CIMR RGB – Re-Gridding Toolbox

D4 - Input/Output Data Definition

Signature Page

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Changelog

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1.1	S&T AS	References 3 5.1.2 Annex D Annex D Annex D	RID01: MS3-MSC-1 RID07: MS3-MSC-7 RID08: MS3-MSC-8 RID09: MS3-MSC-9 RID011: MS3-MSC-11 RID012: MS3-MSC-12	Modifed	2024-12-17
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Acronyms

AMSR2	Advanced Microwave Scanning Radiometer
BG	Backus-Gilbert
CEA	Cylindrical Equal Area
CG	Conjugate Gradients
CIMR	Copernicus Imaging Microwave Radiometer
DIB	Drop-in-the-Bucket
EASE	Equal-Area Scalable Earth
HDF	Hierarchical Data Format
IDS	Inverse Distance Squared
IODD	Input/Output Data Definition
L1b, L2	Level 1b, Level 2
LW	Landweber
LAEA	Lamberts Equal Area
LTS	Long Term Support
NaN	Not a Number
NETCDF	Network Common Data Form
NN	Nearest Neighbour
PAD	Processing and Algorithm Development
rSIR	Radiometer Scatterometer Image Reconstruction
SMAP	Soil Moisture Active Passive
UML	Unified Modelling Language
XML	eXtensible Markup Language

1. Introduction

1.1 Purpose and Scope

This document contains the *Input/Output Data Definition* for the CIMR RGB project, in accordance with the contract and SoW.

This document aims to define the Input and Output Data specifications for the *CIMR Re-Gridding toolBox* (RGB). It outlines the various input data sources that the toolbox can process, such as configuration files, L1b radiometer brightness temperature datasets, and instrument antenna pattern files. Additionally, it describes the format and structure of the regridded output products generated by the RGB.

1.2. Document Structure

The document is structured as follows:

- Section 1 provides an introduction and defines the scope of this document.
- Section 2 provides references.
- Section 3 provides a high-level overview of the Software Architecture of the toolbox.
- Section 4 describes the RGB configuration file and associated command line interface.
- Section 5 provides an overview of the Input and Output data of the toolbox.
- Annex A presents an overview of the antenna pattern processing module that was created in order to convert antenna patterns to a format usable by the toolbox.
- Annex B presents RGB command line options.
- Annex C presents the `JSON` formatted logging configuration file.
- Annex D provides an example CDL for L1c data format.

2. References

2.1. Applicable Documents

AD	Title	Reference
[LI]	Request for Proposal for CIMR RGB RE-GRIDDING TOOL BOX - EXPRO - ESA RFP/3-17792/22/I-AG	Invitation letter: Request for Proposal for CIMR RGB RE-GRIDDING TOOL BOX - EXPRO Activity No. 1000035090 in the esa-star system
[SOW]	Statement of Work for “Statement of Work ESA Express Procurement - EXPRO CIMR RGB – Re-Gridding tool Box”	ESA-EOPG-EOPGMQ-SOW-48
[CC]	Draft Contract for “CIMR RGB Re-Gridding Tool Box - EXPRO”	ESA Contract No. 4000xxxxxx/22/I-AG
[TC]	Conditions of Tender for “CIMR RGB Re-Gridding Tool Box - EXPRO”	Appendix 3 EXPRO Tendering Conditions (EXPRO/TC)

2.2. Reference Documents

RD	Title	Reference
[RD1]	SMAP L1B Radiometer Half-Orbit Time-Ordered Brightness Temperatures, Version 6 (Dataset)	Piepmeier, J. R., Mohammed, P., Peng, J., Kim, E. J., De Amici, G., Chaubell, J. & Ruf, C. (2023). SMAP L1B Radiometer Half-Orbit Time-Ordered Brightness Temperatures. (SPL1BTB, Version 6). [Data Set]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center.
[RD2]	SMAP L1C Radiometer Half-Orbit 36 km EASE-Grid Brightness Temperatures, Version 6	Chan, S., Njoku, E. G. & Colliander, A. (2023). SMAP L1C Radiometer Half-Orbit 36 km EASE-Grid Brightness Temperatures. (SPL1CTB, Version 6). [Data Set]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center.
[RD3]	SMAP Enhanced L1C Radiometer Half-Orbit 9 km EASE-Grid Brightness Temperatures, Version 4	Chaubell, J., Chan, S., Dunbar, R. S., Peng, J. & Yueh, S. (2023). SMAP Enhanced L1C Radiometer Half-Orbit 9 km EASE-Grid Brightness Temperatures. (SPL1CTB_E, Version 4). [Data Set]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center.

[RD4]	SMAP Radiometer Twice-Daily rSIR-Enhanced EASE-Grid 2.0 Brightness Temperatures, Version 2	Brodzik, M. J., Long, D. G. & Hardman, M. A. (2021). SMAP Radiometer Twice-Daily rSIR-Enhanced EASE-Grid 2.0 Brightness Temperatures. (NSIDC-0738, Version 2). [Data Set]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center.
[RD5]	Soil Moisture Active Passive (SMAP) L1-L3 Ancillary Static Data V001	Peng, J., Mohammed, P., Chaubell, J., Chan, S., Kim, S., Das, N., Dunbar, S., Bindlish, R. & Xu, X. (2019). Soil Moisture Active Passive (SMAP) L1-L3 Ancillary Static Data. (SMAP_L1_L3_ANC_STATIC, Version 1). [Data Set]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/HB8BPJ13TDQJ. [describe subset used if applicable]. Date Accessed 11-20-2024.
[RD6]	GCOM-W/AMSR2 L1B Brightness Temperature	Japan Aerospace Exploration Agency. 2012. GCOM-W/AMSR2 L1B Brightness Temperature.
[RD7]	GCOM-W/AMSR2 L1R Brightness Temperature	Japan Aerospace Exploration Agency. 2012. GCOM-W/AMSR2 L1R Brightness Temperature.
[RD8]	TICRA Tools User's Manual	TICRA Tools Version 19.1, December 2019
[RD9]	Generic IPF Interface Specifications	MMFI-GSEG-EOPG-TN-07-0003, v1.8, 2009-08-03
[RD10]	Copernicus Imaging Microwave Radiometer (CIMR) Requirements Document Version 4.0	ESA-EOPSM-CIMR-MRD-3236
[RD11]	CIMR RGB Design Document	CIMR-DD-ST-RGB-001 v1.3
[RD12]	CIMR RGB Level 1c Product Data Format Specifications	CIMR--ICD-ST-RGB-002 v1.3
[RD13]	CIMR RGB Performance Assessment Plan	CIMR-TP-ST-RGB-003 v1.2
[RD14]	CIMR RGB Detailed Processing Model	CIMR-COM-ST-RGB-006
[RD15]	CIMR RGB Software Installation and User Manual	CIMR-UM-ST-RGB-009

3. Software Overview

The primary objective of the RGB is to ingest L1b microwave data and to remap it to a grid of the user's choice. Figure 1 provides a high-level architectural overview of the RGB, where the main processing components are separated into three categories: “Data Management”, “Grid Generation” and “Re-gridding Algorithms”.

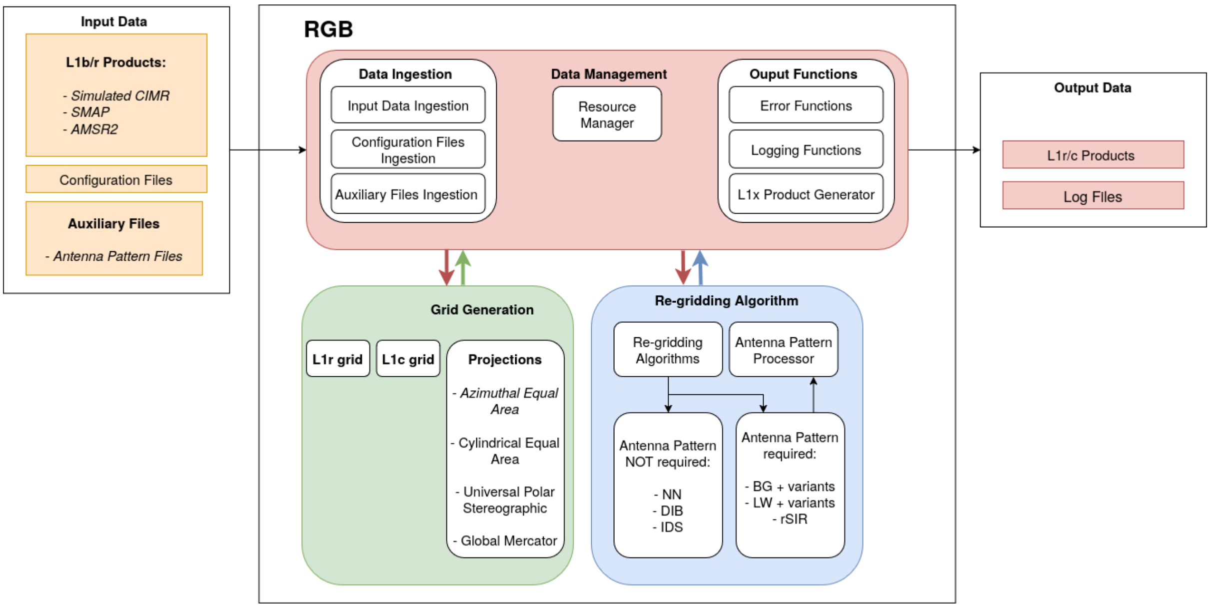


Figure 1 - RGB High Level Architecture.

The ethos of a "toolbox" fundamentally guided the software's design, aimed at providing users with diverse options to experiment with and tailor configurations to achieve optimal regridding solutions for their specific needs. This toolbox approach is governed by a user-configurable configuration file, which is ingested and validated upon startup, then passed through various processing modules to supply the relevant parameters. Users can adjust a range of options, including output grid/projection type, regridding algorithm, and algorithm tuning parameters. A comprehensive description of the configuration file and available parameters is provided in [RD15] - *Software Installation and User Guide*.

After configuration validation, the RGB will ingest some L1b data along with any required auxiliary data files. The system is currently equipped with the capability to ingest certain SMAP, AMSR2, and simulated CIMR products (a detailed description of these datasets can be found in Section 5. After ingestion, a grid will be generated and, along with the source data, passed to the regridding module, where one of a variety of interpolation algorithms can be applied.

Finally, the regridded data will be packaged as a netCDF file according to the structure outlined in the Annex D, along with a log file containing information about the software performance and parameters used for the regridding.

4. Configuration File

The configuration file in XLM format defines all the parameters that are needed by the RGB software in order to perform a regridding of radiometric data. Among other things, the user can select the type of regridding (L1r, L1c), the map projections where to regrid the data (EASE2, stereographic, etc.), the regridding algorithm (inverse distance squared, Backus-Gilbert, etc.) and specific tuning parameters of each algorithm. A correctly validated configuration file is a requirement for the functioning of the toolbox, and a comprehensive list of all user-configurable parameters along with example configuration file is provided in [RD15] - *Software Installation and User Manual*.

5. Input and Auxiliary Data

This section describes the data and auxiliary inputs required for the RGB software. CIMR RGB is a versatile tool capable of working with various datasets, such as CIMR, SMAP, and AMSR2, with the flexibility to support additional datasets in the future. While these datasets share certain similarities, they often use different data formats and conventions across their development and operational lifecycles.

To address these differences, a standardised format for antenna patterns was developed to ensure compatibility and streamline their ingestion into the RGB module. The SMAP antenna patterns were used as the baseline for defining this standard, a summary of which is provided in Section 5.1.2.

5.1. SMAP

5.1.1. L1b and L1c Data

The RGB takes as input *SMAP L1b Radiometer Half Orbit Time-Ordered Brightness Temperatures, Version 6* [RD11]. It is expected that previous versions will still work, but this has not been verified. Associated documentation such as the ATBD, Product Specification and User Manual can all be found on the landing page of the provided reference.

While technically not an input to the RGB, SMAP offers three L1C products that can be used for comparison and results validation. The “basic” product provides an IDS regrid on an EASE2 36km grid [RD12]. The enhanced version provides a BG regrid on an EASE2 9km grid [RD13]. There is also a product that just contains brightness temperatures at various grid resolutions [RD4], interpolated using the rSIR algorithm. The associated product documentation can be found on the product's landing page provided in the reference.

5.1.2. Antenna Patterns

The SMAP radiometer antenna pattern data [RD5] is stored in an HDF5 file format, which consists of two primary groups: `Grid` and `Gain`. The data employs a spherical coordinate system.

The `Grid` group contains two fields, `theta` and `phi`. The `theta` values range from 0 to 180 degrees with a sampling of 0.1 degrees, while `phi` values span from 0 to 360 degrees, also at 0.1-degree sampling.

The `Gain` group includes eight fields representing gain values, provided on a linear scale. The *top-left* coordinates of these matrices correspond to (`theta = 0`, `phi = 0`), while the *bottom-right* coordinates correspond to `(theta = 180` degrees, `phi=360` degrees). These gain fields provide detailed measurements across the entire spherical coordinate system, and their names and descriptions are detailed below.

Table 1 - Internal Structure of the SMAP Antenna Pattern file: `RadiometerAntPattern_170830_v011.h5`

Parameter	Type	Array Size	Description
`/Gain`	Group	-	-
`/Gain/G1h`	Dataset	{3601, 1801}	H co-pol component, real part
`/Gain/G1v`	Dataset	{3601, 1801}	V co-pol component, real part
`/Gain/G2h`	Dataset	{3601, 1801}	H co-pol component, imaginary part
`/Gain/G2v`	Dataset	{3601, 1801}	V co-pol component, imaginary part
`/Gain/G3h`	Dataset	{3601, 1801}	H cross-pol component, real part
`/Gain/G3v`	Dataset	{3601, 1801}	V cross-pol component, real part
`/Gain/G4h`	Dataset	{3601, 1801}	H cross-pol component, imaginary part
`/Gain/G4v`	Dataset	{3601, 1801}	V cross-pol component, imaginary part
`/Grid`	Group	-	-
`/Grid/phi`	Dataset	{3601}	phi angle grid points
`/Grid/theta`	Dataset	{1801}	theta angle grid points

[**Note**]: For more details on SMAP patterns, refer to the *L1-L3 Ancillary Products* [RD5].

