DIMITRI toolbox

Software User Manual

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Document reference :	VICALOPS-SUM-112-MAG
Edition revision :	1.1
Circulation date :	15/04/2026
Customer :	ESA
Ref. Market, consultation :	ESA-EOPG-EOPGMQ-SOW-58

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Distribution List

	Name	Company	Copies
Recipients	Marc Bouvet	ESA	1 (digital)
Internal copy	Customer File	Magellium	1 (digital)
External copy	Sans Objet		

Document Change Record

Iss.	Rev.	Date	Reason	Comments
1	0	23/02/2025	Document creation	None
1	1	15/04/2026	List of sensors and Sites updates	
			Reference to V4.9 changes to V4.10a	

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1 Introduction

1.1 Purpose of document

The purpose of the DIMITRI toolbox is to enable radiometry monitoring for a list of sensors acquiring data between 380 and 2500 nm using a large set of methods which uses sites with specific characteristics.

The software has evolved to account for news sensors, new sites and new methods.

The User Manual provides detailed descriptions of the product functionality and the step-by-step processes for use.

1.2 DIMITRI description

The DIMITRI software package contains a suite of routines for the comparison of Top Of Atmosphere (TOA) reflectance from Earth Observation sensors either between sensors or to simulations. The comparison of TOA reflectances can be done either:

- Between two sensor TOA reflectances in similar spectral bands;
- Between a sensor TOA reflectances and their simulations.

Separately from the development of the DIMITRI software, a database containing remote sensing L1 products from 2002 until the present day for various sensors is continuously being populated. Currently, it holds L1 data from ATSR2 (ESA), AATSR (ESA), MERIS (ESA), MODIS-Aqua (NASA), MODIS Terra (NASA) POLDER-3 (CNES), VEGETATION-2 (VITO), VIRRS-SNPP (NASA), S2A/S2B – MSI, S3A/S3B - OLCI and SLSTR (ESA), LANDSAT-8/ OLI_1 (USGS) over predetermined validation sites (See Table 1-1).

1.2.1 Predefined sites

Table 1-1 : Geolocation values for the predefined DIMITRI validation sites

Site name	Site Type	North Latitude	South Latitude	East Longitude	West Longitude
DOME_C	Ice	-74.9	-75.3	123.9	122.9
ALGERIA-3	Desert	30.82	29.82	8.16	7.16
ALGERIA-3s	Desert	30.42	30.22	7.76	7.56
ALGERIA-5	Desert	31.52	30.52	2.73	1.73
ALGERIA-5s	Desert	31.12	30.92	2.33	2.13
LIBYA-1	Desert	24.92	23.92	13.85	12.85
LIBYA-1s	Desert	24.60	24.40	13.40	13.20
LIBYA-4	Desert	29.05	28.05	23.89	22.89

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LIBYA-4S	Desert	28.65	28.45	23.49	23.29
MAURITANIA-1	Desert	19.9	18.9	-8.8	-9.8
MAURITANIA-1s	Desert	19.5	19.3	-9.2	-9.4
MAURITANIA-2	Desert	21.35	20.35	-8.28	-9.28
MAURITANIA-2s	Desert	20.95	20.75	-8.68	-8.88
GONA	Desert_Small	-23.586	-23.605	15.133	15.113
SPG_OPTIMUM_BIG	Ocean	-24	-28	-118	-122
SIO_OPTIMUM_BIG	Ocean	-25	-29	80	76
NW_PACIFIC_OPTIMUM	Ocean	20	16	159	155
NE_PACIFIC_OPTIMUM	Ocean	20	16	-150	-154
MALDIVES	Cloud	10	-10	90	60
MALDIVES T43NDF	Cloud	10	-10	90	60

1.2.2 Sensors

Table 1-2 : DIMITRI Sensor data information

Sensor	Collection/Processing Number
AATSR	2nd reprocessing
ATSR2	Proc_Processing_2008
Landsat-8/OLI	Collection_2
Landsat-9/OLI	Collection_2
MERIS	3th reprocessing 4th reprocessing
MODIS-Aqua	Collection 6.1
MODIS-Terra	Collection 6.1
PARASOL	Collection 1
VEGETATION – 2*	Collection 2
VIIRS	Collection 2

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Sentinel-2A/MSI	Collection_2
Sentinel-2B/MSI	Collection_2
Sentinel-2C/MSI	Collection_2
Sentinel-3A/OLCI	Collection_4
Sentinel-3B/OLCI	Collection_4
Sentinel-3A/SLSTR	Collection_4
Sentinel-3B/SLSTR	Collection_4

1.3 Related documents

1.3.1 Applicable documents

Table 1-3 : Applicable documents

Id.	Ref.	Description
[SOW]	ESA-EOPG-EOPGMQ-SOW-58	VIcarious CALibration OPerational Service (VICALOPS) and DIMITRI maintenance and evolution Statement Of Work
[AD-0]	AO/1-11515/22/I-NS	Call to tender "VIcarious CALibration OPerational Service (VICALOPS) and DIMITRI maintenance and evolution"
[AD-1]		ESA's Personal Data Protection Framework, accessible at https://esamultimedia.esa.int/docs/LEX-L/ESA_Principles_of_PDP_Rules_of_Procedure_for_DPSA_and_Policy_Final_V3.pdf
[AD-2]		GPP FLEX L1 product definition document (FLX-PDD-EXP-GPP-0001 – v3 – 24/11/2021) + test dataset available from (https://esabox.esa.int/owncloud/index.php/s/Fs0QxbKD3zQSJ9M, pwd: DIMITRI123!)

1.3.2 Reference documents

Table 1-4 : Reference documents

Id.	Description
RD-1	Bouvet M., Intercomparison of imaging spectrometer over the Salar de Uyuni (Bolivia), Proceedings of the 2006 MERIS AATSR Validation Team Workshop
RD-2	Bouvet M. , Ramoino F., Radiometric intercomparison of AATSR, MERIS, and Aqua MODIS over Dome Concordia (Antarctica), Can. J. Remote Sensing, Vol. 36, No. 5, pp. 464–473, 2010

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RD-3	Roujean J.L., Leroy M. and Deschamps P.Y. (1992). A bidirectional reflectance model of the Earth's surface for the correction of remote sensing data. Journal of Geophysical Research, 97(DIS), 20.455-20.468.
RD-4	Irish, R.R. Landsat 7 Automatic Cloud Cover Assessment. See http://landsathandbook.gsfc.nasa.gov/pdfs/ACCA_SPIE_paper.pdf
RD-5	Plummer, S.E. 2008. The GLOBCARBON Cloud Detection System for the Along-Track Scanning Radiometer (ATSR) Sensor Series, IEEE Transactions on Geoscience and Remote Sensing, 46 (6), 1718 – 1727.
RD-6	Barker K., Marrable D. and Mazeran C. 2014. Automated Cloud Screening, ATBD (MO-SCI-ARG-TN-004a), Version 1.0
RD-7	Barker K., Marrable D., Hedley J. and Mazeran C. 2014. Rayleigh Scattering Methodology for Vicarious Calibration, ATBD (MO-SCI-ARG-TN-004b), Version 1.0
RD-8	Barker K., Marrable D., Hedley J. and Mazeran C. 2014. Interband Vicarious Calibration over Sun Glint, ATBD (MO-SCI-ARG-TN-004c), Version 1.0
RD-9	Bouvet M., Radiometric comparison of multispectral imagers over a pseudo-invariant calibration site using a reference radiometric model, Remote Sensing of Environment, Vol. 140, pp. 141–154, 2014
RD-10	Improved cloud screening ATBD. (OPECAL-TN-019-MAG)
RD-11	Vicarious calibration methodology ATBD Sun Glint (OPECAL-TN-022-MAG)
RD-12	Vicarious calibration methodology ATBD Rayleigh (OPECAL-TN-042-MAG)
RD-13	Vicarious calibration methodology ATBD Desert (OPECAL-TN-043-MAG)
RD-14	Hedley 2017. LUT description and use, ATBD (ARG_DIM_QA4EO_LUT_SUM)
RD-15	Hedley 2018. Pressure, latitude and C02 adjustments, ATBD (ARG_DIM_QA4EO_ATM)
RD-16	Hedley 2019. Water-leaving reflectance BRDF (ARG_DIM_QA4EO_WL_BRDF)
RD-17	Alhammoud B. and Hedley J. 2019. Rayleigh Scattering Methodology for Vicarious Calibration, ATBD (MO-SCI-ARG-TN-004b), Version 2.0
RD-18	Alhammoud B. and Hedley J. 2019. Interband Vicarious Calibration over Sun Glint, ATBD (MO-SCI-ARG-TN-004c), Version 2.0
RD-19	Berthelot, B, Vicarious calibration methodology ATBD DCC (RFQ-QA4EO-DIMITRI-TN-010-MAG_ATBD-DCC)
RD-20	Alhammoud B. and C. Mackenzie 2023. Inter-band Vicarious Calibration over Deep Convective Cloud (DCC) ATBD (ARG_DIM_QA4EO_TN_DCC)
RD-21	Berthelot, B, 2023. BRDF snow surfaces model ATBD, (RFQ-QA4EO-DIMITRI-TN-015-MAG)

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RD-22	Alhammoud et al. 2023. Vicarious calibration methodology over Snow ATBD (ARG_DIM_QA4EO_TN_SNOW)

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2 DIMITRI License

2.1 Licence and terms of Use

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Any publication, report, or presentation making use of the software or its results shall include appropriate acknowledgment of ESA and Magellium, including the following citation:

"The authors gratefully acknowledge ESA and Magellium for access to and use of the DIMITRI software (DIMITRI V4.10), which supported the generation of the results presented in this work."

