launch vehicle/satellite interface plane; positively oriented from the launch vehicle towards the satellite; +Xs corresponds to the launch direction.
- +YS: Completes the orthogonal right-handed satellite reference frame; YS is parallel to the launch vehicle/satellite interface plane; (YS is parallel to the satellite solar arrays rotation axis).
- +ZS: Transversal axis; parallel to the launch vehicle/satellite interface plane; positively oriented from the Origin OS towards the "H01" electrical connectors bracket of the PROTEUS platform.

The Spacecraft Body Frame thus already includes the tilt angle, as there are no rotations from Body Frame to Instrument Frame

From the Spacecraft Body Frame to the real pointing of the instrument, there must be one additional rotation. This rotation is required between the Instrument Frame and the Best Fit Plane (which takes into account mispointing due to discrepancies in the antennas' phase centres)

Orbital information in the ancillary data packets is also expressed in the Earth Centred J2000 Inertial Reference Frame, which is the same as above but centred over the Earth. This data shall be propagated and expressed in the EE CFI Earth Fixed CS Frame for all L1 products.

6.4. Discrete Global Grid Analysis

The DGG used for NRT L1c Products is different than the grid used in the L1c nominal products. This is because the needs of ECMWF did not require an intercell distance of 15km for Ocean pixels, and this distance could be relaxed to a bigger amount.

The characteristics of the L1 baseline Discrete Global Grid are known according to the ISEA Hexagonal grid with aperture 4 and resolution 9 (4H9). This grid provides an average intercell distance of 15km, with less than 1km standard deviation, over 2,621,442 pixels. Characteristics of ISEA Hexagonal grids of aperture 4 can be seen in the following table, taken from [RD.02] and this site.

Table 23: ISEA Hexagonal Aperture 4 characteristics

Resolution	Number of Grid Cells	Intercell Distance (km)	Standard Deviation (km)
6	40,962	119.913	7.641
7	163,842	59.957	3.817
8	655,362	29.978	1.908
9	2,621,442	14.989	0.904
10	10,485,762	7.495	Not Available

This 4H9 grid used in the SMOS Fast Processing Centre provides roughly 5500 pixels per scene, under nominal conditions, although the number of pixels varies from scene to scene and also during the orbit (depending on the swath location over the grid, see next figure).