5.2. CIMR

5.2.1. L1b Data

There are currently a variety of simulated CIMR products and product formats circulating within the community, and they are continuously evolving. The RGB has been developed according to the files:

- `SCEPS_l1b_sceps_geo_central_america_scene_1_unfiltered_tot_minimal_nom_nedt_apc_tot_v2p1.nc (SCEPS_L1B_1)`
- `SCEPS_l1b_sceps_geo_polar_scene_1_unfiltered_tot_minimal_nom_nedt_apc_tot_v2p1.nc (SCEPS_L1B_2)`

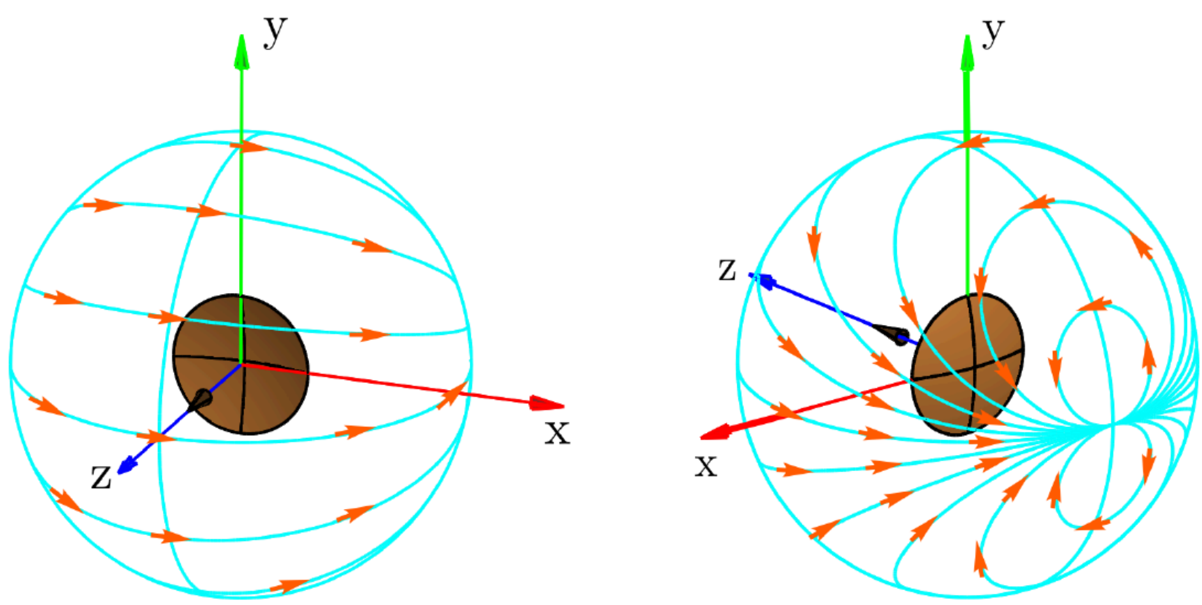
At the time of the initial development of the RGB, these products were the only products available with simulated data. At that time (as well as at the time of writing this document), the latest proposed product format ("`CIMR_E2ESv110_L1B_Product_Format_v0.6.CDL (E2E_PF_6)`") differed to the structure of these products. It was agreed with ESA at this time that the software should be developed based on SCEPS_L1B_1/2 and that the CIMR RGB L1C data and associated product specification document [RD12] should be designed based on the latest product format.

Since then, a simulated data product has been made available (`W_PT-DME-Lisbon-SAT-CIMR-1B_C_DME_20240401T195641_LD_20280110T114800_20280110T115700_002.nc (DEIMOS_L1B_1)`) that aligns with the latest product format (`E2E_PF_6`). Additional work would need to be performed in order to include ingestion functionality for this latest product.

5.2.2. Antenna Patterns

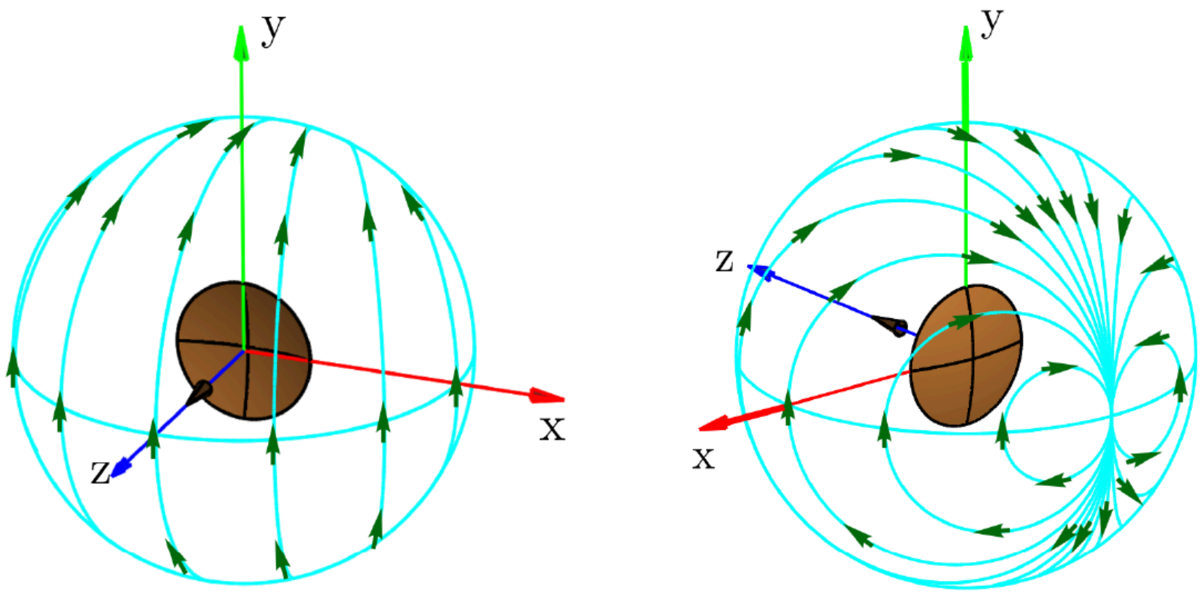
The antenna beam files, generated using GRASP from the TICRA software suite, were provided in a grid format following so-called Ludwig's 3d definition of polarisation. It introduces the so-called co- and cross-polarizations, which offer a consistent characterization of the polarisation across the forward hemisphere of a radiation pattern (see Figures 2a and 3a).

While rigid mathematical treatment is beyond the scope of this document, it is important to note that this definition is especially useful for directive antennas, as it provides a clear description of polarisation from the main beam direction to the outermost sidelobes. However, in the backward hemisphere, this polarisation framework exhibits peculiar behaviour (see Figures 2 and 3). Overall, the Ludwig-3 coordinate system is ideal for representing reflector patterns with their main beam along the z-axis, as shown in Figure 2.



(a) (b)

Figure 2 - The orientation of co-polar unit vectors over the front (a) and back (b) hemispheres. The image is taken from the *TICRA Tools User's Manual* [RD8].



(a) (b)

Figure 3 - The orientation of cross-polar unit vectors over the front (a) and back (b) hemispheres. The image is taken from the *TICRA Tools User's Manual* [RD8].

The GRASP File Format Specification was previously discussed in [RD11]; thus, the description below is built upon that foundation. As was already mentioned, the antenna patterns were provided in grid format with Back Half Space and Front Half Spaces receiving its own file. Hence, the two sets of files were provided for each horn for each band:

```
Ka4-3650-H-BK.grd
Ka4-3650-H-FR.grd
```

where Ka stands for band, 4 is reserved for the horn number, 3650 specifies the central frequency of the current channel, H implies horizontal polarisation, and FR|BK are the acronyms for Forward|Backward or Front Half Space and Back Half Space, respectively.

By simple inspection of the files, it became apparent that some amount of preprocessing will be required since they are very large (~3.6GiB in size) and severely lack metadata. Hence, we have written the stand-alone Python-based preprocessing module as well as defined the unified standard for antenna patterns to be ingested. The module is described in Annex A.

5.2.2.1. RGB Standard for Antenna Patterns

Since the patterns are provided as extremely large text files with `.grd` extension, the first thing was to parse them into a more convenient format, which is HDF5 in this case. It was decided to base the RGB Antenna pattern format on the format of the SMAP antenna patterns, which are described in Section 5.1.2. In addition, some metadata are added to the file, and will be useful in further processing steps of the antenna patterns. The following naming convention (derived to closely resemble the original convention of `grd` files) was introduced for the *parsed* antenna patterns:

```
CIMR-OAP-FR-C1-UVv1.0.0.h5
CIMR-OAP-BK-C1-UVv1.0.0.h5
```

where

- `CIMR` is the name of the experiment (can be e.g., SMAP).
- `OAP` stands for the *Original Antenna Pattern* which implies it was derived from the original GRASP files.
- `FR|BK` stands for Forward|Backward hemisphere of the antenna pattern.
- `C` is the band name
- `1` is the horn number
- `UV` stands for (u,v)-grid.
- `v1.0.0` is the version number

The file contents are summarised in the table below.

Table 2 - Internal Structure of the CIMR Antenna Pattern file: `CIMR-OAP-FR-C1-UVv1.0.0.h5` and `CIMR-OAP-BK-C1-UVv1.0.0.h5`

Parameter	Type	Array Size	Description
/Gain	Group	-	-
/Gain/G1h	Dataset	{2501, 2501}	H co-pol component, real part
/Gain/G1v	Dataset	{2501, 2501}	V co-pol component, real part
/Gain/G2h	Dataset	{2501, 2501}	H co-pol component, imaginary part
/Gain/G2v	Dataset	{2501, 2501}	V co-pol component, imaginary part
/Gain/G3h	Dataset	{2501, 2501}	H cross-pol component, real part
/Gain/G3v	Dataset	{2501, 2501}	V cross-pol component, real part
/Gain/G4h	Dataset	{2501, 2501}	H cross-pol component, imaginary part
/Gain/G4v	Dataset	{2501, 2501}	V cross-pol component, imaginary part
/Grid	Group	-	-
/Grid/dx	Dataset	{SCALAR}	grid spacing in x direction
/Grid/dy	Dataset	{SCALAR}	grid spacing in y direction

`/Grid/nx`	`Dataset`	`{SCALAR}`	number of grid data points in x
`/Grid/ny`	`Dataset`	`{SCALAR}`	number of grid data points in y
`/Grid/u`	`Dataset`	`{2501}`	grid data points in x
`/Grid/v`	`Dataset`	`{2501}`	grid data points in y
`/Grid/xcen`	`Dataset`	`{SCALAR}`	x coordinate of the centre of the antenna pattern
`/Grid/ycen`	`Dataset`	`{SCALAR}`	y coordinate of the centre of the antenna pattern
`/Grid/xs`	`Dataset`	`{SCALAR}`	limit of 2D grid in x
`/Grid/ys`	`Dataset`	`{SCALAR}`	limit of 2D grid in y
`/Version`	`Dataset`	`{SCALAR}`	file version

Since the antenna patterns are initially provided on a (u,v) director cosine grid, which are related to the (θ, ϕ) spherical coordinates through to the equations

$$u = \sin\theta\cos\phi$$

$$v = \sin\theta\sin\phi$$

the conversion into a (θ, ϕ) standard grid is needed to ensure compatibility with the RGB software. The new standardised format is referred to as *preprocessed format*, and it bridges the gap between the raw GRASP data and the requirements of RGB by reformatting the data into the appropriate (θ, ϕ) - grid (as for SMAP antenna patterns).

This file name reflects the following convention:

```
CIMR-PAP-BK-C1-TPv1.0.0.h5
CIMR-PAP-FR-C1-TPv1.0.0.h5
```

where

- `CIMR` is the name of the experiment (can be e.g., SMAP).
- `PAP` stands for the *Preprocessed Antenna Pattern* which implies it was preprocessed (see next section) to be ingestible into RGB software.
- `FR|BK` stands for Forward|Backward hemisphere of the antenna pattern.
- `C` is the band name
- `1` is the horn number
- `TP` stands for (θ, ϕ) - grid.

- `v1.0.0` is the version number

and the file contents are summarised in Table 3.

Table 3 - Internal Structure of the CIMR Antenna Pattern file:
`CIMR-PAP-FR-C1-TPv1.0.0.h5` and `CIMR-PAP-BK-C1-TPv1.0.0.h5`

Parameter	Type	Array Size	Description
/Gain	Group	-	-
/Gain/G1h	Dataset	{3600, 900}	H co-pol component, real part
/Gain/G1v	Dataset	{3600, 900}	V co-pol component, real part
/Gain/G2h	Dataset	{3600, 900}	H co-pol component, imaginary part
/Gain/G2v	Dataset	{3600, 900}	V co-pol component, imaginary part
/Gain/G3h	Dataset	{3600, 900}	H cross-pol component, real part
/Gain/G3v	Dataset	{3600, 900}	V cross-pol component, real part
/Gain/G4h	Dataset	{3600, 900}	H cross-pol component, imaginary part
/Gain/G4v	Dataset	{3600, 900}	V cross-pol component, imaginary part
/Grid	Group	-	-
/Grid/phi	Dataset	{FLOAT ARRAY}	phi angle grid points in degrees
/Grid/theta	Dataset	{FLOAT ARRAY}	phi angle grid points in degrees
/Version	Dataset	{SCALAR}	file version

The number of `phi` and `theta` points is a parameter of the stand-alone antenna pattern processing module. Since antenna patterns of different bands and feedhorns have gains with different angular extension, it was important to adjust the angular resolution accordingly.

Table 4 - Properties of the (θ, ϕ) - grid for the preprocessed antenna pattern files, for each of the CIMR bands.