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Users are invited to submit suggestions for improvements or modifications to contact-vicalops@magellium.fr

Any proposed changes may be reviewed and, subject to ESA approval, incorporated into future versions of the software without obligation or compensation.

2.2 How to get DIMITRI?

The official version of the original DIMITRI source code is available at https://www.vicalops.org.

Access Requirements:

- Users must register to gain access to the software.

Required Data Files:

For proper functionality, the following auxiliary and meteorological data files must be downloaded from the website:

- AUX_DAT_DIMITRI_v4.10.tar
- AUX_METEO_DIMITRI_v4.10.tar

2.3 DIMITRI package content

The DIMITRI software package includes the following files:

- DIMITRI_TOOLBOX_V40.tar – The main software toolbox.

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- AUX_DAT_DIMITRI_v4.10.tar – Required auxiliary data.
- AUX_METEO_DIMITRI_v4.10.tar – Meteorological data necessary for proper functioning.
- TDS_INSTALLATION_v4.10.tar - Test Data Set – Provided for verifying that the code is functioning correctly.

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3 Software Installation

3.1 Software requirements

- Idl 9.0 or above
- Libradtran v2.0.5

3.1.1 IDL

Interactive Data Language (IDL) is a high-level programming language widely used for data analysis, visualization, and scientific computing. It is particularly popular in fields such as astronomy, remote sensing, medical imaging, and geophysics due to its powerful built-in mathematical and graphical capabilities.

A full IDL license will allow command line usage, modification of routines and recompilation of the software package with user-written code if desired.

https://www.nv5geospatialsoftware.com/Products/IDL

3.1.2 LibradTran v2.0.5

libRadtran - library for radiative transfer - is a collection of C and Fortran functions and programs for calculation of solar and thermal radiation in the Earth's atmosphere. libRadtran is freely available under the GNU General Public License. It allows one to compute (polarized) radiances, irradiance, and actinic fluxes in the solar and thermal spectral regions. libRadtran has been used for various applications, including remote sensing of clouds, aerosols and trace gases in the Earth's atmosphere (Emde, C, et al., 2016).

DIMITRI makes use of the MYSTIC radiative transfer code to perform TOA observation over desert and snow sites The Mystic model is available from the LibRadTran package (www.libradtran.org).

In addition, the OPAC libraries (www.libradtran.org), netCDF and libnetCDF libraries (http://www.unidata.ucar.edu/netCDF), Data for the REPTRAN absorption parameterization and Full resolution extraterrestrial spectrum by Kurucz et al. (1992), are required.

Please visit the libradtran webpage for compilation of LibRadTran package. https://www.libradtran.org/doku.php?id=download

LibRadtran reference publications:

- C. Emde, R. Buras-Schnell, A. Kylling, B. Mayer, J. Gasteiger, U. Hamann, J. Kylling, B. Richter, C. Pause, T. Dowling, and L. Bugliaro. The libradtran software package for radiative transfer calculations (version 2.0.1). *Geoscientific Model Development*, 9(5):1647-1672, 2016.
- B. Mayer and A. Kylling. Technical note: The libRadtran software package for radiative transfer calculations - description and examples of use. *Atmos. Chem. Phys.*, 5: 1855-1877, 2005.

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3.2 Additional Data Requirements

DIMITRI uses auxiliary data that needed to be downloaded from the vicalops web site.

The necessary files are:

- AUX_DAT_DIMITRI_v4.10.tar
- AUX_METEO_DIMITRI_V4.10.tar

These files are essential for the proper functioning of the software.

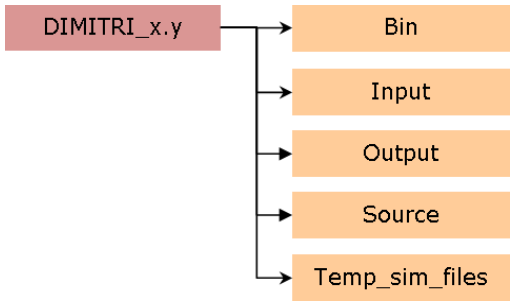
3.3 Installation

The DIMITRI software package is downloaded as a compressed file. To install DIMITRI unzip the file into the desired installation location.

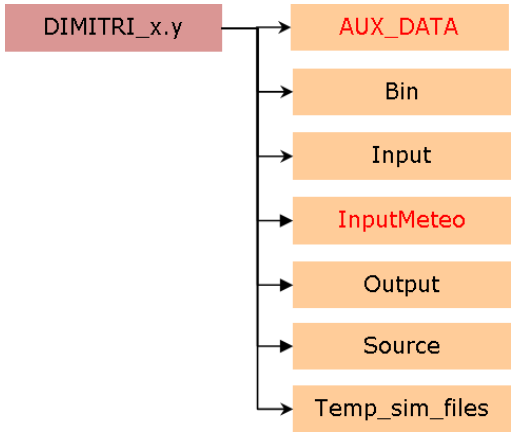
Linux users can install the DIMITRI package by typing:

tar –xfvz DIMITRI_Vx.y.tar.gz

The following tree structure appears under the installation folder:



The auxiliary data and meteorological data zip files must be uncompressed under 'DIMITRI_x.y' folder. Two new folders appear:



The installation is now completed.

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3.4 Validation of the installation

A test dataset is provided to check that the installation has been completed correctly.

This includes acquisitions for these two sensors:

- OLCI_1
- MSI_A

Table 3-1: Installation Test sites.

Sensor	Site_TestDesert	Site_TestSnow	Site_TestOcean	Site_SUNGLINT_Test	Site_TestDCC
OLCI_A	10 products	10 products	10 products	10 products	10 products
MSI_A	2 products	10 products	None	None	2 products

The TDS has been carefully selected to allow methodologies to be tested.

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4 Software User Manual

4.1 Quick start

After extraction, DIMITRI is ready to be used. To launch the software, navigate to the "DIMITRI_x.y" folder (where 'x' or 'x.y' represents the installed version number) and double-click the "DIMITRI_Vx.sav" file.

These commands will load the **DIMITRI Human Machine Interface (HMI)**.

If you have a full IDL license, all DIMITRI routines can be executed through the command line. To restore the routines, enter the following command in IDL:

IDL>restore, 'DIMITRI_Vx.sav'

You can then run DIMITRI by typing:

IDL>DIMITRI_Vx

4.2 Main DIMITRI HMI

The DIMITRI HMI includes a set of primary and secondary functions, all of which are designed for use via the command line as well as through the DIMITRI HMI.

Figure 4-1 illustrates the DIMITRI HMI for version V4.10.0.

The following sections describe the functionalities (buttons) available in the HMI.

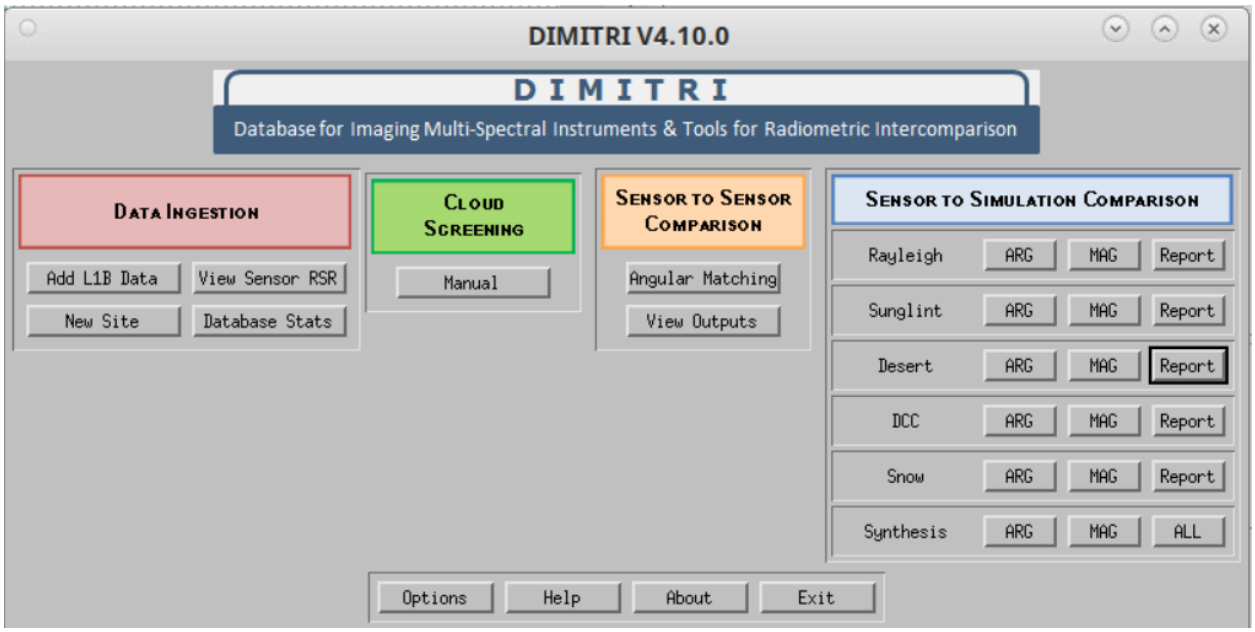


Figure 4-1 : The DIMITRI HMI start window as seen since DIMITRI_V4.x.y onwards.