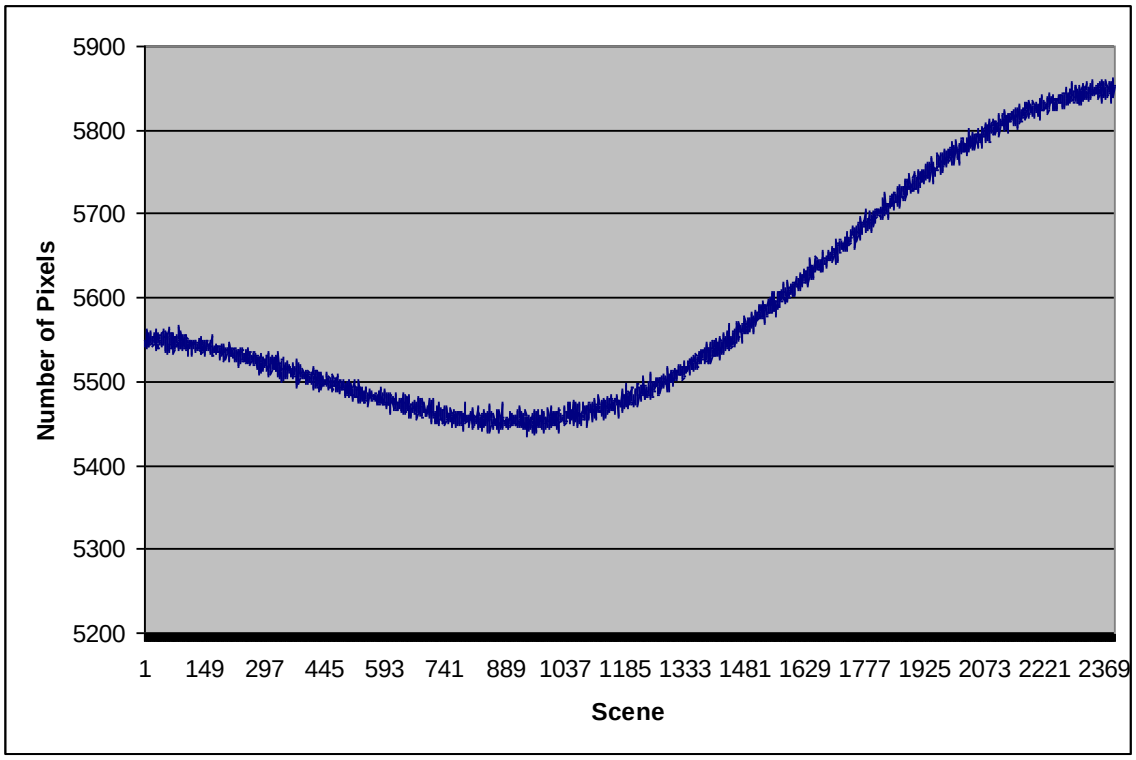

Figure 6: Pixel number variation along the orbit

However, this DGG provides a discretisation that is too high for the SMOS natural pixel size, which is about 30km diameter on boresight, and can go up to 90km at high incidence angles. With this resolution, SMOS pixels would be centred on the DGG nodes, but they would cover up to the centres of the six adjacent nodes, effectively overlapping completely. This can be easily seen in the following figure, where the blue hexagons represent the ISEA cells (of which only the centre coordinates are used in the processing), and the yellow circles represent SMOS synthesized beams in the boresight direction (footprints):

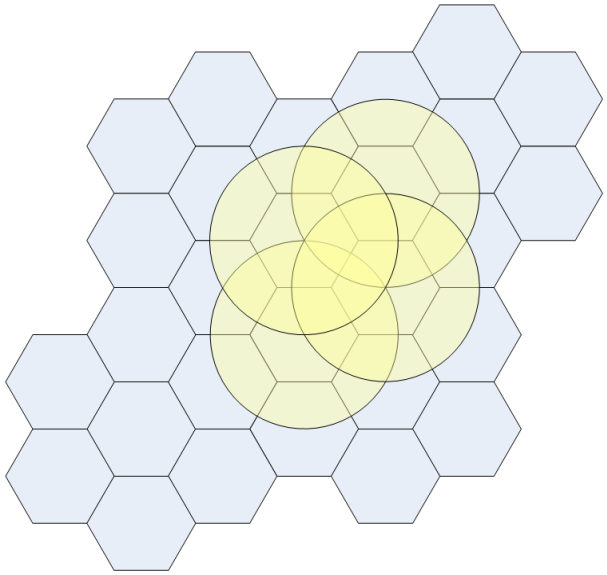

Figure 7: ISEA 4H9 and SMOS footprints

A dedicated study demonstrated that the best candidate for Ocean pixels in NRT products was the ISEA Hexagonal grid with aperture 4 and resolution 8 (4H8). This grid contains 655,362 pixels, with an averaged intercell distance of 30km and a standard deviation of 2km (as shown above). It has an added advantage in that the pixels within the 4H8 grid are **completely** contained within the 4H9 grid, so that L2 processing does not need any kind of interpolation to use the same nodes as in the operational chain. These nodes would come out naturally from the NRT processing.

Using this grid for NRT L1c processing over Ocena areas means that only **25%** of the previous pixels need to be processed, indicating a direct performance improvement in the order of 400% over those areas.

Representing the same footprints in the 4H8 grid results in a different overlapping of adjacent pixels, as the number of grid points is reduced. However, it is still possible to have overlap for footprints out of the boresight direction, as they tend to be elliptical due to the distortion that appears with incidence angle (e.g. red and green footprints):