Band	$\theta_{\max}$	$\mathrm{d}\theta$	$\mathrm{d}\phi$	size `theta` array	size `phi` array
L	5 deg	0.1 deg	0.1 deg	50	3600
C	2 deg	0.04 deg	0.04 deg	50	900
X	1.3 deg	0.025 deg	0.025 deg	52	14400

K	0.6 deg	0.012 deg	0.012 deg	50	30000
Ka	0.3 deg	0.006 deg	0.006 deg	50	60000

5.3. AMSR2

5.3.1. L1b/r Data

The RGB takes as input *GCOM-W/AMSR2 L1B Brightness Temperature* [RD6].

JAXA/NASA does not offer L1C products derived from AMSR L1B BTs. L1R regrids can be compared with *GCOM-W/AMSR2 L1R Brightness Temperature* [RD7]. [**Note**]: This product is a BG regrid, the functionality of which will not be provided in the RGB for AMSR2 data, as the antenna patterns were unobtainable. However, the user will have the ability to perform a BG regrid with the use of a simulated antenna pattern.

5.3.2. Antenna Patterns

While we successfully accessed antenna pattern data for several instruments, the patterns for the **AMSR2 instrument** were unfortunately unavailable, as was already mentioned. Despite extensive efforts, including outreach and searches through repositories, the data could not be obtained due to restrictions or lack of accessibility. This meant that only the regridding algorithms that do not use antenna patterns are available for this product

5.4. Logging

The software includes a configurable logging functionality, which is set up through a JSON file whose location is specified via XML parameter file. This JSON file specifies the logging parameters, such as log levels, output formats, and file locations for log storage. By using this configuration file, users can tailor the logging behaviour to their specific needs, ensuring that important operational details are recorded appropriately while avoiding unnecessary verbosity.

The operation of logging functionality is explained in *Software Installation and User Manual* [RD15]. For users looking for a ready-to-use example or a template for their logging configuration, a formatted `JSON` file is provided in Annex C. This annex serves as a practical reference, demonstrating the structure and key-value pairs required to configure the logging system effectively.

5.5. Output Data

When running the full pipeline, the RGB will package the regridded data into a netCDF file and save it in a user specified directory. As users are able to choose the bands, variables and whether to separate the scan direction, the exact content of the output is dependent on the user's input. However, the general structure of output data is the same for all data types (SMAP, CIMR, AMSR2).

There is a difference in structure of the output file depending on whether the user has selected an L1c or L1r target grid.

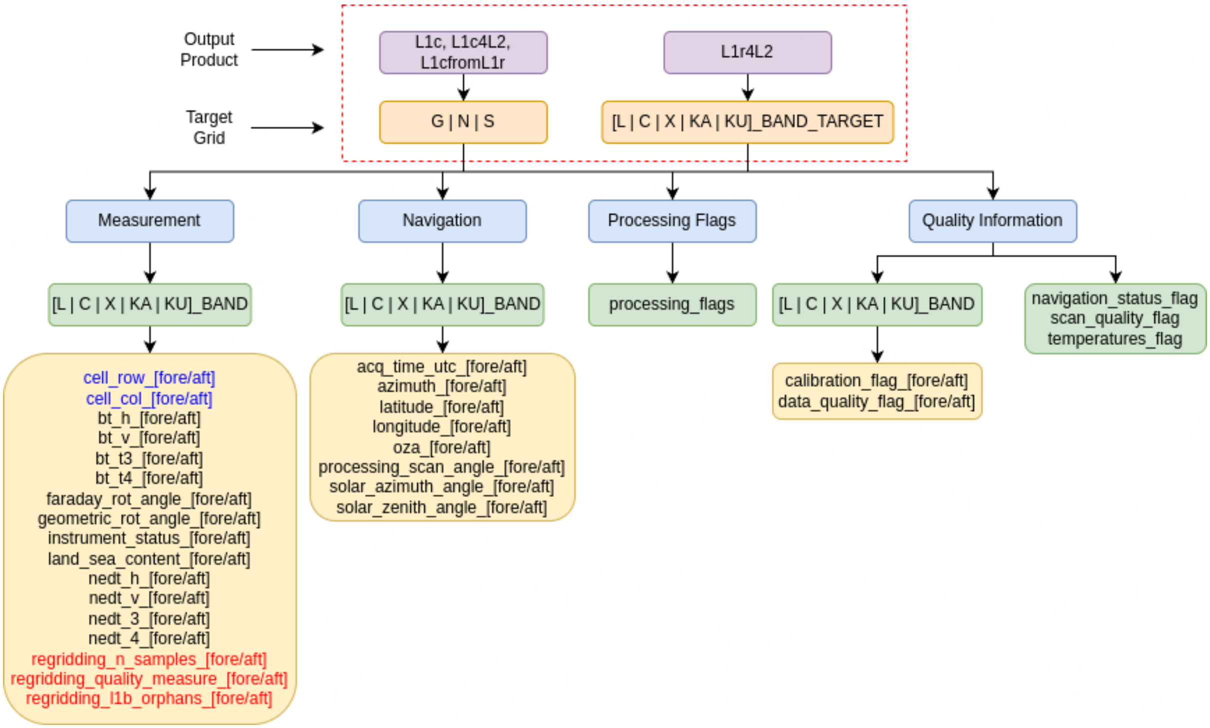


Figure 4 - General Structure for RGB netCDF output data. Variables in red are added as a result of the regridding. Blue variables will only appear in the L1C product and not L1R

Figure 4 provides the general structure for RGB output data, tailored for CIMR notation. The only difference between an L1c and L1r regrid is the target band group, which is one or multiple projections for L1c data and one or multiple band footprints for L1r data. Additionally, L1c data has the additional variables "`cell_col`" and "`cell_row`" which are grid indexes used to reconstruct the target grid.

The output netCDF will always follow the general structure outlined in Figure 4, however, when a user selects less variables for regridding, this will of course reflect as less variables in the output file.

5.5.1. L1c

An example CDL can be found in Annex D. A selection of bands (`L`, `C`, `Ka`) are regridded, with a selection of variables (`bt_h`, `bt_v`, `longitude`, `latitude`, `processing_scan_angle`, `regridding_n_samples`, `regridding_l1b_orphans`, `oza`, `acq_time_utc`, `azimuth`) included. Samples have been separated into fore and aft scans. The variables are all provided as a one-dimensional array of size `N_fore` or `N_aft`, representing the number of output cells that was regridded for each scan direction.

The chosen output grid can be reconstructed with the `cell_row` and `cell_col` variables. This preserves memory and allows for the flexibility of having a variety of potential grids included in the netCDF file without hard coding the dimensions.

5.5.2. L1r

A formal L1r CDL was not included in order to reduce the length of this document. However, as can be seen in Figure 3, the only difference between the L1c CDL in Annex D, is the definition of the target grid group, which in the case of an L1r file, will be the target band as opposed to the grid projection.

Another difference is the size of the variables. For L1c, the variables are one dimensional and reconstructed using the row and column indexes. In the case of L1r, the variables will be provided in the 3-dimensional scan geometry of the target band, with dimensions (x = Feed horn number, y = Earth sample number, z = scan number).

5.5.3. L1c from L1r

The RGB also provides functionality to first regrid L1b⟶L1r, followed by a regrid of L1r⟶L1c. In this case, the toolbox re-ingests the output from the first regrid. The final output will share the exact same structure as the standard L1c regrid, the description of which is provided in Section 5.5.1 and Annex D.

Annex A - Antenna Pattern Preprocessing Module

To prepare the GRASP antenna patterns for RGB compatibility, several preprocessing steps are necessary. These patterns are supplied on regular Cartesian grids, defined in tilted director cosine coordinates and following the GRASP Ludwig-3 basis convention. So, the standalone preprocessing module was developed for this purpose.

The software is part of the `cimr-rgb` package whose installation is described in detail in [RD15] - *Software Installation and User Manual*. In addition, the module outputs are explained in the Section 5.5 of this document. Below, its modus operandi is briefly summarised.

Once the `cimr-rgb` package has been installed, the `cimr-grasp` executable becomes available to the user in the current `python` virtual environment. To run it (assuming active `python` virtual environment), one can simply type (from anywhere in the system):

```
$ cimr-grasp /path/to/grasp_config.xml
```

in their terminal window.

The line above supplies the executable a suitable XML parameter file and it throws an error, if the file is not found or has incorrectly specified fields. The default parameter file is located inside `configs` directory of the `root` of CIMR RGB project's GitHub repository and is labelled `grasp_config.xml`. For convenience, the contents of the configuration file are copied below.

```
<?xml version="1.0" encoding="UTF-8"?>
<config>
  <paths>
    <outdir>output/cimr_grasp</outdir>-->
    <datadir>dpr/AP</datadir>
  </paths>
  <parameters>
    <use_bhs>False</use_bhs>
    <recenter_beam>true</recenter_beam>
    <chunk_data>True</chunk_data>
    <grid_res_phi>0.1</grid_res_phi>
    <grid_res_theta>0.1</grid_res_theta>
    <grid_max_theta>5.</grid_max_theta>
    <overlap_margin>0.1</overlap_margin>
    <num_chunks>4</num_chunks>
    <interp_method>linear</interp_method>
    <file_version>0.6.3</file_version>
  </parameters>
  <logging>
    <use_rgb_logging>true</use_rgb_logging>
    <use_rgb_decoration>true</use_rgb_decoration>
    <logger_config>src/cimr_rgb/logger_config.json</logger_config>
  </logging>
</config>
```

These parameters are described in the following table.

Table 5 - CIMR GRASP Configuration Parameters.

Parameter Group	Parameter	Description	Valid Input
`<paths>`	`<outdir>`	Specifies the output directory	File path string
	`<datadir>`	Specifies the path to data directory	File path string
`<parameters>`	`<use_bhs>`	Whether to include BHS in the analysis. CIMR RGB does not employ the BHS antenna patterns, so their generation can be avoided (to speed up the code).	Boolean
	`<recenter_beam>`	Specifies whether to recenter the antenna patterns on its maximum gain value.	Boolean
	`<chunk_data>`	Specifies whether to use chunking strategy (see below).	Boolean
	`<grid_res_phi>`	Specifies resolution for resulting grid for phi angle	Float
	`<grid_res_theta>`	Specifies resolution for resulting grid for phi angle	Float
	`<grid_max_theta>`	Specified the maximum theta in the theta grid	Float
	`<overlap_margin>`	Specifies the percentage overlap for a given chunk (explanation is given below). For instance, 0.1 means 10% overlap.	Float.
	`<num_chunks>`	Specifies number of chunks. See explanation below.	Integer
	`<interp_method>`	Specifies the interpolation method to use among the ones provided by `scipy.interpolate.griddata` interpolation routines.	String. Possible values are: `{'linear', 'nearest', 'cubic'}`

	`<file_version>`	Specifies version string of the generated patterns (to distinguish between generations).	String
`<logging>`	`<use_rgb_logging>`	Specifies whether to use custom RGB Logging	Boolean
	`<use_rgb_decoration>`	Specifies whether to use custom RGB decorator (used to track the performance of the given method)	Boolean
	`<logger_config>`	Specifies the path to the logger configuration file	File path string

Once the supplied configuration file is evaluated, and no inconsistencies are found, the software starts its operation. Overall, it does the following operations:

1. Checks for the existence of the output directory and creates it if it is not found.
2. *Parses antenna patterns* (the `*.grd` files) located inside the data directory specified by the `<datadir>` parameter.

   [**Note**]: The executable assumes the specific data directory structure to correctly parse CIMR antenna patterns, meaning that for each of the bands to be preprocessed, there should be dedicated directory created which is named after the band in question.

   For instance, say the `<datadir>` parameter received the value of `$HOME/.local/cimr_grasp/AP`. Then, if the user wants to preprocess only L and C bands, then corresponding directories should be created inside that path, namely `$HOME/.local/cimr_grasp/AP/L` and `$HOME/.local/cimr_grasp/AP/C`. Then the antenna patterns to be preprocessed should be placed into corresponding directories like so:
   `$HOME/.local/cimr_grasp/AP/L/L-14135-H-BK.grd`,
   `$HOME/.local/cimr_grasp/AP/L/L-14135-H-FR.grd`,
   `$HOME/.local/cimr_grasp/AP/C/C1-6875-H-BK.grd`,
   `$HOME/.local/cimr_grasp/AP/C/C1-6875-H-FR.grd`,
   `$HOME/.local/cimr_grasp/AP/C/C2-6875-H-BK.grd`,
   `$HOME/.local/cimr_grasp/AP/C/C2-6875-H-FR.grd`
   and so on.
3. Parsing happens one file at a time, and the resulting files will be placed inside `/path/to/output/dir/parsed/v<file_version>` (controlled by the `<outdir>` and the `<file_version>` parameters). For example, if the `<outdir>` parameter was specific as `$HOME/.local/cimr_grasp/output and the <file_version>` was specified as `1.0.0`, then the `parsed` and v1.0.0 directories will be created in the nested structure like

so: `$HOME/.local/cimr_grasp/output/parsed/v1.0.0`. Parsed antenna patterns in the HDF5 file format will be placed there.

4. *(Optional) Performs beam recentering* (based on the max gain values of Ghh component).
5. Creates coarser `(theta, phi)-grid` with a given resolution controlled by the <grid_res_[phi|theta]> parameters, converts this grid into the cartesian representation with a given `(x, y)-grid`, and interpolates original patterns defined on `(u, v)-grid` into `(x, y)-grid`. The reason for this approach is explained below.
6. Saves resulting patterns one at the time into the preprocessed directory following similar logic as described above, i.e., `/path/to/output/dir/preprocessed/v<file_version>`. For example, if the `<outdir>` parameter was specific as `$HOME/.local/cimr_grasp/output` and the `<file_version>` was specified as `1.0.0`, then the `preprocessed` and v1.0.0 directories will be created in the nested structure like so: `$HOME/.local/cimr_grasp/output/preprocessed/v1.0.0`. Preprocessed antenna patterns in the HDF5 file format will be placed there.

The interpolation process, as described in Step 5, is implemented in its current form primarily due to RAM constraints during computation. Initially, the approach involved converting the original **u,v** Cartesian grid into its spherical representation (**theta, phi**) and directly interpolating it into a coarser **theta, phi** grid. However, for larger antenna patterns, this process became computationally prohibitive, often taking an impractical amount of time. To address this, data chunking was attempted to perform piece-wise interpolation. Unfortunately, the original **theta, phi** grid was not rectilinear, making it impossible to achieve a physically meaningful interpolation in such a manner.