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4.3 Data Ingestion

4.3.1 Add L1B Data

The data are ingested if available in the 'Input' directory under the main DIMITRI directory. The data must be sorted by site name, sensor type, processing version and acquisition year.

Ingestion can be done over one of the sites listed in Table 1-1 or over a new site defined through the 'New Site' button of the main DIMITRI HMI (Section 4.3.2).

In addition, in the specific case of L1 products that are intended for use with the sun glint calibration methodologies, users have to first add their L1 acquisitions under the /Input/Site_SUNGLINT directory. Subdirectories follow the same nomenclature as the one described for site data ingestion.



Figure 4-2: Input folder structure.

The Input folder tree structure observes the following rules:

- DIMITRI_x.y/Input/Site_[SITE]/[SENSOR]/Proc_[COLLECTION]/[ACQ_YEAR]

With [SITE] : Site name,

[SENSOR] : Sensor name,

[COLLECTION] : Collection or processing version of the L1 product,

[ACQ_YEAR] : Acquisition year (YYYY format).

Examples:

- DIMITRI_4.9.0\Input\Site_Libya4\MERIS\Proc_4th_Reprocessing\2012
- DIMITRI_4.9.0\Input\Site_SIO_OPTIMUM_BIG\OLCI_A\Proc_Collection_1\2021

For further details on ingestion process, see Section 5.3.

The "Add L1B data" button starts the ingestion of L1 data products into DIMITRI. User can choose to ingest data from a given sensor, over a given site and for a given year via the HMI (Figure 4-3)

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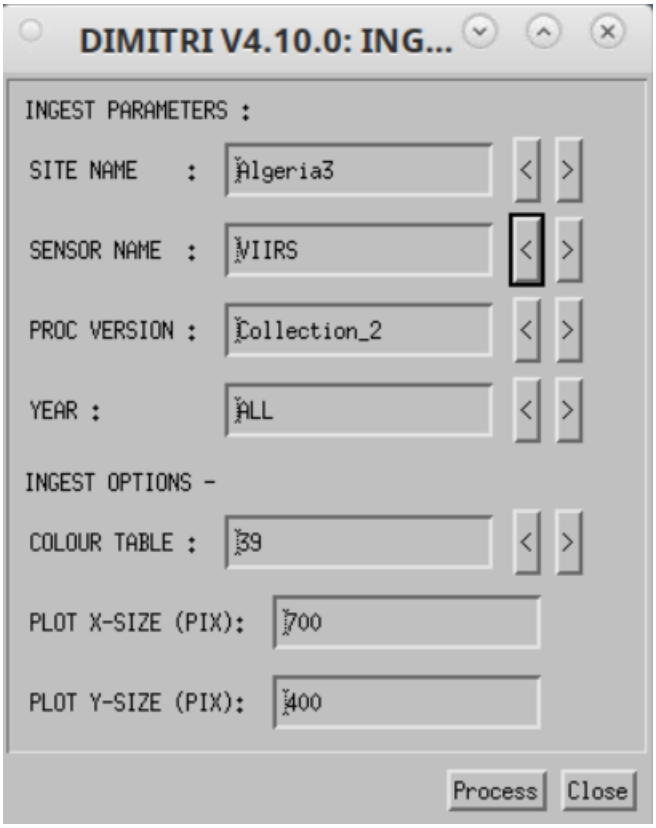


Figure 4-3: The 'Add L1B Data' HMI window as seen from DIMITRI_V4.x.y onwards.

All data are then automatically cloud screened according to cloud screening algorithm associated to the each sensor (Section 4.4.1). The key physical quantity extracted from all L1 files is the TOA Reflectance at any given wavelength defined as:

$$\rho = \pi \frac{L}{F_0 . d^2 . Cos(\theta_s)}$$

Where:

- ρ = reflectance,
- L = TOA Radiance,
- F_0 = Solar Irradiance Flux,
- θ_s = Solar Zenith Angle,
- d^2 = Earth-Sun distance correction factor.

The ingestion process can take several minutes per L1 product, depending on system performance and sensor type (as well as whether child or parent products are used).

Final comment: If storage is an issue, once the ingestion and the creation of the required files are complete, the original L1 products can be removed from the input folder, as DIMITRI no longer requires direct access to them.

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4.3.2 New Site

The "New Site" button launches the new site creation tool. This feature allows users to add a new site to the DIMITRI database by specifying:

- Site Name
- Site Type
- Geolocation coordinates (North, South, East, and West)

Once these parameters are selected, DIMITRI automatically generates the required input folders, eliminating the need for manual folder creation.

After the site is created, L1 products should be placed in the appropriate input folders before ingestion into DIMITRI.

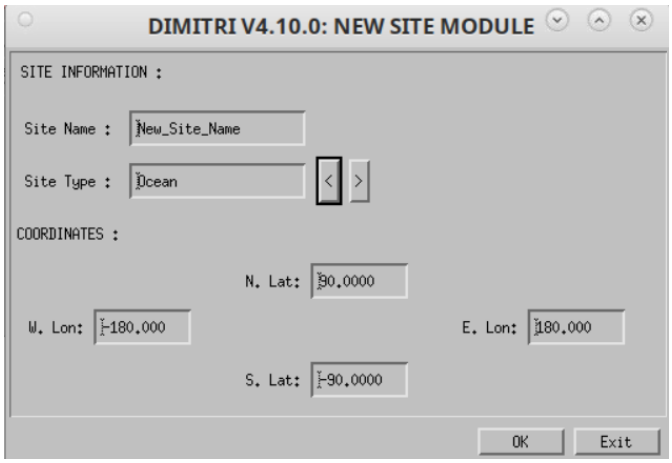


Figure 4-4: The 'New site' HMI window as seen from DIMITRI_V4.x.y onwards.

4.3.3 View sensor RSR

The Relative Spectral Response (RSR) viewer enables users to generate and visualize plots of sensor RSR functions within a user-specified wavelength range.

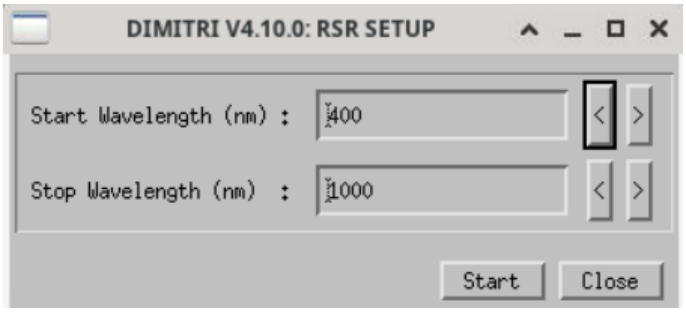


Figure 4-5: The 'RSR viewer' HMI window as seen from DIMITRI_V4.x.y onwards.

Key Features:

- Users can view the associated reflectance for each sensor as the spectrum is convoluted with the sensor RSR.

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- New site spectra can be added to the DIMITRI_x.y/AUX_DATA/spectral_response/USER_Sites folder.

File Format Requirements:

- The files must be semi-colon separated (;).
- Each file must contain two columns:
  - Wavelength (nm)
  - RSR function values (ranging between 0 and 1).

```
==> RSR_MERIS_BAND_0.txt
Wavelength;Response
405.5; 0.0000518550
405.6; 0.0000957914
405.7; 0.0001733730
405.8; 0.0003073845
405.9; 0.0005340484
406.0; 0.0009090797
406.1; 0.0015161700
406.2; 0.0024775440
406.3; 0.0039661060
```

Figure 4-6: RSR file format

4.3.4 Database statistics

The "Database Stats" button launches the database statistics module, which provides up-to-date statistics on the current DIMITRI database file.

Features:

- Displays the number of ingested products for each sensor over each site.
- Generates visual plots summarizing ingestion statistics.
- Allows users to save plots in JPG, PNG, and CSV formats for further analysis.

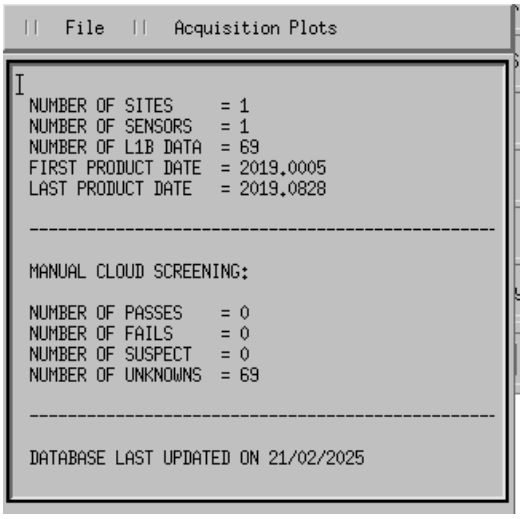


Figure 4-7: The 'Database Stats' HMI window as seen from DIMITRI_V4.x.y onwards.

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4.4 Cloud Screening

Cloud screening is an essential step in filtering out acquisitions and individual pixels that are cloud-contaminated. These pixels cannot be used for comparisons between sensor observations or between sensor data and simulations.

DIMITRI provides two cloud screening methods:

Automatic Cloud Screening

- Performed automatically during data ingestion.
- A cloud mask is computed and included in the ingested product.