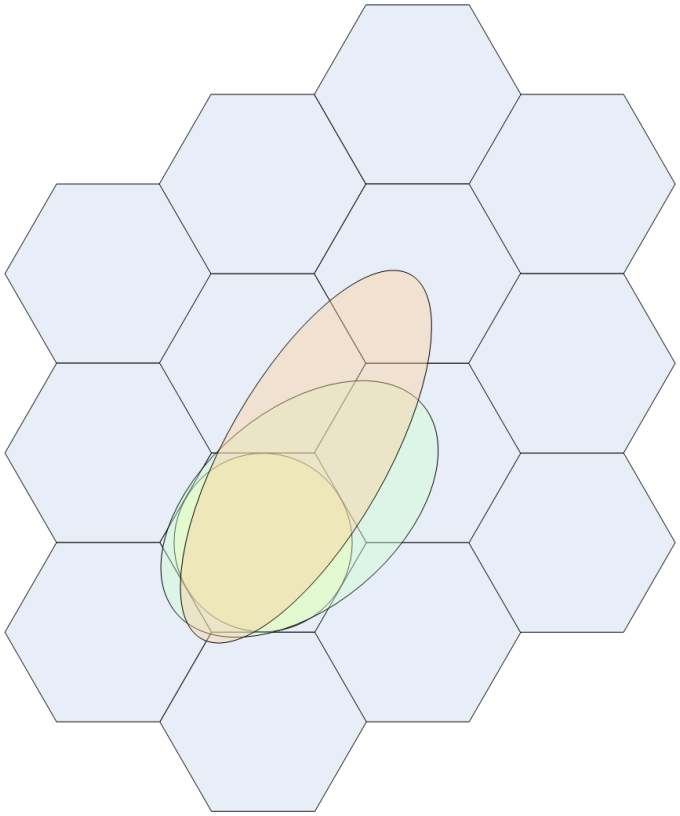

Figure 8: ISEA 4H8 and SMOS footprints

The footprints presented in the image correspond to the same pixel (same lat-lon coordinates) but were taken at different incidence angles. They come from the projection of the SMOS synthetic beam (an elliptical cone delimited by the 3dB contour) over the Earth ellipsoid.

Finally, further activities were performed by DEIMOS on the DGG in order to improve it with elevation data from a DEM (GETASSE30), and the creation of the associated Land-Sea Mask. Additionally, the DGG was expanded for coastlines making, as the need for differentiation was greater on those areas. The next figure shows the ISEA 4H9 pixels within 200km of the GSHHS dilated coastline.

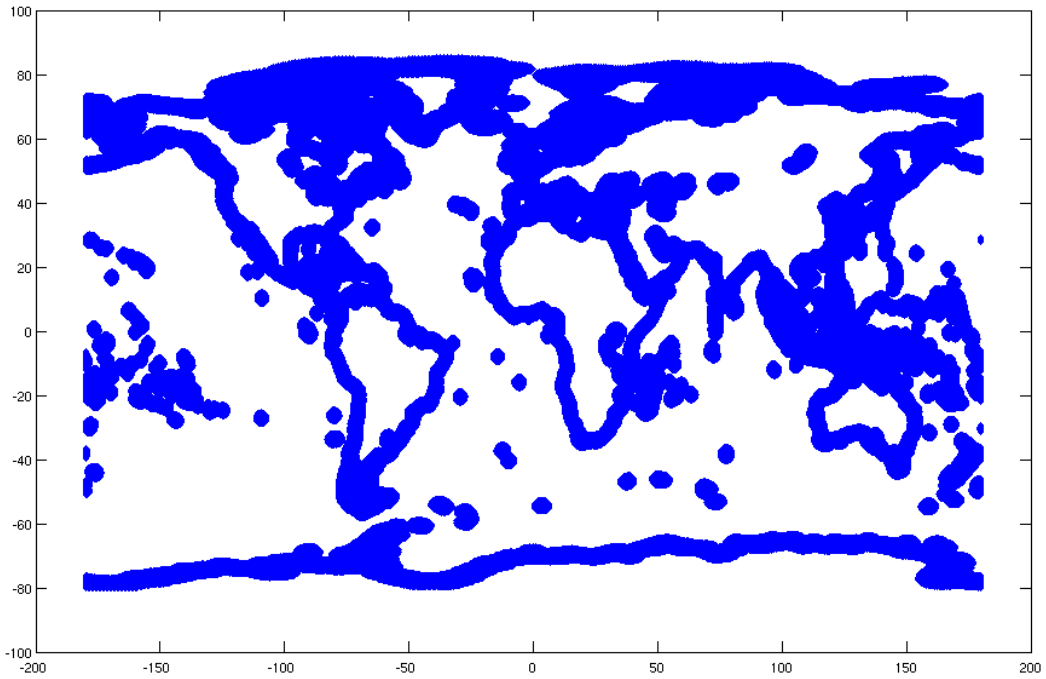

Figure 9: ISEA 4H9 pixels within 200km coastline

With this dilated coastline of 200km, the number of ISEA 4H9 pixels falling within the increased resolution zone is 731,803 (25% of which are already contained in the ISEA 4H8 grid). In this situation, the total number of grid points that are used in the NRT L1c processing is approximately 1,205,000, still below **50%** of what is used operationally.