To overcome this limitation, an alternative strategy was adopted. Instead of directly interpolating from **u,v** to **theta, phi**, a coarser **theta, phi** grid was defined and converted back to its Cartesian representation, referred to as **x,y** (distinct from the original **u,v**). Interpolation was then performed by mapping the original **u,v** data onto this new **x,y** grid in chunks. The process works as follows:

1. **Chunk Division**:
   The original grid is divided into a specified number of chunks. Interpolation is performed sequentially, chunk by chunk, moving left to right and down to up. The downscaled grid has fewer data points (is coarser), but the grid borders are preserved. This ensures that the starting point of the first chunk and the ending point of the last chunk align with the corresponding borders of the original grid. Any leftover data that does not fit neatly within the chunk size is treated as a separate chunk.
2. **Non-Rectilinear Downscaled Grid**:
   The downscaled **theta, phi** grid is not rectilinear, meaning gain values from the original grid do not map directly. To address this, a **mask** was defined that determines whether a data point from the original grid falls within the downscaled chunk. This ensures that gain values from the original grid correctly correspond to locations on the downscaled grid.
3. **Border Noisiness and Overlap Margin**:
   During interpolation, border noisiness can occur at the edges of each chunk. To mitigate this,

an "overlap margin" was introduced, defaulting to 10% of the chunk size. This means that only 90% of the original data is used for a given chunk, with the overlap ensuring smooth interpolation behaviour. However, this approach introduces discontinuities at the borders between consecutive chunks.

4. **Chunk Shifting**:
   To address these discontinuities, each consecutive chunk is shifted slightly (left or up, depending on the grid orientation) by an amount equal to the overlap margin plus an additional shift (determined programmatically). This ensures continuity between chunks while maintaining the integrity of the interpolated data.

Annex B - RGB Command Line Options

```
usage: cimr-rgb [-h] [-t INPUT_DATA_TYPE] [-p INPUT_DATA_PATH] [-app
ANTENNA_PATTERNS_PATH] [-sfa SPLIT_FORE_AFT] [-sb SOURCE_BAND] [-tb
TARGET_BAND] [-qc QUALITY_CONTROL] [-gt GRID_TYPE] [-gd GRID_DEFINITION]
             [-pd PROJECTION_DEFINITION] [-rg REDUCED_GRID_INDS] [-ra
REGRIDDING_ALGORITHM] [-sr SEARCH_RADIUS] [-mn MAX_NEIGHBOURS] [-vtr
VARIABLES_TO_REGRID] [-sam SOURCE_ANTENNA_METHOD] [-tam
TARGET_ANTENNA_METHOD]
             [-pm POLARISATION_METHOD] [-sat SOURCE_ANTENNA_THRESHOLD]
[-tat TARGET_ANTENNA_THRESHOLD] [-mat MRF_GRID_DEFINITION] [-mpt
MRF_PROJECTION_DEFINITION] [-sgp SOURCE_GAUSSIAN_PARAMS] [-tgp
TARGET_GAUSSIAN_PARAMS]
             [-bs BORESIGHT_SHIFT] [-rsir RSIR_ITERATION] [-bgs
BG_SMOOTHING] [-std SAVE_TO_DISK] [-op OUTPUT_PATH] [-V VERSION] [-cp
LOGGING_PARAMS_CONFIG] [-d LOGGING_PARAMS_DECORATE]
             [config_file]

Update XML configuration parameters.

positional arguments:
  config_file           Path to the XML parameter file.

options:
  -h, --help            show this help message and exit
  -t INPUT_DATA_TYPE, --input-data-type INPUT_DATA_TYPE
                        Value for InputData/type parameter.
  -p INPUT_DATA_PATH, --input-data-path INPUT_DATA_PATH
                        Value for InputData/path parameter.
  -app ANTENNA_PATTERNS_PATH, --antenna-patterns-path ANTENNA_PATTERNS_PATH
                        Value for InputData/antenna_patterns_path
parameter.
  -sfa SPLIT_FORE_AFT, --split-fore-aft SPLIT_FORE_AFT
                        Value for InputData/split_fore_aft parameter.
  -sb SOURCE_BAND, --source-band SOURCE_BAND
                        Value for InputData/source_band parameter.
  -tb TARGET_BAND, --target-band TARGET_BAND
                        Value for InputData/target_band parameter.
  -qc QUALITY_CONTROL, --quality-control QUALITY_CONTROL
                        Value for InputData/quality_control parameter.
  -gt GRID_TYPE, --grid-type GRID_TYPE
                        Value for GridParams/grid_type parameter.
  -gd GRID_DEFINITION, --grid-definition GRID_DEFINITION
                        Value for GridParams/grid_definition parameter.
  -pd PROJECTION_DEFINITION, --projection-definition PROJECTION_DEFINITION
                        Value for GridParams/projection_definition
parameter.
  -rg REDUCED_GRID_INDS, --reduced-grid-inds REDUCED_GRID_INDS
                        Value for GridParams/reduced_grid_inds parameter.
  -ra REGRIDDING_ALGORITHM, --regridding-algorithm REGRIDDING_ALGORITHM
                        Value for ReGridderParams/regridding_algorithm
parameter.
  -sr SEARCH_RADIUS, --search-radius SEARCH_RADIUS
                        Value for ReGridderParams/search_radius parameter.
  -mn MAX_NEIGHBOURS, --max-neighbors MAX_NEIGHBOURS
                        Value for ReGridderParams/max_neighbours
parameter.
  -vtr VARIABLES_TO_REGRID, --variables-to-regrid VARIABLES_TO_REGRID
                        Value for ReGridderParams/variables_to_regrid
```

```
parameter.
  -sam SOURCE_ANTENNA_METHOD, --source-antenna-method SOURCE_ANTENNA_METHOD
                        Value for ReGridderParams/source_antenna_method
parameter.
  -tam TARGET_ANTENNA_METHOD, --target-antenna-method TARGET_ANTENNA_METHOD
                        Value for ReGridderParams/target_antenna_method
parameter.
  -pm POLARISATION_METHOD, --polarisation-method POLARISATION_METHOD
                        Value for ReGridderParams/polarisation_method
parameter.
  -sat SOURCE_ANTENNA_THRESHOLD, --source-antenna-threshold
SOURCE_ANTENNA_THRESHOLD
                        Value for ReGridderParams/source_antenna_threshold
parameter.
  -tat TARGET_ANTENNA_THRESHOLD, --target-antenna-threshold
TARGET_ANTENNA_THRESHOLD
                        Value for ReGridderParams/target_antenna_threshold
parameter.
  -mat MRF_GRID_DEFINITION, --mrf-grid-definition MRF_GRID_DEFINITION
                        Value for ReGridderParams/MRF_grid_definition
parameter.
  -mpt MRF_PROJECTION_DEFINITION, --mrf-projection-definition
MRF_PROJECTION_DEFINITION
                        Value for
ReGridderParams/MRF_projection_definition parameter.
  -sgp SOURCE_GAUSSIAN_PARAMS, --source-gaussian-params
SOURCE_GAUSSIAN_PARAMS
                        Value for ReGridderParams/source_gaussian_params
parameter.
  -tgp TARGET_GAUSSIAN_PARAMS, --target-gaussian-params
TARGET_GAUSSIAN_PARAMS
                        Value for ReGridderParams/target_gaussian_params
parameter.
  -bs BORESIGHT_SHIFT, --boresight-shift BORESIGHT_SHIFT
                        Value for ReGridderParams/boresight_shift
parameter.
  -rsir RSIR_ITERATION, --rsir-iteration RSIR_ITERATION
                        Value for ReGridderParams/rsir_iteration
parameter.
  -bgs BG_SMOOTHING, --bg-smoothing BG_SMOOTHING
                        Value for ReGridderParams/bg_smoothing parameter.
  -std SAVE_TO_DISK, --save-to-disk SAVE_TO_DISK
                        Value for OutputData/save_to_disk parameter.
  -op OUTPUT_PATH, --output-path OUTPUT_PATH
                        Value for OutputData/output_path parameter.
  -V VERSION, --version VERSION
                        Value for OutputData/version parameter.
  -cp LOGGING_PARAMS_CONFIG, --logging-params-config LOGGING_PARAMS_CONFIG
                        Value for LoggingParams/config_path parameter.
  -d LOGGING_PARAMS_DECORATE, --logging-params-decorate
LOGGING_PARAMS_DECORATE
                        Value for LoggingParams/decorate parameter.
```

Annex C - JSON Logging File

This annex provides an example of a `JSON` logging configuration file that is ingestible by the software. The file serves as a template to demonstrate the structure and parameters required to configure the logging functionality effectively.

Please note that while this example adheres to the software's ingestion requirements, the end formatting of the `JSON` file can be modified to suit specific user preferences or operational needs. Users are encouraged to adapt the template as necessary, ensuring it aligns with their desired logging behaviour and system specifications.

```
{
  "version": 1,
  "disable_existing_loggers": false,
  "loggers": {
      "rgb-logger": {
      "level": "INFO",
      "handlers": ["stdout", "file"],
      "propagate": false
      }
  },
  "handlers": {
      "stdout": {
      "class": "logging.StreamHandler",
      "formatter": "simple",
      "stream": "ext://sys.stdout",
      "level": "INFO"
      },
      "file": {
      "class": "logging.FileHandler",
      "level": "INFO",
      "formatter": "balanced",
      "filename": "cimr.log",
      "mode": "w"
      }
  },
  "formatters": {
      "simple": {
      "format": "[%(name)s - %(levelname)s]: %(message)s"
      },
      "simple2": {
      "format": "[%(name)s - %(levelname)s | %(module)s - L%(lineno)d]:
%(message)s"
      },
      "advanced": {
      "format":
"[%(levelname)s][%(name)s][%(module)s][%(funcName)s][L%(lineno)d][%(asctime
)s]: %(message)s",
      "datefmt": "%Y-%m-%dT%H:%M:%S%z"
      },
      "balanced": {
      "format":
"[%(asctime)s][%(levelname)s|%(name)s][%(module)s|%(funcName)s|L%(lineno)d]
: %(message)s",
      "datefmt": "%Y-%m-%dT%H:%M:%S"
```

```
            }
    }
}
```