Manual Cloud Screening

- Allows users to verify and modify the automatic cloud detection results.
- The HMI provides a quick-look visualization tool, enabling users to manually apply a flag that overrides the automatic cloud screening results.

4.4.1 Automatic Cloud Screening

Since **DIMITRI v4.0**, a new set of **automated cloud screening schemes** has been introduced to enable the utilization of all the methodologies implemented in the software. **ARGANS** uses its own cloud screening method, while **MAGELLIUM** applies a separate, distinct approach tailored to specific site types.

These two parallel cloud screening schemes are referred to with the following tags:

- 'AUTO_CS_1' for the ARGANS cloud screening scheme
- 'AUTO_CS_2' for the MAGELLIUM cloud screening scheme

These tags are used in various files generated during the ingestion of new data, ensuring the appropriate cloud screening methodology is applied to each dataset.

Since DIMITRI v2.0, the following cloud screening algorithms have been implemented by ARGANS for each sensor:

- **Landsat ACCA** (RD-4): ATSR2, AATSR, MODIS-Aqua, Sentinel-3/SLSTR
- **GlobCarbon** (RD-5): MERIS, PARASOL, Sentinel-2A/MSI, Sentinel-3/OLCI
- **VGT-operational**: VEGETATION

These algorithms were adapted by MAGELLIUM in DIMITRI v4.0 for Ocean and Desert site types for each sensor (RD-10). Specifically:

- Over the ocean, cloud detection has been implemented to identify clouds over sun glint targets. Additionally, a spatial coherence test has been added to flag clouds in sun glint and site data ingestion.
- Over the desert, a reference created from clear data acquired over the site is used to distinguish between clear and cloud-contaminated pixels.

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The cloudiness data for each product over the validation site is stored in the DIMITRI database and used with the selected cloudiness thresholds for:

- Sensor-to-sensor processes (Section 4.5)
- Sensor-to-simulation processes (Section 4.7)

4.4.2 Manual Cloud Screening

In addition to the automated cloud screening, users can access the manual cloud screening module. This module allows visualization of the product quicklook for manual determination of whether the product is cloudy, clear, or contains errors (suspect).

The manual cloud screening results always override the automated cloud screening.

The following flags are used to define cloudiness in the database for manual cloud screening:

- -1: No manual cloud screening applied (default)
- 0: Clear
- 1: Cloudy
- 2: Suspect

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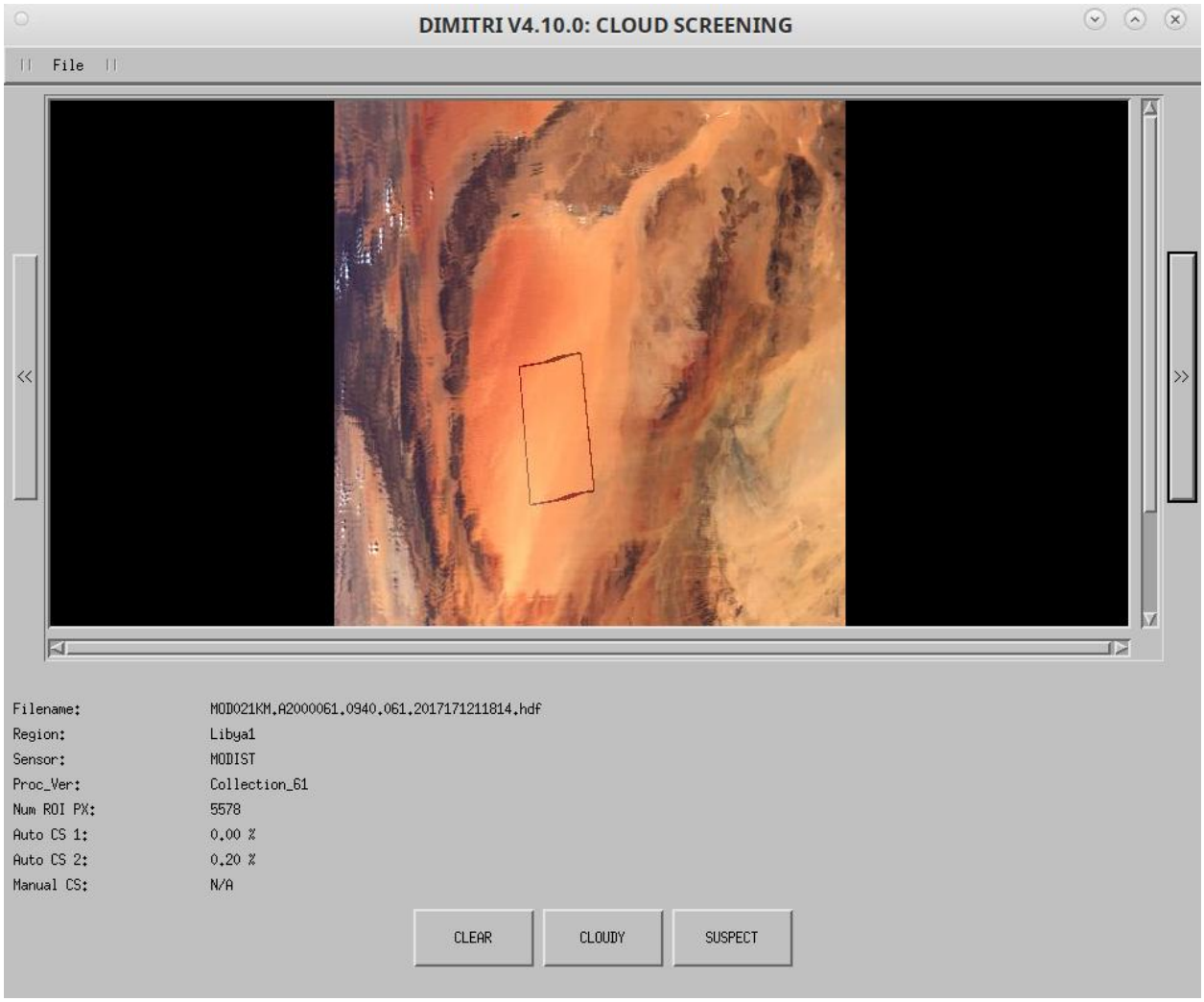


Figure 4-8: Manual Cloud Screening HMI window as seen from DIMITRI_V4.x.y onwards

4.5 Sensor To Sensor Comparison

4.5.1 Angular Matching

The "Angular Matching" button initiates the intercomparison between a "reference" sensor and a set of "calibration" sensors (Figure 4-9), which can be radiometrically compared to the reference sensor. This intercomparison process identifies acquisitions made between the two sensors at similar times and under similar geometries.

The results of the intercomparison are saved in an output folder. The folder name can be left as "auto" to generate an automatic folder name (e.g., "DIMITRI_x.y/Output/SIO_20110426_REF_MERIS_2nd_Reprocessing"). Alternatively, the folder name can be defined by the User

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4.5.2 Sensor Selection

The "calibration" sensors and their respective L1 processing versions can be selected by moving the required sensor configuration into the right-hand list. This can be done by highlighting the configuration and pressing the ">>" button. If there are unwanted configurations, they can be removed from the list by selecting the configuration and pressing the "<<" button.

The temporal and angular matching between sensors over the site is performed based on the data stored in the DIMITRI database file (located at DIMITRI_x.y/Bin/DIMITRI_DATABASE.CSV). This ensures that the sensors are compared with the appropriate acquisition timings and geometries.

4.6 Angular Matching Criteria

The AMC (Angular Matching Criterion) is used to geometrically match satellite data from two different sensors. It is based on the Solar Zenith Angle (SZA), Viewing Zenith Angle (VZA), and Relative Azimuth Angle (RAA). These parameters can be selected and used to update the AMC threshold for selecting corresponding satellite observations.

The AMC is calculated using the following formula:

$$AMC = \sqrt{([SZA_1 - SZA_2]^2 + [VZA_1 - VZA_2]^2 + \frac{1}{4}[|RAA_1| - |RAA_2|]^2)}$$

The User has the option to refine the matching criteria by selecting absolute angle criteria for the following parameters:

- Viewing Zenith Angle (VZA)
- Viewing Azimuth Angle (VAA)
- Solar Zenith Angle (SZA)
- Solar Azimuth Angle (SAA)

By selecting absolute angle criteria for these parameters, the user can impose stricter matching conditions to ensure that the data from different sensors are geometrically aligned within specific limits. This helps to improve the precision and reliability of the sensor-to-sensor comparisons, especially for intercomparison and calibration purposes.

4.6.1 Temporal, Spatial and Cloud Criteria

The final parameter selections allow the User to define the following criteria for matching satellite observations:

- Maximum Allowed Acquisition Time Difference (in days): This parameter specifies the maximum time difference between two satellite observations for them to be considered for comparison. This ensures that the satellite data used in the intercomparison is temporally aligned.

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- Automated Cloud Percentage Threshold: This is the threshold percentage for cloud cover that determines whether a satellite observation can be used in the comparison. If the automated cloud screening indicates that the cloud coverage exceeds this percentage, the observation will be excluded from the comparison.
- Percentage of the Region of Interest (ROI) Covered: This defines the minimum percentage of the Region of Interest (ROI) that must be covered by valid data for the observation to be considered for matching.

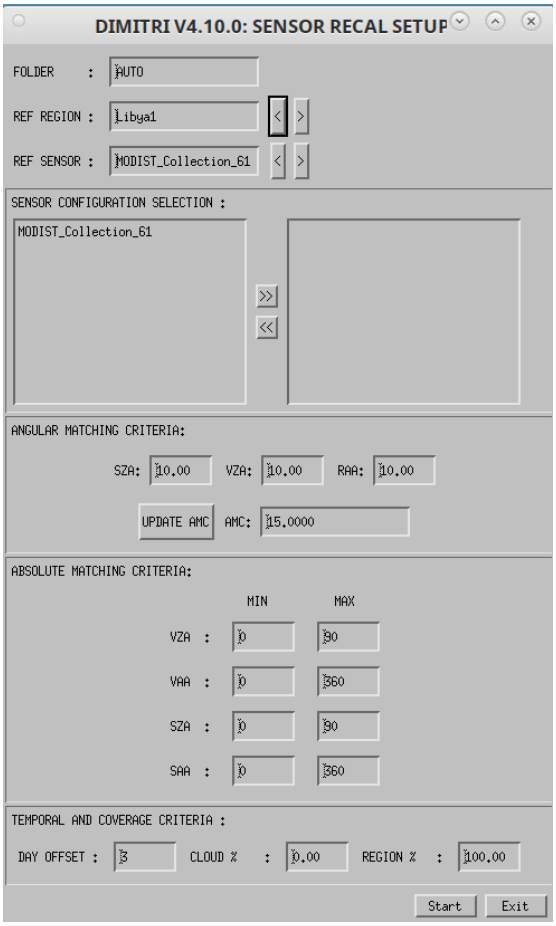


Figure 4-9: The DIMITRI Sensor Recalibration HMI window as seen from DIMITRI_V4.x.y onwards

If the input ROI (Region of Interest) percentage coverage is set to less than 100%, the system compares the expected number of pixels for the selected sensor against the actual number of pixels for each observation. This comparison ensures that the sensor data meets the required coverage criteria for the ROI.

However, if the ROI percentage coverage is set to 100%, a different test is used:

- Only products where the four corners of the defined ROI are covered are retained. This is made possible by using the "ROI_COVER" flag within the DIMITRI database to track the coverage.
- This check is particularly important for sensors like MODIS-Aqua, where the pixel resolution changes across the swath. At higher viewing zenith angles, fewer pixels are required to fully cover the ROI. This may result in the data being recorded as not fully covered due to the expected constant pixel resolution, even though the actual coverage might be sufficient.

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Thus, it is recommended to always set the ROI percentage coverage to 100% to ensure accurate and reliable data coverage.

When the above conditions are met, any satellite observations from two separate sensors (or configurations) that align within the defined temporal, spatial, and cloud coverage criteria are known as "doublets". Doublets refer to pairs of satellite observations from different sensors that match closely in time and space, making them suitable for comparison and analysis.

4.6.2 Final Steps

Once all parameters have been selected, the START button initiates the Sensor Recalibration process. This process involves several key steps:

- Doublet Matching: This involves identifying and matching pairs of satellite observations from the "reference" sensor and the "calibration" sensors. These doublets are selected based on the temporal, spatial, and cloud coverage criteria specified earlier.
- Generation of a Polynomial: After doublet matching, a polynomial is generated to fit the temporal variations of the radiometric difference between the "reference" sensor and all the "calibration" sensors. This polynomial allows for adjusting the radiometric values of the calibration sensors so that they align with the reference sensor's scale.
- Recalibration of Calibration Sensors: The final step involves recalibrating the data from the "calibration" sensors to the radiometric scale of the "reference" sensor. This recalibration process ensures that the data from different sensors can be compared directly.

These steps are referred to as doublet extraction, intercalibration, and recalibration, and they result in a "super sensor" time series of sensor observations. This series contains data from multiple sensors, all aligned to the reference sensor's radiometric scale, but covering the same location with varying viewing and solar geometries.

Polynomial Model for Intercalibration:

During the intercalibration step, a polynomial fit is applied to model the temporal differences between the calibration and reference sensor for each specific band. The model used for the polynomial fit is:

$$y = Ax^2 + Bx + C$$

Where:

- y represents the radiometric difference.
- x represents time (or another appropriate temporal parameter).
- A, B, and C are the coefficients of the polynomial.

These coefficients are determined using a least squares regression fit, which minimizes the differences between the observed and predicted values. The coefficients are then saved in the "ICAL" CSV files. No weighting is applied to the polynomial model computation during this process.

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Covariance Matrix:

In addition to the polynomial coefficients, a covariance matrix is also generated and output in the "ICAL" CSV file. The covariance matrix is a 3x3 array that represents the uncertainty in the polynomial coefficients. The rows and columns of this matrix correspond to the coefficients A, B, and C.

For example:

- CVAR_A1 refers to the covariance value for the [1,1] element of the matrix (the covariance between coefficient A and itself).
- The matrix output provides additional statistical information that helps assess the reliability and precision of the polynomial fit.

This ensures that the recalibration process is not only accurate but also statistically sound, allowing users to evaluate the confidence in the results based on the covariance matrix.

4.6.3 Super Sensor observation uncertainty

The final output of the process previously described is the time series of super sensor observations. All sensors observations have been rescaled to the reference sensor radiometric scale. This does not mean that the super sensor observations have the same systematic uncertainty than the reference sensor because the methodology has introduced additional uncertainties, both random and systematic.

Key Assumptions:

- It is assumed that all standard satellite TOA reflectance values carry both systematic and random uncertainties of 3% each (3σ), as per reference RD-6.
- Additionally, the doublet matching process itself introduces:
    - 3% systematic uncertainty (relative to the reference sensor),
    - 3% random uncertainty (3σ) (see references RD-1 and RD-2).

The super sensor observation radiometric systematic uncertainty is thus 3% with respect to the reference sensor radiometric scale.

The combined random uncertainty associated to the super sensor observations is the quadratic sum of the random uncertainties of the calibration sensor + reference sensor + methodology uncertainty. This amounts to 5.2% (3σ). The consistency of this figure is checked against the value of the RMSE of the polynomial fit to the radiometric differences between the calibration and reference sensor doublets. If the polynomial's RMSE fit is greater than the combined random uncertainty then this value becomes the random uncertainty for the calibration sensor time series; the super sensor observations can therefore have different uncertainties for each day and wavelength depending on which 'calibration' sensor data has been used.

The propagated uncertainties are output in both internal IDL save files and semi-colon delimited CSV files. Please note, updated uncertainty propagation is foreseen for future releases of DIMITRI.

4.6.4 View outputs

The visualisation module provides a quick and easy opportunity to view any output results from Sensor Recalibration. Each menu is dynamically created depending on which data is available in the output folder selected.

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Plots can be generated and saved as JPG's or PNG's, or as a semi-colon delimited (CSV) file. Statistics on plotted data can also be viewed through the visualisation module and saved as a CSV file (see Figure 4-10).

- **TOA RHO:** Plots Sensor doublet observations, Super Sensor and simulated VEGETATION time series.
- **RECAL RHO:** Plots the recalibrated time series data for each "calibration sensor" used.
- **RHO Bias:** Plots the reflectance bias (difference to "reference" sensor) for each "calibration" sensor
- **POLY Bias:** Plots the polynomial bias (difference to "reference" sensor) for each "calibration" sensor
- **VZA/VAA/SZA/SAA:** Plots the doublet angular information
- **AMC:** Plots the computed AMC values between observations

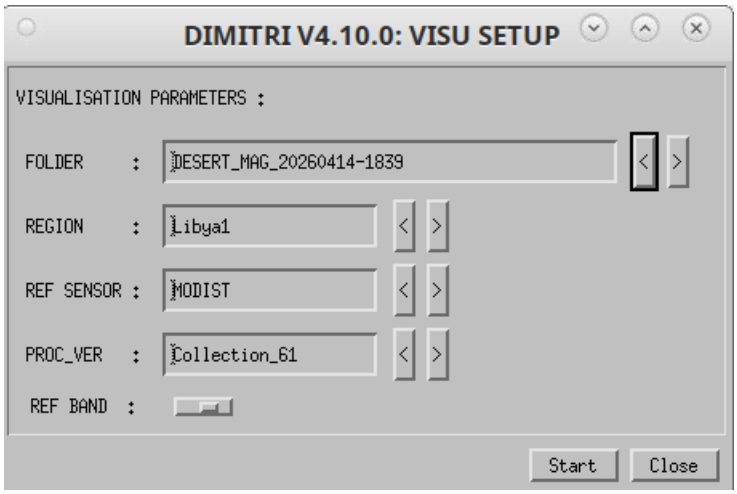


Figure 4-10: The DIMITRI VISU Setup HMI window as seen from DIMITRI_V4.x.y onwards

4.7 Sensor-to-Simulation Comparison

The sensor to simulation comparison methodologies are harmonized to use the same input data format and to provide the same output data format (See section 5.4.1 and 6.2.2.2 for details).

Four methodologies are available:

- Desert (over 6 CEOS PICS sites);
- DCC.
- Rayleigh;
- Sun Glint;
- Snow (ARG method over Dome-C site).

Each of them has been implemented by ARGANS and MAGELLIUM with specific algorithms.

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4.7.1 Sensor-to-simulation over the Rayleigh scattering approach.

4.7.1.1 ARGANS methodology

The 'ARG' button in the 'Rayleigh' box starts the setup module for ARGANS simulation over clear oceanic site without sun glint.