Annex D - L1c and L1r CDLs

L1c CDL:

```
netcdf CIMR_L1C_BG_36km_2025-01-15_17-11-11 {
dimensions:
      n_feeds_L_BAND = UNLIMITED ; // (1 currently)
      n_samples_L_BAND = UNLIMITED ; // (691 currently)
      n_l1b_scans = 74 ;
      time = 1 ;
      y = UNLIMITED ; // (0 currently)
      x = UNLIMITED ; // (451 currently)

// global attributes:
      :conventions = "CF-1.6" ;
      :naming_authority = "European Space Agency" ;
      :processing_level = "L1C" ;
      :comment = "Test data set output that represents an example L1C product for evaluation of
CIMR instrument" ;
      :license = "MIT" ;
      :date_created = "2025-01-15T17:11:11Z" ;
      :creator_name = "insert your name" ;
      :creator_email = "test@email.com" ;
      :creator_url = "insert your url" ;
      :creator_institution = "insert your institution" ;
      :project = "CIMR Re-Gridding toolBox (RGB)" ;
      :date_modified = "2025-01-15T17:11:11Z" ;
      :date_issued = "2025-01-15T17:11:11Z" ;
      :date_metadata_modified = "2025-01-15T17:11:11Z" ;
      :product_version = "1.0.0" ;
      :platform = "CIMR" ;
      :instrument = "CIMR" ;
      :keywords = "satellites, passive microwave radiometry" ;
      :input_level1b_filename =
"SCEPS_l1b_sceps_geo_central_america_scene_1_unfiltered_tot_minimal_nom_nedt_apc_tot_v2p1.nc" ;
      :level_01_atbd = "Level 0, 1 Algorithms Theoretical Baseline Document Description and
Performance analysis, Thales Alenia Space, 20/06/2022" ;
      :mission_requirement_document = "Copernicus Imaging Microwave Radiometer (CIMR) Mission
Requirements Document, version 5, ESA-EOPSM-CIMR-MRD-3236, 11/02/2023" ;
      :antenna_pattern_files = "CIMR-PAP-FR-L0-TPv1.0.0.h5" ;
      :antenna_pattern_source = "Antenna patterns were generated using CIMR-GRASP software.
These were derived from the original antenna patterns provided by Thales Alenia Space in
September 2022, where V-pol and H-pol complex amplitudes were assumed to be identical." ;

group: G {

  group: Measurement {

      group: L_BAND {
      variables:
      double bt_h_fore(x) ;
            bt_h_fore:_FillValue = 9.96920996838687e+36 ;
            bt_h_fore:units = "K" ;
            bt_h_fore:_Storage = "contiguous" ;
            bt_h_fore:long_name = "H-polarised TOA Brightness Temperatures" ;
            bt_h_fore:grid_mapping = "crs" ;
            bt_h_fore:coverage_content_type = "Grid" ;
            bt_h_fore:valid_range = "0,2147483647" ;
            bt_h_fore:comment = "Earth-Gridded TOA h-polarised L_BAND_fore BTS interpolated on
a EASE2_G36km grid" ;
```

```
      double nedt_v_fore(x) ;
            nedt_v_fore:_FillValue = 9.96920996838687e+36 ;
            nedt_v_fore:units = "K" ;
            nedt_v_fore:_Storage = "contiguous" ;
            nedt_v_fore:long_name = "Noise Equivalent Delta Temperature." ;
            nedt_v_fore:grid_mapping = "crs" ;
            nedt_v_fore:coverage_content_type = "Grid" ;
            nedt_v_fore:valid_range = "0, 65504" ;
            nedt_v_fore:comment = "Radiometric resolution of each measured BT." ;
      double nedt_3_fore(x) ;
            nedt_3_fore:_FillValue = 9.96920996838687e+36 ;
            nedt_3_fore:units = "K" ;
            nedt_3_fore:_Storage = "contiguous" ;
            nedt_3_fore:long_name = "Noise Equivalent Delta Temperature." ;
            nedt_3_fore:grid_mapping = "crs" ;
            nedt_3_fore:coverage_content_type = "Grid" ;
            nedt_3_fore:valid_range = "0, 65504" ;
            nedt_3_fore:comment = "Radiometric resolution of each measured BT." ;
      double bt_3_fore(x) ;
            bt_3_fore:_FillValue = 9.96920996838687e+36 ;
            bt_3_fore:units = "K" ;
            bt_3_fore:_Storage = "contiguous" ;
            bt_3_fore:long_name = "Stokes 3-polarised TOA Brightness Temperatures" ;
            bt_3_fore:grid_mapping = "crs" ;
            bt_3_fore:coverage_content_type = "Grid" ;
            bt_3_fore:valid_range = "TBD" ;
            bt_3_fore:comment = "Earth-Gridded TOA L_BAND_fore BTS interpolated on a
EASE2_G36km grid, third stokes parameter of the surface polarisation basis" ;
      double nedt_4_fore(x) ;
            nedt_4_fore:_FillValue = 9.96920996838687e+36 ;
            nedt_4_fore:units = "K" ;
            nedt_4_fore:_Storage = "contiguous" ;
            nedt_4_fore:long_name = "Noise Equivalent Delta Temperature." ;
            nedt_4_fore:grid_mapping = "crs" ;
            nedt_4_fore:coverage_content_type = "Grid" ;
            nedt_4_fore:valid_range = "0, 65504" ;
            nedt_4_fore:comment = "Radiometric resolution of each measured BT." ;
      double bt_v_fore(x) ;
            bt_v_fore:_FillValue = 9.96920996838687e+36 ;
            bt_v_fore:units = "K" ;
            bt_v_fore:_Storage = "contiguous" ;
            bt_v_fore:long_name = "V-polarised TOA Brightness Temperatures" ;
            bt_v_fore:grid_mapping = "crs" ;
            bt_v_fore:coverage_content_type = "Grid" ;
            bt_v_fore:valid_range = "0,2147483647" ;
            bt_v_fore:comment = "Earth-Gridded TOA v-polarised L_BAND_fore BTS interpolated on
a EASE2_G36km grid" ;
      double nedt_h_fore(x) ;
            nedt_h_fore:_FillValue = 9.96920996838687e+36 ;
            nedt_h_fore:units = "K" ;
            nedt_h_fore:_Storage = "contiguous" ;
            nedt_h_fore:long_name = "Noise Equivalent Delta Temperature." ;
            nedt_h_fore:grid_mapping = "crs" ;
            nedt_h_fore:coverage_content_type = "Grid" ;
            nedt_h_fore:valid_range = "0, 65504" ;
            nedt_h_fore:comment = "Radiometric resolution of each measured BT." ;
      double bt_4_fore(x) ;
            bt_4_fore:_FillValue = 9.96920996838687e+36 ;
            bt_4_fore:units = "K" ;
            bt_4_fore:_Storage = "contiguous" ;
```

```
            bt_4_fore:long_name = "Stokes 4-polarised TOA Brightness Temperatures" ;
            bt_4_fore:grid_mapping = "crs" ;
            bt_4_fore:coverage_content_type = "Grid" ;
            bt_4_fore:valid_range = "TBD" ;
            bt_4_fore:comment = "Earth-Gridded TOA L_BAND_fore BTS interpolated on a
EASE2_G36km grid, fourth stokes parameter of the surface polarisation basis" ;
      int64 cell_row_fore(x) ;
            cell_row_fore:_FillValue = -9223372036854775806LL ;
            cell_row_fore:units = "Grid x-coordinate" ;
            cell_row_fore:_Storage = "contiguous" ;
            cell_row_fore:long_name = " Grid row index (fore scan) for the chosen output grid"
;
            cell_row_fore:grid_mapping = "crs" ;
            cell_row_fore:coverage_content_type = "Grid" ;
            cell_row_fore:valid_range = "0,2147483647" ;
            cell_row_fore:comment = "Grid row Index (fore scan) for the chosen output grid.
This variable is used to reconstruct the chosen output grid." ;
      int64 cell_col_fore(x) ;
            cell_col_fore:_FillValue = -9223372036854775806LL ;
            cell_col_fore:units = "Grid y-coordinate" ;
            cell_col_fore:_Storage = "contiguous" ;
            cell_col_fore:long_name = "Grid column index (fore scan) for the chosen output
grid" ;
            cell_col_fore:grid_mapping = "crs" ;
            cell_col_fore:coverage_content_type = "Grid" ;
            cell_col_fore:valid_range = "0,2147483647" ;
            cell_col_fore:comment = "Grid row index (fore scan) for the chosen output grid.
This variable is used to reconstruct the chosen output grid." ;
      int64 regridding_n_samples_fore(x) ;
            regridding_n_samples_fore:_FillValue = -9223372036854775806LL ;
            regridding_n_samples_fore:units = "N/A" ;
            regridding_n_samples_fore:_Storage = "contiguous" ;
            regridding_n_samples_fore:long_name = "Number of earth samples used for
interpolation" ;
            regridding_n_samples_fore:grid_mapping = "crs" ;
            regridding_n_samples_fore:coverage_content_type = "Grid" ;
            regridding_n_samples_fore:valid_range = "1, 65535" ;
            regridding_n_samples_fore:comment = "Number of L1b [h|v|t3|t4] polarised
L_BAND_fore brightness temperature Earth samples used in the [Backus-Gilbert|rSIR|LW] remapping
interpolation." ;
      double regridding_l1b_orphans_fore(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            regridding_l1b_orphans_fore:_FillValue = 9.96920996838687e+36 ;
            regridding_l1b_orphans_fore:units = "N/A" ;
            regridding_l1b_orphans_fore:_Storage = "contiguous" ;
            regridding_l1b_orphans_fore:long_name = "Indication of L1b orphaned Earth samples."
;
            regridding_l1b_orphans_fore:grid_mapping = "crs" ;
            regridding_l1b_orphans_fore:coverage_content_type = "Grid" ;
            regridding_l1b_orphans_fore:valid_range = "0, 1" ;
            regridding_l1b_orphans_fore:comment = "Whether each L_BAND L1b measurement sample
was unused (1) or used (0) in [Backus-Gilbert|rSIR|LW] regridding interpolation of fore scan
samples. In the fore-scan regridding nearly all aft scan samples would be orphan (unused), for
instance, and vice versa. It would also occur if the swath stretches outside the projection
window. Orphaned samples may also occur if nearest neighbour or linear interpolation is used."
;
      double bt_h_aft(x) ;
            bt_h_aft:_FillValue = 9.96920996838687e+36 ;
            bt_h_aft:units = "K" ;
            bt_h_aft:_Storage = "contiguous" ;
            bt_h_aft:long_name = "H-polarised TOA Brightness Temperatures" ;
```

```
            bt_h_aft:grid_mapping = "crs" ;
            bt_h_aft:coverage_content_type = "Grid" ;
            bt_h_aft:valid_range = "0,2147483647" ;
            bt_h_aft:comment = "Earth-Gridded TOA h-polarised L_BAND_aft BTS interpolated on a
EASE2_G36km grid" ;
      double nedt_v_aft(x) ;
            nedt_v_aft:_FillValue = 9.96920996838687e+36 ;
            nedt_v_aft:units = "K" ;
            nedt_v_aft:_Storage = "contiguous" ;
            nedt_v_aft:long_name = "Noise Equivalent Delta Temperature." ;
            nedt_v_aft:grid_mapping = "crs" ;
            nedt_v_aft:coverage_content_type = "Grid" ;
            nedt_v_aft:valid_range = "0, 65504" ;
            nedt_v_aft:comment = "Radiometric resolution of each measured BT." ;
      double nedt_3_aft(x) ;
            nedt_3_aft:_FillValue = 9.96920996838687e+36 ;
            nedt_3_aft:units = "K" ;
            nedt_3_aft:_Storage = "contiguous" ;
            nedt_3_aft:long_name = "Noise Equivalent Delta Temperature." ;
            nedt_3_aft:grid_mapping = "crs" ;
            nedt_3_aft:coverage_content_type = "Grid" ;
            nedt_3_aft:valid_range = "0, 65504" ;
            nedt_3_aft:comment = "Radiometric resolution of each measured BT." ;
      double bt_3_aft(x) ;
            bt_3_aft:_FillValue = 9.96920996838687e+36 ;
            bt_3_aft:units = "K" ;
            bt_3_aft:_Storage = "contiguous" ;
            bt_3_aft:long_name = "Stokes 3-polarised TOA Brightness Temperatures" ;
            bt_3_aft:grid_mapping = "crs" ;
            bt_3_aft:coverage_content_type = "Grid" ;
            bt_3_aft:valid_range = "TBD" ;
            bt_3_aft:comment = "Earth-Gridded TOA L_BAND_aft BTS interpolated on a EASE2_G36km
grid, third stokes parameter of the surface polarisation basis" ;
      double nedt_4_aft(x) ;
            nedt_4_aft:_FillValue = 9.96920996838687e+36 ;
            nedt_4_aft:units = "K" ;
            nedt_4_aft:_Storage = "contiguous" ;
            nedt_4_aft:long_name = "Noise Equivalent Delta Temperature." ;
            nedt_4_aft:grid_mapping = "crs" ;
            nedt_4_aft:coverage_content_type = "Grid" ;
            nedt_4_aft:valid_range = "0, 65504" ;
            nedt_4_aft:comment = "Radiometric resolution of each measured BT." ;
      double bt_v_aft(x) ;
            bt_v_aft:_FillValue = 9.96920996838687e+36 ;
            bt_v_aft:units = "K" ;
            bt_v_aft:_Storage = "contiguous" ;
            bt_v_aft:long_name = "V-polarised TOA Brightness Temperatures" ;
            bt_v_aft:grid_mapping = "crs" ;
            bt_v_aft:coverage_content_type = "Grid" ;
            bt_v_aft:valid_range = "0,2147483647" ;
            bt_v_aft:comment = "Earth-Gridded TOA v-polarised L_BAND_aft BTS interpolated on a
EASE2_G36km grid" ;
      double nedt_h_aft(x) ;
            nedt_h_aft:_FillValue = 9.96920996838687e+36 ;
            nedt_h_aft:units = "K" ;
            nedt_h_aft:_Storage = "contiguous" ;
            nedt_h_aft:long_name = "Noise Equivalent Delta Temperature." ;
            nedt_h_aft:grid_mapping = "crs" ;
            nedt_h_aft:coverage_content_type = "Grid" ;
            nedt_h_aft:valid_range = "0, 65504" ;
```

```
            nedt_h_aft:comment = "Radiometric resolution of each measured BT." ;
      double bt_4_aft(x) ;
            bt_4_aft:_FillValue = 9.96920996838687e+36 ;
            bt_4_aft:units = "K" ;
            bt_4_aft:_Storage = "contiguous" ;
            bt_4_aft:long_name = "Stokes 4-polarised TOA Brightness Temperatures" ;
            bt_4_aft:grid_mapping = "crs" ;
            bt_4_aft:coverage_content_type = "Grid" ;
            bt_4_aft:valid_range = "TBD" ;
            bt_4_aft:comment = "Earth-Gridded TOA L_BAND_aft BTS interpolated on a EASE2_G36km
grid, fourth stokes parameter of the surface polarisation basis" ;
      int64 cell_row_aft(x) ;
            cell_row_aft:_FillValue = -9223372036854775806LL ;
            cell_row_aft:units = "Grid x-coordinate" ;
            cell_row_aft:_Storage = "contiguous" ;
            cell_row_aft:long_name = "Grid row Index (aft scan) for the chosen output grid" ;
            cell_row_aft:grid_mapping = "crs" ;
            cell_row_aft:coverage_content_type = "Grid" ;
            cell_row_aft:valid_range = "0,2147483647" ;
            cell_row_aft:comment = "Grid row Index (aft scan) for the chosen output grid. This
variable is used to reconstruct the chosen output grid." ;
      int64 cell_col_aft(x) ;
            cell_col_aft:_FillValue = -9223372036854775806LL ;
            cell_col_aft:units = "Grid y-coordinate" ;
            cell_col_aft:_Storage = "contiguous" ;
            cell_col_aft:long_name = "Grid column index (aft scan) for the chosen output grid"
;
            cell_col_aft:grid_mapping = "crs" ;
            cell_col_aft:coverage_content_type = "Grid" ;
            cell_col_aft:valid_range = "0,2147483647" ;
            cell_col_aft:comment = "Grid row index (aft scan) for the chosen output grid. This
variable is used to reconstruct the chosen output grid." ;
      int64 regridding_n_samples_aft(x) ;
            regridding_n_samples_aft:_FillValue = -9223372036854775806LL ;
            regridding_n_samples_aft:units = "N/A" ;
            regridding_n_samples_aft:_Storage = "contiguous" ;
            regridding_n_samples_aft:long_name = "Number of earth samples used for
interpolation" ;
            regridding_n_samples_aft:grid_mapping = "crs" ;
            regridding_n_samples_aft:coverage_content_type = "Grid" ;
            regridding_n_samples_aft:valid_range = "1, 65535" ;
            regridding_n_samples_aft:comment = "Number of L1b [h|v|t3|t4] polarised L_BAND_aft
brightness temperature Earth samples used in the [Backus-Gilbert|rSIR|LW] remapping
interpolation." ;
      double regridding_l1b_orphans_aft(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            regridding_l1b_orphans_aft:_FillValue = 9.96920996838687e+36 ;
            regridding_l1b_orphans_aft:units = "N/A" ;
            regridding_l1b_orphans_aft:_Storage = "contiguous" ;
            regridding_l1b_orphans_aft:long_name = "Indication of L1b orphaned Earth samples."
;
            regridding_l1b_orphans_aft:grid_mapping = "crs" ;
            regridding_l1b_orphans_aft:coverage_content_type = "Grid" ;
            regridding_l1b_orphans_aft:valid_range = "0, 1" ;
            regridding_l1b_orphans_aft:comment = "Whether each L_BAND L1b measurement sample
was unused (1) or used (0) in [Backus-Gilbert|rSIR|LW] regridding interpolation of aft scan
samples. In the fore-scan regridding nearly all aft scan samples would be orphan (unused), for
instance, and vice versa. It would also occur if the swath stretches outside the projection
window. Orphaned samples may also occur if nearest neighbour or linear interpolation is used."
;
      } // group L_BAND
```

```
      } // group Measurement

  group: Navigation {

      group: L_BAND {
      variables:
      double acq_time_utc_fore(x) ;
            acq_time_utc_fore:_FillValue = 9.96920996838687e+36 ;
            acq_time_utc_fore:units = "N/A" ;
            acq_time_utc_fore:_Storage = "contiguous" ;
            acq_time_utc_fore:long_name = "Interpolated UTC Acquisition time of Earth Sample
acquisitions." ;
            acq_time_utc_fore:grid_mapping = "crs" ;
            acq_time_utc_fore:coverage_content_type = "Grid" ;
            acq_time_utc_fore:valid_range = "0, 4,294,967,295" ;
            acq_time_utc_fore:comment = "UTC acquisition times expressed in seconds (seconds
since 2000-01-01 00:00:00 UTC). The value of time_earth will be scaled with the interpolation
weights of all time_earth Earth samples used in the interpolation of that grid cell. " ;
      double processing_scan_angle_fore(x) ;
            processing_scan_angle_fore:_FillValue = 9.96920996838687e+36 ;
            processing_scan_angle_fore:units = "deg" ;
            processing_scan_angle_fore:_Storage = "contiguous" ;
            processing_scan_angle_fore:long_name = "Interpolated scan angle of acquisitions" ;
            processing_scan_angle_fore:grid_mapping = "crs" ;
            processing_scan_angle_fore:coverage_content_type = "Grid" ;
            processing_scan_angle_fore:valid_range = "0,359.99" ;
            string processing_scan_angle_fore:comment = "The processing scan angle of the L1b
L_BAND_fore Earth view samples. The value of scan angle will be scaled with the interpolation
weights of all scan angle Earth samples used in the interpolation of that grid cell.
Measurements from different feed horns are combined. The scan angle is defined as the azimuth
angle of the antenna boresight measured from the ground track vector. The scan angle is 90°
when the boresight points in the same direction as the ground track vector and increases
clockwise when viewed from above." ;
      double azimuth_fore(x) ;
            azimuth_fore:_FillValue = 9.96920996838687e+36 ;
            azimuth_fore:units = "deg" ;
            azimuth_fore:_Storage = "contiguous" ;
            azimuth_fore:long_name = "Interpolated Earth Azimuth angle of the acquisitions." ;
            azimuth_fore:grid_mapping = "crs" ;
            azimuth_fore:coverage_content_type = "Grid" ;
            azimuth_fore:valid_range = "0,359.99" ;
            azimuth_fore:comment = "Level 1b L_BAND_fore Earth observation azimuth angles of
the acquisitions, positive counterclockwise from due east. The value of observation azimuth
angle will be scaled with the interpolation weights of all observation azimuth angle Earth
samples used in the interpolation of that grid cell." ;
      double oza_fore(x) ;
            oza_fore:_FillValue = 9.96920996838687e+36 ;
            oza_fore:units = "deg" ;
            oza_fore:_Storage = "contiguous" ;
            oza_fore:long_name = "Interpolated Observation Zenith Angle of acquisitions." ;
            oza_fore:grid_mapping = "crs" ;
            oza_fore:coverage_content_type = "Grid" ;
            oza_fore:valid_range = "0,359.99" ;
            oza_fore:comment = "Level 1b L_BAND_fore Earth Observation zenith angles of the
acquisitions. The value of OZA will be scaled with the interpolation weights of all observation
OZA Earth samples used in the interpolation of that grid cell. The OZA is defined as the
included angle between the antenna Boresight vector and the normal to the Earth\'s surface." ;
      double latitude_fore(x) ;
            latitude_fore:_FillValue = 9.96920996838687e+36 ;
            latitude_fore:units = "deg" ;
```

```
            latitude_fore:_Storage = "contiguous" ;
            latitude_fore:long_name = "Latitude of the centre of a EASE2_G36km PROJ grid cell."
;
            latitude_fore:grid_mapping = "crs" ;
            latitude_fore:coverage_content_type = "Grid" ;
            latitude_fore:valid_range = "-90, 90" ;
            latitude_fore:comment = "Latitude of the centre of a EASE2_G36km PROJ grid cell." ;
      double longitude_fore(x) ;
            longitude_fore:_FillValue = 9.96920996838687e+36 ;
            longitude_fore:units = "deg" ;
            longitude_fore:_Storage = "contiguous" ;
            longitude_fore:long_name = "Longitude of the centre of a EASE2_G36km PROJ grid
cell." ;
            longitude_fore:grid_mapping = "crs" ;
            longitude_fore:coverage_content_type = "Grid" ;
            longitude_fore:valid_range = "-180, 179.99" ;
            longitude_fore:comment = "Longitude of the centre of a EASE2_G36km PROJ grid cell."
;
      double acq_time_utc_aft(x) ;
            acq_time_utc_aft:_FillValue = 9.96920996838687e+36 ;
            acq_time_utc_aft:units = "N/A" ;
            acq_time_utc_aft:_Storage = "contiguous" ;
            acq_time_utc_aft:long_name = "Interpolated UTC Acquisition time of Earth Sample
acquisitions." ;
            acq_time_utc_aft:grid_mapping = "crs" ;
            acq_time_utc_aft:coverage_content_type = "Grid" ;
            acq_time_utc_aft:valid_range = "0, 4,294,967,295" ;
            acq_time_utc_aft:comment = "UTC acquisition times expressed in seconds (seconds
since 2000-01-01 00:00:00 UTC). The value of time_earth will be scaled with the interpolation
weights of all time_earth Earth samples used in the interpolation of that grid cell. " ;
      double processing_scan_angle_aft(x) ;
            processing_scan_angle_aft:_FillValue = 9.96920996838687e+36 ;
            processing_scan_angle_aft:units = "deg" ;
            processing_scan_angle_aft:_Storage = "contiguous" ;
            processing_scan_angle_aft:long_name = "Interpolated scan angle of acquisitions" ;
            processing_scan_angle_aft:grid_mapping = "crs" ;
            processing_scan_angle_aft:coverage_content_type = "Grid" ;
            processing_scan_angle_aft:valid_range = "0,359.99" ;
            string processing_scan_angle_aft:comment = "The processing scan angle of the L1b
L_BAND_aft Earth view samples. The value of scan angle will be scaled with the interpolation
weights of all scan angle Earth samples used in the interpolation of that grid cell.
Measurements from different feed horns are combined. The scan angle is defined as the azimuth
angle of the antenna boresight measured from the ground track vector. The scan angle is 90°
when the boresight points in the same direction as the ground track vector and increases
clockwise when viewed from above." ;
      double azimuth_aft(x) ;
            azimuth_aft:_FillValue = 9.96920996838687e+36 ;
            azimuth_aft:units = "deg" ;
            azimuth_aft:_Storage = "contiguous" ;
            azimuth_aft:long_name = "Interpolated Earth Azimuth angle of the acquisitions." ;
            azimuth_aft:grid_mapping = "crs" ;
            azimuth_aft:coverage_content_type = "Grid" ;
            azimuth_aft:valid_range = "0,359.99" ;
            azimuth_aft:comment = "Level 1b L_BAND_aft Earth observation azimuth angles of the
acquisitions, positive counterclockwise from due east. The value of observation azimuth angle
will be scaled with the interpolation weights of all observation azimuth angle Earth samples
used in the interpolation of that grid cell." ;
      double oza_aft(x) ;
            oza_aft:_FillValue = 9.96920996838687e+36 ;
            oza_aft:units = "deg" ;
```

```
            oza_aft:_Storage = "contiguous" ;
            oza_aft:long_name = "Interpolated Observation Zenith Angle of acquisitions." ;
            oza_aft:grid_mapping = "crs" ;
            oza_aft:coverage_content_type = "Grid" ;
            oza_aft:valid_range = "0,359.99" ;
            oza_aft:comment = "Level 1b L_BAND_aft Earth Observation zenith angles of the
acquisitions. The value of OZA will be scaled with the interpolation weights of all observation
OZA Earth samples used in the interpolation of that grid cell. The OZA is defined as the
included angle between the antenna Boresight vector and the normal to the Earth\'s surface." ;
      double latitude_aft(x) ;
            latitude_aft:_FillValue = 9.96920996838687e+36 ;
            latitude_aft:units = "deg" ;
            latitude_aft:_Storage = "contiguous" ;
            latitude_aft:long_name = "Latitude of the centre of a EASE2_G36km PROJ grid cell."
;
            latitude_aft:grid_mapping = "crs" ;
            latitude_aft:coverage_content_type = "Grid" ;
            latitude_aft:valid_range = "-90, 90" ;
            latitude_aft:comment = "Latitude of the centre of a EASE2_G36km PROJ grid cell." ;
      double longitude_aft(x) ;
            longitude_aft:_FillValue = 9.96920996838687e+36 ;
            longitude_aft:units = "deg" ;
            longitude_aft:_Storage = "contiguous" ;
            longitude_aft:long_name = "Longitude of the centre of a EASE2_G36km PROJ grid
cell." ;
            longitude_aft:grid_mapping = "crs" ;
            longitude_aft:coverage_content_type = "Grid" ;
            longitude_aft:valid_range = "-180, 179.99" ;
            longitude_aft:comment = "Longitude of the centre of a EASE2_G36km PROJ grid cell."
;
      } // group L_BAND
      } // group Navigation

  group: Processing_flags {
       int processing_flag_fore(x) ;
            processing_flag_fore:_FillValue = 9.96920996838687e+36 ;
            processing_flag_fore:units = "N/A" ;
            processing_flag_fore:_Storage = "contiguous" ;
            processing_flag_fore:long_name = "An 8-bit binary string of 1's and 0's indicating
RGB processing specific flags used in the derivation of L1C/R data. Bit position '0'
corresponds to the least significant bit. " ;
            processing_flag_fore:grid_mapping = "crs" ;
            processing_flag_fore:coverage_content_type = "Grid" ;
            processing_flag_fore:valid_range = "0,7" ;
            string processing_flag_fore:comment = "An 8-bit binary string of 1's and 0's
indicating RGB processing specific flags used in the derivation of L1C/R data. Bit position '0'
corresponds to the least significant bit. Bit 0: 0 = Number of neighbours available was within
or equal to the selected max_neighbours config parameter. 1 = There were more neighbours
available than the selected max_neighbours config parameter. Bit 1: 0 = All antenna patterns
used for the target sample were resolved and projected to the target grid. 1 = One or more of
the antenna patterns used for the target samples were not resolved or unable to be projected to
the target grid. Bit 2: 0 = Iterative technique not used OR target relative tolerance was
reached (convergence) in the inversion algorithm. 1 = Iterative technique used and target
relative tolerance not met for the in the inversion algorithm (non-convergence). Bit 3: 0 = The
Integration grid for the target cell was constructed. 1 = The integration grid for the target
cell could not be constructed. Bit 4: 0 = 0 = Antenna patterns not used OR overlap between
source and target patterns deemed sufficient to yield reliable results. 1 = Antenna patterns
used and overlap between source and target patterns deemed insufficient to yield reliable
results. Bit 5: 0 = This bit is currently not used. 1 = This bit is currently not used. Bit 6:
0 = This bit is currently not used. 1 = This bit is currently not used. Bit 7: 0 = This bit is
```

```
currently not used. 1 = This bit is currently not used." ;
      int processing_flag_aft(x) ;
            processing_flag_aft:_FillValue = 9.96920996838687e+36 ;
            processing_flag_aft:units = "N/A" ;
            processing_flag_aft:_Storage = "contiguous" ;
            processing_flag_aft:long_name = "An 8-bit binary string of 1's and 0's indicating
RGB processing specific flags used in the derivation of L1C/R data. Bit position '0'
corresponds to the least significant bit. For aft scan" ;
            processing_flag_aft:grid_mapping = "crs" ;
            processing_flag_aft:coverage_content_type = "Grid" ;
            processing_flag_aft:valid_range = "0,7" ;
            string processing_flag_aft:comment = "An 8-bit binary string of 1's and 0's
indicating RGB processing specific flags used in the derivation of L1C/R data. Bit position '0'
corresponds to the least significant bit. Bit 0: 0 = Number of neighbours available was within
or equal to the selected max_neighbours config parameter. 1 = There were more neighbours
available than the selected max_neighbours config parameter. Bit 1: 0 = All antenna patterns
used for the target sample were resolved and projected to the target grid. 1 = One or more of
the antenna patterns used for the target samples were not resolved or unable to be projected to
the target grid. Bit 2: 0 = Iterative technique not used OR target relative tolerance was
reached (convergence) in the inversion algorithm. 1 = Iterative technique used and target
relative tolerance not met for the inversion algorithm (non-convergence). Bit 3: 0 = The
Integration grid for the target cell was constructed. 1 = The integration grid for the target
cell could not be constructed. Bit 4: 0 = 0 = Antenna patterns not used OR overlap between
source and target patterns deemed sufficient to yield reliable results. 1 = Antenna patterns
used and overlap between source and target patterns deemed insufficient to yield reliable
results. Bit 5: 0 = This bit is currently not used. 1 = This bit is currently not used. Bit 6:
0 = This bit is currently not used. 1 = This bit is currently not used. Bit 7: 0 = This bit is
currently not used. 1 = This bit is currently not used."
      } // group Processing_flags

      } // group Processing_flags

  group: Quality_information {

      group: L_BAND {
      } // group L_BAND
      } // group Quality_information
  } // group G
}
```