The Rayleigh methodology allows both HMI and command line activation. All processing parameters specific to the Rayleigh methodology are selectable by the user through a setup window (Figure 4-11):

- Case study (site, sensor, processing version and year);
- Cloud and region coverage percentage; note that scenes having a manual cloud screening set to 0 will be selected whatever the automated cloud screening value;
- Chlorophyll concentration, either by monthly climatology put in the DIMITRI auxiliary folder or by a fixed values;
- Maximum wind speed;
- Maximum Rayleigh corrected normalised radiance at 865 nm;
- Aerosol model, among an automated list built on all models existing in DIMITRI auxiliary folder, sensor per sensor.

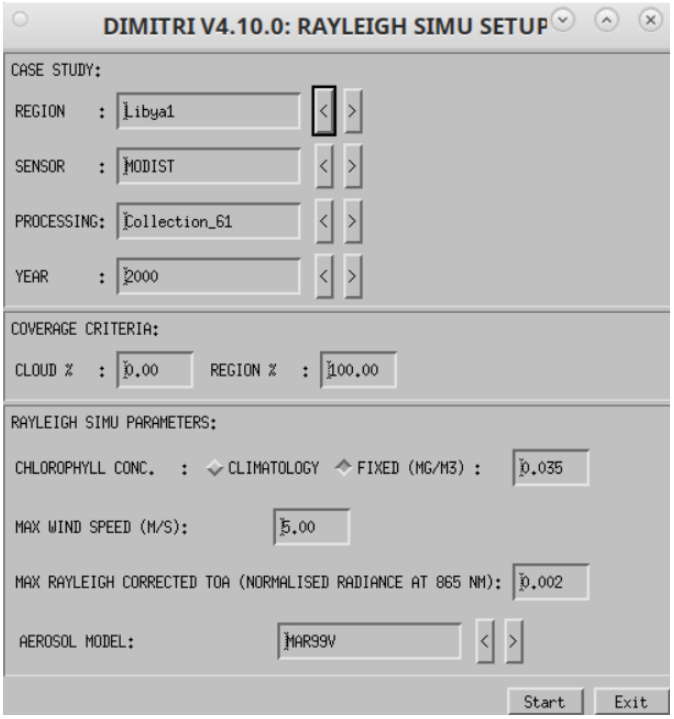


Figure 4-11: ARGANS Rayleigh Simulation setup module HMI as seen from DIMITRI_V4.x.y onwards

4.7.1.2 MAGELLIUM methodology

The 'MAG' button in the 'Rayleigh' box starts the setup module for MAGELLIUM simulation over clear oceanic site without sun glint. The Rayleigh methodology allows both HMI and command line activation.

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Only the case study parameters (site, sensor, processing version and year) are selectable by the user through a new window (Figure 4-12).

The processing parameters are described in the ATBD document (RD-12).

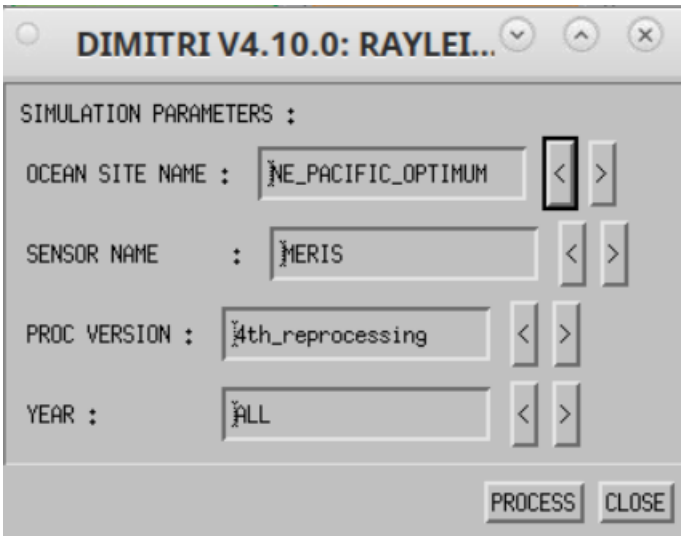


Figure 4-12: MAGELLIUM Rayleigh Calibration setup module HMI as seen from DIMITRI_V4.x.y onwards

4.7.2 Sensor-to-simulation following the Sun glint approach.

4.7.2.1 ARGANS methodology

The 'ARG' button in the 'Sun glint' box starts the setup module for simulation over sun glint following ARGANS approach (RD-8). This methodology allows both HMI and command line activation.

All processing parameters specific to the glint calibration are selectable by the user through a new window (Figure 4-13):

- Case study (site, sensor, processing version and year);
- Cloud and region coverage percentage; note that scenes having a manual cloud screening set to 0 will be selected whatever the automated cloud screening value;
- Chlorophyll concentration, either by monthly climatology put in the DIMITRI auxiliary folder or by a fixed values;
- Maximum wind speed;
- Maximum angle between viewing and specular directions;
- Reference band for the calibration;
- Absolute calibration coefficient for the reference band; this coefficient must be understood as in the Rayleigh absolute calibration
- Aerosol optical thickness at 865 nm;
- Aerosol model, among an automated list built on all models existing in DIMITRI auxiliary folder, sensor per sensor.

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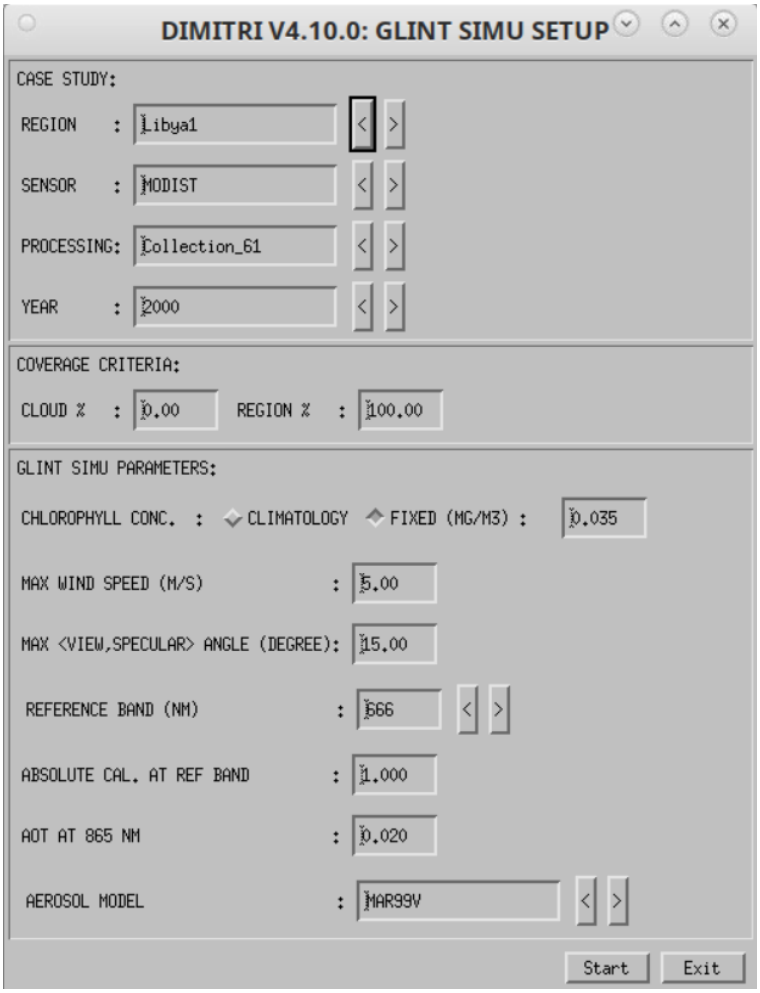


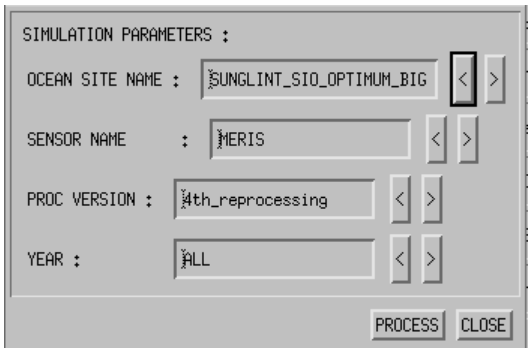
Figure 4-13: ARGANS Sun Glint simulations setup module HMI as seen from DIMITRI_V4.x.y onwards

4.7.2.2 MAGELLIUM methodology

The 'MAG' button in the 'Sun glint' box starts the setup module for simulation over Sun glint following MAGELLIUM's approach. The glint calibration methodology allows both HMI and command line activation.

Only the case study parameters (site, sensor, processing version and year) are selectable by the user through a new window (Figure 4-14).

The processing parameters are described in the ATBD document (RD-11)



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Figure 4-14: MAGELLIUM Sun glint Calibration setup module HMI as seen from DIMITRI_V4.x.y onwards

4.7.3 Sensor-to-simulation over the 6 Desert CEOS PICS sites

4.7.3.1 ARGANS methodology

The 'ARG' button in the 'Desert' box starts the ARGANS setup module to simulate TOA observations in the visible to NIR spectral range over the six CEOS Pseudo-Invariant calibration sites (http://calval.cr.usgs.gov/rst-resources/sites_catalog/ceos-reference-sites/). This methodology is based on a physical radiative transfer model simulating the coupling between a realistic atmosphere and a spectral surface BRDF model (See RD-9). The model was calibrated to mimic MERIS spectral observations in the period 2006 to 2009 over each desert site. The model allows mimicking observations from sensors with spectral bands in the spectral range 390 nm – 960 nm.

This methodology allows both HMI and command line activation.

All processing parameters specific to the Desert calibration are selectable by the user through a new window (Figure 4-15):

- Case study (site, sensor, processing version and year);
- Desert calibration parameters: Number of Jobs and CPUS, Number of photons.

For the default value of the number of CPUs is set to 1, while DIMITRI retrieves the maximum CPUs of the platform and allows the user to choose jobs-number in the range of [1, max-CPUs]. The default Number of photons is set to 1500.

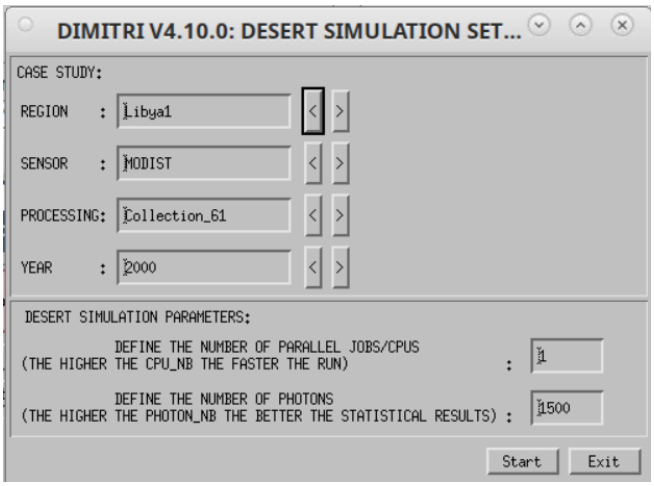


Figure 4-15: ARGANS Desert Calibration setup module HMI as seen from DIMITRI_V4.x.y onwards

4.7.3.2 MAGELLIUM methodology

The 'MAG' button in the 'Desert' box starts the setup module for MAGELLIUM calibration over the 6 CEOS Pseudo-Invariant calibration sites. The desert calibration methodology allows both HMI and command line activation.

Only the case study parameters (site, sensor, processing version and year) are selectable by the user through a new window (Figure 4-16).

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The processing parameters are described in the ATBD document (RD-13)

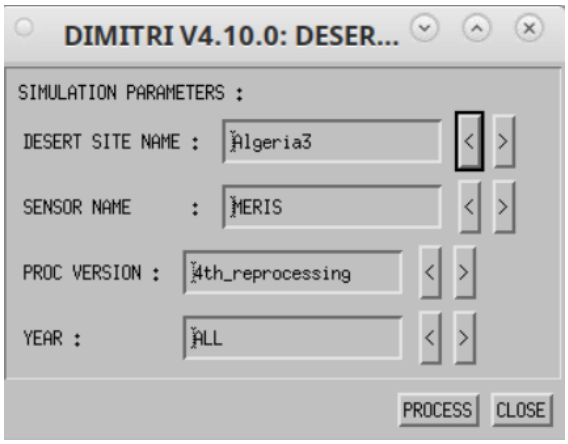


Figure 4-16: MAGELLIUM Desert Calibration setup module HMI as seen from DIMITRI_V4.x.y onwards

4.7.4 Sensor-to-simulation over the DCC methodology

4.7.4.1 ARGANS methodology

The 'ARG' button in the 'DCC' box triggers the setup module for ARGANS calibration, specifically designed for DCC calibration sites. This module is intended exclusively for the Sentinel-2A/B MSI (Multispectral Imager) sensor. The DCC calibration methodology allows both HMI and command line activation.

Processing parameters specific to the DCC calibration are selectable by the user through a setup window (Figure 4-17):

- Case study (site, sensor, processing version and year);
- Cloud and region coverage percentage;
- Reference band for the calibration;
- Absolute calibration coefficient for the reference band; this coefficient must be understood as in the Rayleigh absolute calibration
- Macro-pixel size in pixel-number;

The processing parameters are described in the ATBD document (RD-20)

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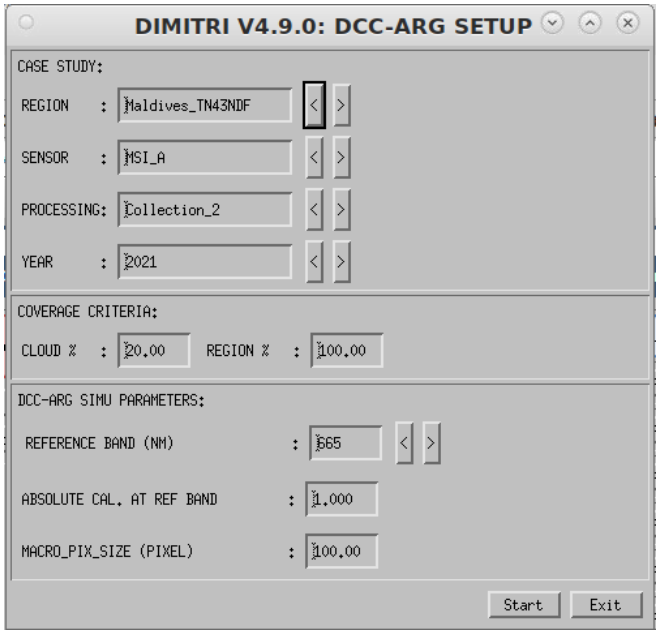


Figure 4-17: ARGANS DCC Calibration setup module HMI as seen from DIMITRI_V4.x.y onwards

4.7.4.2 MAGELLIUM methodology

The 'MAG' button in the 'DCC' box starts the setup module for MAGELLIUM calibration over the DCC Pseudo-Invariant calibration site (and only). The DCC calibration methodology allows both HMI and command line activation.

Only the case study parameters (site, sensor, processing version and year) are selectable by the user through a new window (Figure 4-18).

The processing parameters are described in the ATBD document (RD-19)

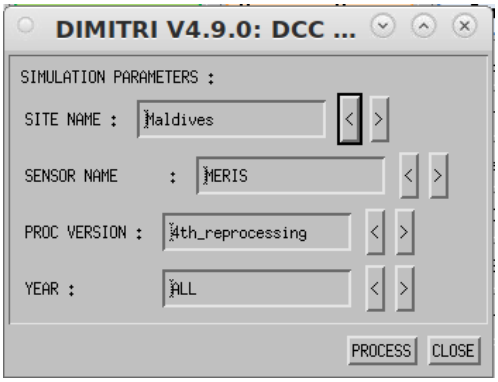


Figure 4-18: MAGELLIUM DCC Calibration setup module HMI as seen from DIMITRI_V4.x.y onwards

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4.7.5 Sensor-to-simulation over the Snow PICS Dome-C site

4.7.5.1 ARGANS methodology

The 'ARG' button in the 'Snow' box starts the ARGANS setup module to simulate TOA observations in the visible to NIR spectral range over the Snow Pseudo-Invariant calibration sites (e.g. Dome-C). This methodology is based on a physical radiative transfer model simulating the coupling between a realistic atmosphere and a spectral surface BRDF model (See RD-21 & RD-22). The model was calibrated to mimic MERIS spectral observations in the period 2006 to 2009 over Dome-C site. The model allows mimicking observations from sensors with spectral bands in the spectral range 390 nm – 960 nm.

This methodology allows both HMI and command line activation.

All processing parameters specific to the Snow calibration are selectable by the user through a new window (Figure 4-19):

- Case study (site, sensor, processing version and year);
- Snow calibration parameters: Number of Jobs and CPUS, Number of photons.

For the default value of the number of CPUs is set to 1, while DIMITRI retrieves the maximum CPUs of the platform and allows the user to choose jobs-number in the range of [1, max-CPUs]. The default Number of photons is set to 1500.

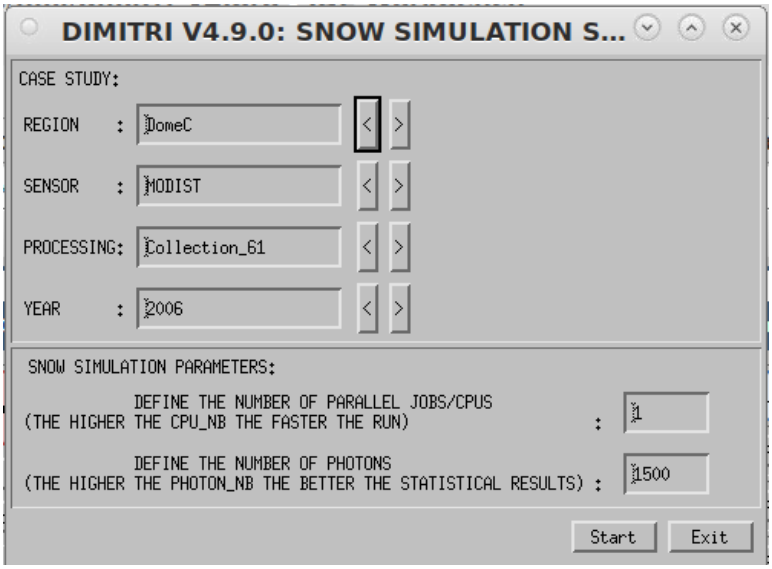


Figure 4-19: ARGANS Snow Calibration setup module HMI as seen from DIMITRI_V4.x.y onwards

4.8 Report

The calibration reporting process provides two types of output files (for details see section 0):

- The CSV statistical report database common to all products.
- The figure files (JPG format): one file created for each triplet [product, viewing direction, band], (Band number x Viewing direction number) figure files per product. The figure contains the temporal variability of the ratio RTOA measured / RTOA simulated (Figure 4-20).