L1R CDL:

```
netcdf CIMR_L1R_BG_2025-01-15_17-18-00 {
dimensions:
      n_feeds_L_BAND = UNLIMITED ; // (4 currently)
      n_samples_L_BAND = UNLIMITED ; // (2747 currently)
      n_l1b_scans = 74 ;

// global attributes:
      :conventions = "CF-1.6" ;
      :naming_authority = "European Space Agency" ;
      :processing_level = "L1R" ;
      :comment = "Test data set output that represents an example L1R product for evaluation
of CIMR instrument" ;
      :license = "MIT" ;
      :date_created = "2025-01-15T17:18:00Z" ;
      :creator_name = "insert your name" ;
      :creator_email = "test@email.com" ;
```

```
      :creator_url = "insert your url" ;
      :creator_institution = "insert your institution" ;
      :project = "CIMR Re-Gridding toolBox (RGB)" ;
      :date_modified = "2025-01-15T17:18:00Z" ;
      :date_issued = "2025-01-15T17:18:00Z" ;
      :date_metadata_modified = "2025-01-15T17:18:00Z" ;
      :product_version = "1.0.0" ;
      :platform = "CIMR" ;
      :instrument = "CIMR" ;
      :keywords = "satellites, passive microwave radiometry" ;
      :input_level1b_filename =
"SCEPS_l1b_sceps_geo_central_america_scene_1_unfiltered_tot_minimal_nom_nedt_apc_tot_v2p1.nc"
;
      :level_01_atbd = "Level 0, 1 Algorithms Theoretical Baseline Document Description and
Performance analysis, Thales Alenia Space, 20/06/2022" ;
      :mission_requirement_document = "Copernicus Imaging Microwave Radiometer (CIMR) Mission
Requirements Document, version 5, ESA-EOPSM-CIMR-MRD-3236, 11/02/2023" ;
      :antenna_pattern_files = "CIMR-PAP-FR-C3-TPv1.0.0.h5, CIMR-PAP-FR-C2-TPv1.0.0.h5,
CIMR-PAP-FR-C1-TPv1.0.0.h5, CIMR-PAP-FR-C0-TPv1.0.0.h5" ;
      :antenna_pattern_source = "Antenna patterns were generated using CIMR-GRASP software.
These were derived from the original antenna patterns provided by Thales Alenia Space in
September 2022, where V-pol and H-pol complex amplitudes were assumed to be identical." ;

group: C_BAND_TARGET {

  group: Measurement {

      group: L_BAND {
      variables:
      double bt_3_fore(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            bt_3_fore:_FillValue = 9.96920996838687e+36 ;
            bt_3_fore:units = "K" ;
            bt_3_fore:_Storage = "contiguous" ;
            bt_3_fore:long_name = "Stokes 3-polarised TOA Brightness Temperatures" ;
            bt_3_fore:grid_mapping = "crs" ;
            bt_3_fore:coverage_content_type = "Grid" ;
            bt_3_fore:valid_range = "TBD" ;
            bt_3_fore:comment = "Earth-Gridded TOA L_BAND_fore BTS interpolated on a None
grid, third stokes parameter of the surface polarisation basis" ;
      double nedt_v_fore(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            nedt_v_fore:_FillValue = 9.96920996838687e+36 ;
            nedt_v_fore:units = "K" ;
            nedt_v_fore:_Storage = "contiguous" ;
            nedt_v_fore:long_name = "Noise Equivalent Delta Temperature." ;
            nedt_v_fore:grid_mapping = "crs" ;
            nedt_v_fore:coverage_content_type = "Grid" ;
            nedt_v_fore:valid_range = "0, 65504" ;
            nedt_v_fore:comment = "Radiometric resolution of each measured BT." ;
      double bt_4_fore(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            bt_4_fore:_FillValue = 9.96920996838687e+36 ;
            bt_4_fore:units = "K" ;
            bt_4_fore:_Storage = "contiguous" ;
            bt_4_fore:long_name = "Stokes 4-polarised TOA Brightness Temperatures" ;
            bt_4_fore:grid_mapping = "crs" ;
            bt_4_fore:coverage_content_type = "Grid" ;
            bt_4_fore:valid_range = "TBD" ;
            bt_4_fore:comment = "Earth-Gridded TOA L_BAND_fore BTS interpolated on a None
grid, fourth stokes parameter of the surface polarisation basis" ;
      double bt_v_fore(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            bt_v_fore:_FillValue = 9.96920996838687e+36 ;
```

```
            bt_v_fore:units = "K" ;
            bt_v_fore:_Storage = "contiguous" ;
            bt_v_fore:long_name = "V-polarised TOA Brightness Temperatures" ;
            bt_v_fore:grid_mapping = "crs" ;
            bt_v_fore:coverage_content_type = "Grid" ;
            bt_v_fore:valid_range = "0,2147483647" ;
            bt_v_fore:comment = "Earth-Gridded TOA v-polarised L_BAND_fore BTS interpolated on
a None grid" ;
      double nedt_h_fore(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            nedt_h_fore:_FillValue = 9.96920996838687e+36 ;
            nedt_h_fore:units = "K" ;
            nedt_h_fore:_Storage = "contiguous" ;
            nedt_h_fore:long_name = "Noise Equivalent Delta Temperature." ;
            nedt_h_fore:grid_mapping = "crs" ;
            nedt_h_fore:coverage_content_type = "Grid" ;
            nedt_h_fore:valid_range = "0, 65504" ;
            nedt_h_fore:comment = "Radiometric resolution of each measured BT." ;
      double nedt_3_fore(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            nedt_3_fore:_FillValue = 9.96920996838687e+36 ;
            nedt_3_fore:units = "K" ;
            nedt_3_fore:_Storage = "contiguous" ;
            nedt_3_fore:long_name = "Noise Equivalent Delta Temperature." ;
            nedt_3_fore:grid_mapping = "crs" ;
            nedt_3_fore:coverage_content_type = "Grid" ;
            nedt_3_fore:valid_range = "0, 65504" ;
            nedt_3_fore:comment = "Radiometric resolution of each measured BT." ;
      double nedt_4_fore(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            nedt_4_fore:_FillValue = 9.96920996838687e+36 ;
            nedt_4_fore:units = "K" ;
            nedt_4_fore:_Storage = "contiguous" ;
            nedt_4_fore:long_name = "Noise Equivalent Delta Temperature." ;
            nedt_4_fore:grid_mapping = "crs" ;
            nedt_4_fore:coverage_content_type = "Grid" ;
            nedt_4_fore:valid_range = "0, 65504" ;
            nedt_4_fore:comment = "Radiometric resolution of each measured BT." ;
      double bt_h_fore(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            bt_h_fore:_FillValue = 9.96920996838687e+36 ;
            bt_h_fore:units = "K" ;
            bt_h_fore:_Storage = "contiguous" ;
            bt_h_fore:long_name = "H-polarised TOA Brightness Temperatures" ;
            bt_h_fore:grid_mapping = "crs" ;
            bt_h_fore:coverage_content_type = "Grid" ;
            bt_h_fore:valid_range = "0,2147483647" ;
            bt_h_fore:comment = "Earth-Gridded TOA h-polarised L_BAND_fore BTS interpolated on
a None grid" ;
      double regridding_n_samples_fore(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            regridding_n_samples_fore:_FillValue = 9.96920996838687e+36 ;
            regridding_n_samples_fore:units = "N/A" ;
            regridding_n_samples_fore:_Storage = "contiguous" ;
            regridding_n_samples_fore:long_name = "Number of earth samples used for
interpolation" ;
            regridding_n_samples_fore:grid_mapping = "crs" ;
            regridding_n_samples_fore:coverage_content_type = "Grid" ;
            regridding_n_samples_fore:valid_range = "1, 65535" ;
            regridding_n_samples_fore:comment = "Number of L1b [h|v|t3|t4] polarised
L_BAND_fore brightness temperature Earth samples used in the [Backus-Gilbert|rSIR|LW]
remapping interpolation." ;
      double regridding_l1b_orphans_fore(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            regridding_l1b_orphans_fore:_FillValue = 9.96920996838687e+36 ;
            regridding_l1b_orphans_fore:units = "N/A" ;
```

```
            regridding_l1b_orphans_fore:_Storage = "contiguous" ;
            regridding_l1b_orphans_fore:long_name = "Indication of L1b orphaned Earth
samples." ;
            regridding_l1b_orphans_fore:grid_mapping = "crs" ;
            regridding_l1b_orphans_fore:coverage_content_type = "Grid" ;
            regridding_l1b_orphans_fore:valid_range = "0, 1" ;
            regridding_l1b_orphans_fore:comment = "Whether each L_BAND L1b measurement sample
was unused (1) or used (0) in [Backus-Gilbert|rSIR|LW] regridding interpolation of fore scan
samples. In the fore-scan regridding nearly all aft scan samples would be orphan (unused), for
instance, and vice versa. It would also occur if the swath stretches outside the projection
window. Orphaned samples may also occur if nearest neighbour or linear interpolation is used."
;
      double bt_3_aft(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            bt_3_aft:_FillValue = 9.96920996838687e+36 ;
            bt_3_aft:units = "K" ;
            bt_3_aft:_Storage = "contiguous" ;
            bt_3_aft:long_name = "Stokes 3-polarised TOA Brightness Temperatures" ;
            bt_3_aft:grid_mapping = "crs" ;
            bt_3_aft:coverage_content_type = "Grid" ;
            bt_3_aft:valid_range = "TBD" ;
            bt_3_aft:comment = "Earth-Gridded TOA L_BAND_aft BTS interpolated on a None grid,
third stokes parameter of the surface polarisation basis" ;
      double nedt_v_aft(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            nedt_v_aft:_FillValue = 9.96920996838687e+36 ;
            nedt_v_aft:units = "K" ;
            nedt_v_aft:_Storage = "contiguous" ;
            nedt_v_aft:long_name = "Noise Equivalent Delta Temperature." ;
            nedt_v_aft:grid_mapping = "crs" ;
            nedt_v_aft:coverage_content_type = "Grid" ;
            nedt_v_aft:valid_range = "0, 65504" ;
            nedt_v_aft:comment = "Radiometric resolution of each measured BT." ;
      double bt_4_aft(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            bt_4_aft:_FillValue = 9.96920996838687e+36 ;
            bt_4_aft:units = "K" ;
            bt_4_aft:_Storage = "contiguous" ;
            bt_4_aft:long_name = "Stokes 4-polarised TOA Brightness Temperatures" ;
            bt_4_aft:grid_mapping = "crs" ;
            bt_4_aft:coverage_content_type = "Grid" ;
            bt_4_aft:valid_range = "TBD" ;
            bt_4_aft:comment = "Earth-Gridded TOA L_BAND_aft BTS interpolated on a None grid,
fourth stokes parameter of the surface polarisation basis" ;
      double bt_v_aft(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            bt_v_aft:_FillValue = 9.96920996838687e+36 ;
            bt_v_aft:units = "K" ;
            bt_v_aft:_Storage = "contiguous" ;
            bt_v_aft:long_name = "V-polarised TOA Brightness Temperatures" ;
            bt_v_aft:grid_mapping = "crs" ;
            bt_v_aft:coverage_content_type = "Grid" ;
            bt_v_aft:valid_range = "0,2147483647" ;
            bt_v_aft:comment = "Earth-Gridded TOA v-polarised L_BAND_aft BTS interpolated on a
None grid" ;
      double nedt_h_aft(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            nedt_h_aft:_FillValue = 9.96920996838687e+36 ;
            nedt_h_aft:units = "K" ;
            nedt_h_aft:_Storage = "contiguous" ;
            nedt_h_aft:long_name = "Noise Equivalent Delta Temperature." ;
            nedt_h_aft:grid_mapping = "crs" ;
            nedt_h_aft:coverage_content_type = "Grid" ;
            nedt_h_aft:valid_range = "0, 65504" ;
            nedt_h_aft:comment = "Radiometric resolution of each measured BT." ;
```

```
      double nedt_3_aft(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            nedt_3_aft:_FillValue = 9.96920996838687e+36 ;
            nedt_3_aft:units = "K" ;
            nedt_3_aft:_Storage = "contiguous" ;
            nedt_3_aft:long_name = "Noise Equivalent Delta Temperature." ;
            nedt_3_aft:grid_mapping = "crs" ;
            nedt_3_aft:coverage_content_type = "Grid" ;
            nedt_3_aft:valid_range = "0, 65504" ;
            nedt_3_aft:comment = "Radiometric resolution of each measured BT." ;
      double nedt_4_aft(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            nedt_4_aft:_FillValue = 9.96920996838687e+36 ;
            nedt_4_aft:units = "K" ;
            nedt_4_aft:_Storage = "contiguous" ;
            nedt_4_aft:long_name = "Noise Equivalent Delta Temperature." ;
            nedt_4_aft:grid_mapping = "crs" ;
            nedt_4_aft:coverage_content_type = "Grid" ;
            nedt_4_aft:valid_range = "0, 65504" ;
            nedt_4_aft:comment = "Radiometric resolution of each measured BT." ;
      double bt_h_aft(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            bt_h_aft:_FillValue = 9.96920996838687e+36 ;
            bt_h_aft:units = "K" ;
            bt_h_aft:_Storage = "contiguous" ;
            bt_h_aft:long_name = "H-polarised TOA Brightness Temperatures" ;
            bt_h_aft:grid_mapping = "crs" ;
            bt_h_aft:coverage_content_type = "Grid" ;
            bt_h_aft:valid_range = "0,2147483647" ;
            bt_h_aft:comment = "Earth-Gridded TOA h-polarised L_BAND_aft BTS interpolated on a
None grid" ;
      double regridding_n_samples_aft(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            regridding_n_samples_aft:_FillValue = 9.96920996838687e+36 ;
            regridding_n_samples_aft:units = "N/A" ;
            regridding_n_samples_aft:_Storage = "contiguous" ;
            regridding_n_samples_aft:long_name = "Number of earth samples used for
interpolation" ;
            regridding_n_samples_aft:grid_mapping = "crs" ;
            regridding_n_samples_aft:coverage_content_type = "Grid" ;
            regridding_n_samples_aft:valid_range = "1, 65535" ;
            regridding_n_samples_aft:comment = "Number of L1b [h|v|t3|t4] polarised L_BAND_aft
brightness temperature Earth samples used in the [Backus-Gilbert|rSIR|LW] remapping
interpolation." ;
      double regridding_l1b_orphans_aft(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            regridding_l1b_orphans_aft:_FillValue = 9.96920996838687e+36 ;
            regridding_l1b_orphans_aft:units = "N/A" ;
            regridding_l1b_orphans_aft:_Storage = "contiguous" ;
            regridding_l1b_orphans_aft:long_name = "Indication of L1b orphaned Earth samples."
;
            regridding_l1b_orphans_aft:grid_mapping = "crs" ;
            regridding_l1b_orphans_aft:coverage_content_type = "Grid" ;
            regridding_l1b_orphans_aft:valid_range = "0, 1" ;
            regridding_l1b_orphans_aft:comment = "Whether each L_BAND L1b measurement sample
was unused (1) or used (0) in [Backus-Gilbert|rSIR|LW] regridding interpolation of aft scan
samples. In the fore-scan regridding nearly all aft scan samples would be orphan (unused), for
instance, and vice versa. It would also occur if the swath stretches outside the projection
window. Orphaned samples may also occur if nearest neighbour or linear interpolation is used."
;
      } // group L_BAND
      } // group Measurement

  group: Navigation {
```

```
      group: L_BAND {
      variables:
      double longitude_fore(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            longitude_fore:_FillValue = 9.96920996838687e+36 ;
            longitude_fore:units = "deg" ;
            longitude_fore:_Storage = "contiguous" ;
            longitude_fore:long_name = "Longitude of the centre of a None PROJ grid cell." ;
            longitude_fore:grid_mapping = "crs" ;
            longitude_fore:coverage_content_type = "Grid" ;
            longitude_fore:valid_range = "-180, 179.99" ;
            longitude_fore:comment = "Longitude of the centre of a None PROJ grid cell." ;
      double latitude_fore(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            latitude_fore:_FillValue = 9.96920996838687e+36 ;
            latitude_fore:units = "deg" ;
            latitude_fore:_Storage = "contiguous" ;
            latitude_fore:long_name = "Latitude of the centre of a None PROJ grid cell." ;
            latitude_fore:grid_mapping = "crs" ;
            latitude_fore:coverage_content_type = "Grid" ;
            latitude_fore:valid_range = "-90, 90" ;
            latitude_fore:comment = "Latitude of the centre of a None PROJ grid cell." ;
      double acq_time_utc_fore(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            acq_time_utc_fore:_FillValue = 9.96920996838687e+36 ;
            acq_time_utc_fore:units = "N/A" ;
            acq_time_utc_fore:_Storage = "contiguous" ;
            acq_time_utc_fore:long_name = "Interpolated UTC Acquisition time of Earth Sample
acquisitions." ;
            acq_time_utc_fore:grid_mapping = "crs" ;
            acq_time_utc_fore:coverage_content_type = "Grid" ;
            acq_time_utc_fore:valid_range = "0, 4,294,967,295" ;
            acq_time_utc_fore:comment = "UTC acquisition times expressed in seconds (seconds
since 2000-01-01 00:00:00 UTC). The value of time_earth will be scaled with the interpolation
weights of all time_earth Earth samples used in the interpolation of that grid cell. " ;
      double oza_fore(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            oza_fore:_FillValue = 9.96920996838687e+36 ;
            oza_fore:units = "deg" ;
            oza_fore:_Storage = "contiguous" ;
            oza_fore:long_name = "Interpolated Observation Zenith Angle of acquisitions." ;
            oza_fore:grid_mapping = "crs" ;
            oza_fore:coverage_content_type = "Grid" ;
            oza_fore:valid_range = "0,359.99" ;
            oza_fore:comment = "Level 1b L_BAND_fore Earth Observation zenith angles of the
acquisitions. The value of OZA will be scaled with the interpolation weights of all
observation OZA Earth samples used in the interpolation of that grid cell. The OZA is defined
as the included angle between the antenna Boresight vector and the normal to the Earth\'s
surface." ;
      double processing_scan_angle_fore(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            processing_scan_angle_fore:_FillValue = 9.96920996838687e+36 ;
            processing_scan_angle_fore:units = "deg" ;
            processing_scan_angle_fore:_Storage = "contiguous" ;
            processing_scan_angle_fore:long_name = "Interpolated scan angle of acquisitions" ;
            processing_scan_angle_fore:grid_mapping = "crs" ;
            processing_scan_angle_fore:coverage_content_type = "Grid" ;
            processing_scan_angle_fore:valid_range = "0,359.99" ;
            string processing_scan_angle_fore:comment = "The processing scan angle of the L1b
L_BAND_fore Earth view samples. The value of scan angle will be scaled with the interpolation
weights of all scan angle Earth samples used in the interpolation of that grid cell.
Measurements from different feed horns are combined. The scan angle is defined as the azimuth
angle of the antenna boresight measured from the ground track vector. The scan angle is 90°
when the boresight points in the same direction as the ground track vector and increases
clockwise when viewed from above." ;
```

```
      double azimuth_fore(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            azimuth_fore:_FillValue = 9.96920996838687e+36 ;
            azimuth_fore:units = "deg" ;
            azimuth_fore:_Storage = "contiguous" ;
            azimuth_fore:long_name = "Interpolated Earth Azimuth angle of the acquisitions." ;
            azimuth_fore:grid_mapping = "crs" ;
            azimuth_fore:coverage_content_type = "Grid" ;
            azimuth_fore:valid_range = "0,359.99" ;
            azimuth_fore:comment = "Level 1b L_BAND_fore Earth observation azimuth angles of
the acquisitions, positive counterclockwise from due east. The value of observation azimuth
angle will be scaled with the interpolation weights of all observation azimuth angle Earth
samples used in the interpolation of that grid cell." ;
      double longitude_aft(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            longitude_aft:_FillValue = 9.96920996838687e+36 ;
            longitude_aft:units = "deg" ;
            longitude_aft:_Storage = "contiguous" ;
            longitude_aft:long_name = "Longitude of the centre of a None PROJ grid cell." ;
            longitude_aft:grid_mapping = "crs" ;
            longitude_aft:coverage_content_type = "Grid" ;
            longitude_aft:valid_range = "-180, 179.99" ;
            longitude_aft:comment = "Longitude of the centre of a None PROJ grid cell." ;
      double latitude_aft(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            latitude_aft:_FillValue = 9.96920996838687e+36 ;
            latitude_aft:units = "deg" ;
            latitude_aft:_Storage = "contiguous" ;
            latitude_aft:long_name = "Latitude of the centre of a None PROJ grid cell." ;
            latitude_aft:grid_mapping = "crs" ;
            latitude_aft:coverage_content_type = "Grid" ;
            latitude_aft:valid_range = "-90, 90" ;
            latitude_aft:comment = "Latitude of the centre of a None PROJ grid cell." ;
      double acq_time_utc_aft(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            acq_time_utc_aft:_FillValue = 9.96920996838687e+36 ;
            acq_time_utc_aft:units = "N/A" ;
            acq_time_utc_aft:_Storage = "contiguous" ;
            acq_time_utc_aft:long_name = "Interpolated UTC Acquisition time of Earth Sample
acquisitions." ;
            acq_time_utc_aft:grid_mapping = "crs" ;
            acq_time_utc_aft:coverage_content_type = "Grid" ;
            acq_time_utc_aft:valid_range = "0, 4,294,967,295" ;
            acq_time_utc_aft:comment = "UTC acquisition times expressed in seconds (seconds
since 2000-01-01 00:00:00 UTC). The value of time_earth will be scaled with the interpolation
weights of all time_earth Earth samples used in the interpolation of that grid cell. " ;
      double oza_aft(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            oza_aft:_FillValue = 9.96920996838687e+36 ;
            oza_aft:units = "deg" ;
            oza_aft:_Storage = "contiguous" ;
            oza_aft:long_name = "Interpolated Observation Zenith Angle of acquisitions." ;
            oza_aft:grid_mapping = "crs" ;
            oza_aft:coverage_content_type = "Grid" ;
            oza_aft:valid_range = "0,359.99" ;
            oza_aft:comment = "Level 1b L_BAND_aft Earth Observation zenith angles of the
acquisitions. The value of OZA will be scaled with the interpolation weights of all
observation OZA Earth samples used in the interpolation of that grid cell. The OZA is defined
as the included angle between the antenna Boresight vector and the normal to the Earth\'s
surface." ;
      double processing_scan_angle_aft(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            processing_scan_angle_aft:_FillValue = 9.96920996838687e+36 ;
            processing_scan_angle_aft:units = "deg" ;
            processing_scan_angle_aft:_Storage = "contiguous" ;
            processing_scan_angle_aft:long_name = "Interpolated scan angle of acquisitions" ;
```

```
            processing_scan_angle_aft:grid_mapping = "crs" ;
            processing_scan_angle_aft:coverage_content_type = "Grid" ;
            processing_scan_angle_aft:valid_range = "0,359.99" ;
            string processing_scan_angle_aft:comment = "The processing scan angle of the L1b
L_BAND_aft Earth view samples. The value of scan angle will be scaled with the interpolation
weights of all scan angle Earth samples used in the interpolation of that grid cell.
Measurements from different feed horns are combined. The scan angle is defined as the azimuth
angle of the antenna boresight measured from the ground track vector. The scan angle is 90°
when the boresight points in the same direction as the ground track vector and increases
clockwise when viewed from above." ;
      double azimuth_aft(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            azimuth_aft:_FillValue = 9.96920996838687e+36 ;
            azimuth_aft:units = "deg" ;
            azimuth_aft:_Storage = "contiguous" ;
            azimuth_aft:long_name = "Interpolated Earth Azimuth angle of the acquisitions." ;
            azimuth_aft:grid_mapping = "crs" ;
            azimuth_aft:coverage_content_type = "Grid" ;
            azimuth_aft:valid_range = "0,359.99" ;
            azimuth_aft:comment = "Level 1b L_BAND_aft Earth observation azimuth angles of the
acquisitions, positive counterclockwise from due east. The value of observation azimuth angle
will be scaled with the interpolation weights of all observation azimuth angle Earth samples
used in the interpolation of that grid cell." ;
      } // group L_BAND
      } // group Navigation

  group: Processing_flags {
      int processing_flag_fore(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            processing_flag_fore:_FillValue = 9.96920996838687e+36 ;
            processing_flag_fore:units = "N/A" ;
            processing_flag_fore:_Storage = "contiguous" ;
            processing_flag_fore:long_name = "An 8-bit binary string of 1’s and 0’s indicating
RGB processing specific flags used in the derivation of L1C/R data. Bit position ‘0’
corresponds to the least significant bit. For fore scan." ;
            processing_flag_fore:grid_mapping = "crs" ;
            processing_flag_fore:coverage_content_type = "Grid" ;
            processing_flag_fore:valid_range = "0,7" ;
            string processing_flag_fore:comment = "An 8-bit binary string of 1’s and 0’s
indicating RGB processing specific flags used in the derivation of L1C/R data. Bit position
‘0’ corresponds to the least significant bit. Bit 0: 0 = Number of neighbours available was
within or equal to the selected max_neighbours config parameter. 1 = There were more
neighbours available than the selected max_neighbours config parameter. Bit 1: 0 = All antenna
patterns used for the target sample were resolved and projected to the target grid. 1 = One or
more of the antenna patterns used for the target samples were not resolved or unable to be
projected to the target grid. Bit 2: 0 = Iterative technique not used OR target relative
tolerance was reached (convergence) in the inversion algorithm. 1 = Iterative technique used
and target relative tolerance not met in the inversion algorithm (non-convergence). Bit 3: 0 =
The Integration grid for the target cell was constructed. 1 = The integration grid for the
target cell could not be constructed. Bit 4: 0 = 0 = Antenna patterns not used OR overlap
between source and target patterns deemed sufficient to yield reliable results. 1 = Antenna
patterns used and overlap between source and target patterns deemed insufficient to yield
reliable results. Bit 5: 0 = This bit is currently not used. 1 = This bit is currently not
used. Bit 6: 0 = This bit is currently not used. 1 = This bit is currently not used. Bit 7: 0
= This bit is currently not used. 1 = This bit is currently not used." ;
      int processing_flag_aft(n_l1b_scans, n_samples_L_BAND, n_feeds_L_BAND) ;
            processing_flag_aft:_FillValue = 9.96920996838687e+36 ;
            processing_flag_aft:units = "N/A" ;
            processing_flag_aft:_Storage = "contiguous" ;
            processing_flag_aft:long_name = "An 8-bit binary string of 1’s and 0’s indicating
RGB processing specific flags used in the derivation of L1C/R data. Bit position ‘0’
corresponds to the least significant bit. For aft scan" ;
```

```
            processing_flag_aft:grid_mapping = "crs" ;
            processing_flag_aft:coverage_content_type = "Grid" ;
            processing_flag_aft:valid_range = "0,7" ;
            string processing_flag_aft:comment = "An 8-bit binary string of 1’s and 0’s
indicating RGB processing specific flags used in the derivation of L1C/R data. Bit position
‘0’ corresponds to the least significant bit. Bit 0: 0 = Number of neighbours available was
within or equal to the selected max_neighbours config parameter. 1 = There were more
neighbours available than the selected max_neighbours config parameter. Bit 1: 0 = All antenna
patterns used for the target sample were resolved and projected to the target grid. 1 = One or
more of the antenna patterns used for the target samples were not resolved or unable to be
projected to the target grid. Bit 2: 0 = Iterative technique not used OR target relative
tolerance was reached (convergence) in the inversion algorithm. 1 = Iterative technique used
and target relative tolerance not met in the inversion algorithm (non-convergence). Bit 3: 0 =
The Integration grid for the target cell was constructed. 1 = The integration grid for the
target cell could not be constructed. Bit 4: 0 = 0 = Antenna patterns not used OR overlap
between source and target patterns deemed sufficient to yield reliable results. 1 = Antenna
patterns used and overlap between source and target patterns deemed insufficient to yield
reliable results. Bit 5: 0 = This bit is currently not used. 1 = This bit is currently not
used. Bit 6: 0 = This bit is currently not used. 1 = This bit is currently not used. Bit 7: 0
= This bit is currently not used. 1 = This bit is currently not used."
      } // group Processing_flags

  group: Quality_information {

      group: L_BAND {
      } // group L_BAND
      } // group Quality_information
  } // group C_BAND_TARGET
}
```