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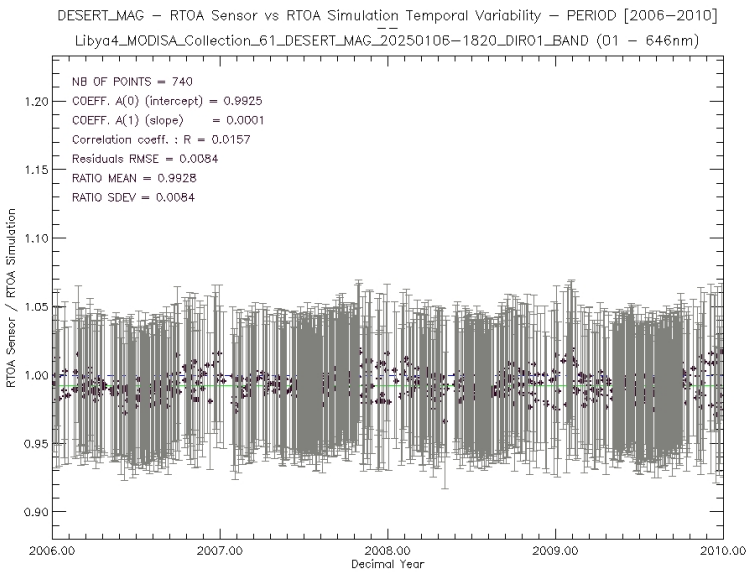


Figure 4-20: Time series of rho_TOA_sensor / rho_simulated reporting graphs example

4.9 Synthesis plots

The synthesis process (Figure 4-21) allows to average the time series of the calibration methods (ARGANS/Magellium/ALL) is reported on a unique plot as a function of the wavelength by sensor.

- The user chose the sensor, the reprocessing version, then the plots will be generated from the last run from each method.
- The user has the option of activate/deactivate the "Method's Selection" used to generate the outputs.

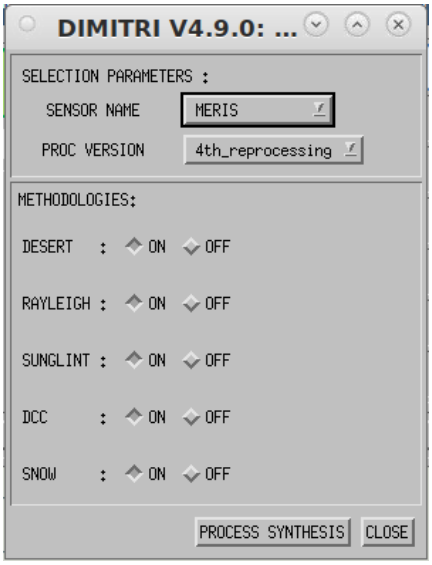


Figure 4-21: The synthesis process setup module HMI as seen from DIMITRI_V4.x.y onwards

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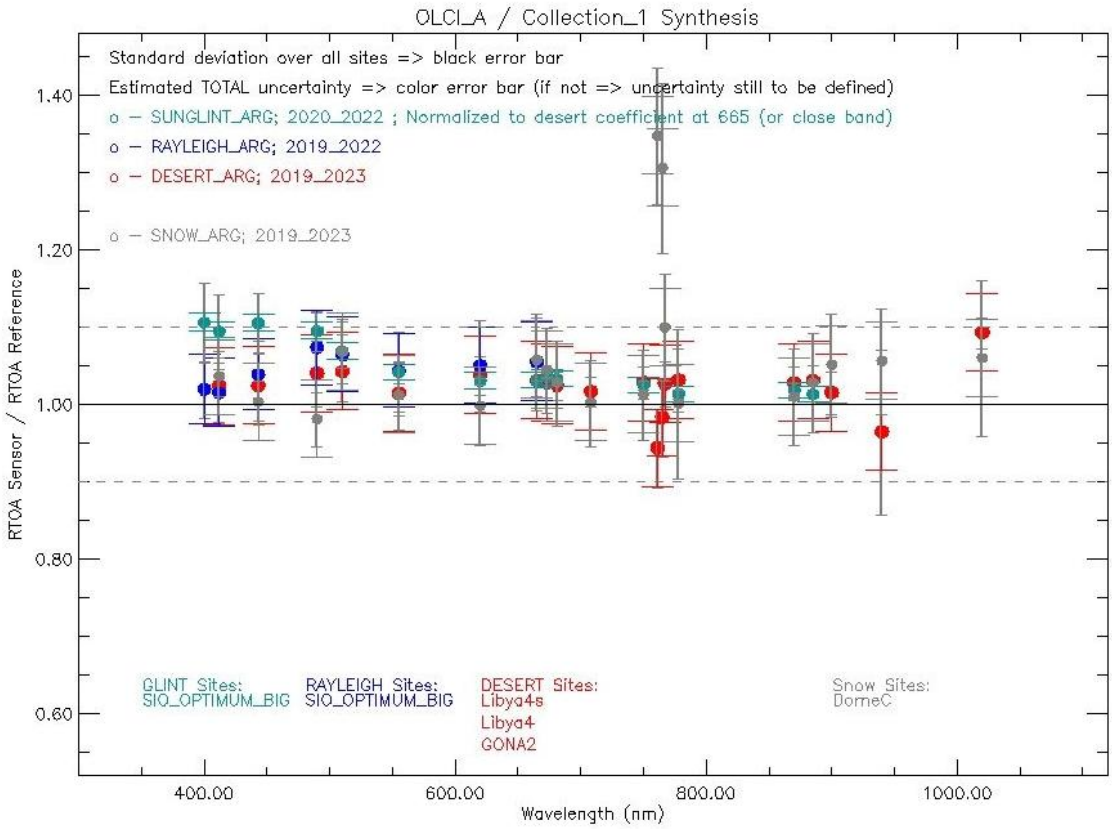


Figure 4-22 : Results synthesis example

4.10 Options

The "Options" module allows the definition of the DIMITRI configuration parameters including plot size, colour table, and RGB (red / green / blue) overlays. These values are then loaded into modules as default values.

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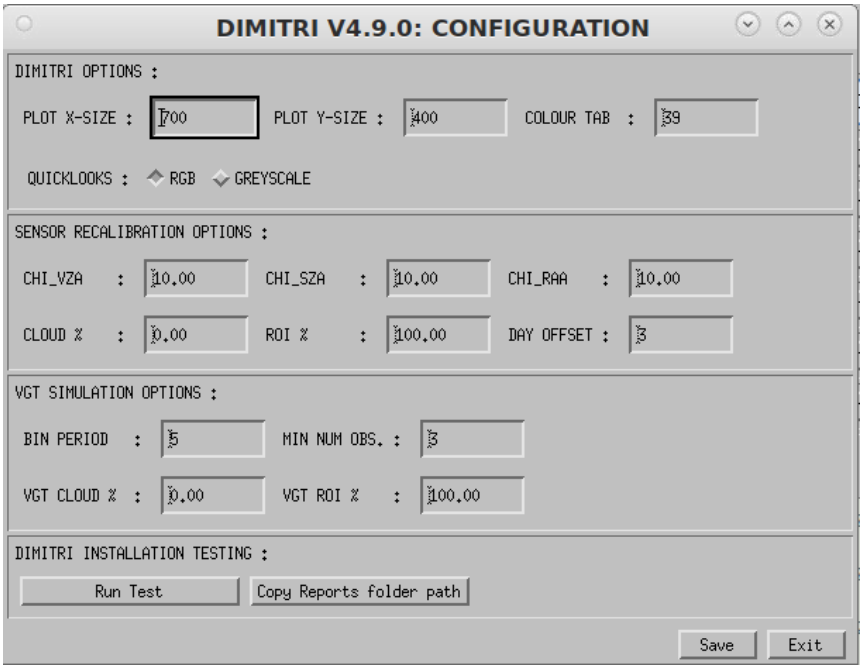


Figure 4-23: HMI to define options

4.11 Help

Opens this user manual.

4.12 About

Displays information regarding the version of DIMITRI.

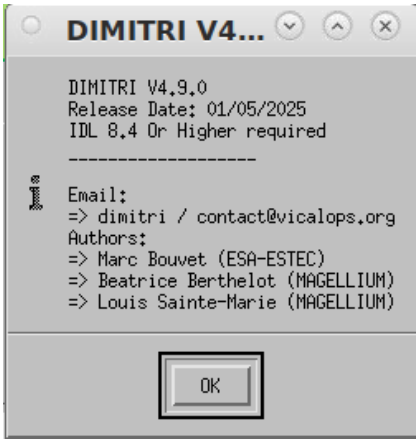


Figure 4-24: DIMITRI contact

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5 Advance Software User Manual

5.1 Recompilation

DIMITRI 4.9.0 has been developed using IDL 9.0 and is open for modification and further development by users with full IDL licenses. However, ESA and MAGELLIUM do not take responsibility for any potential damage that modifications may cause to the user's system.

Source Code & Compilation:

- All source code routines are stored in the 'Source' folder.
- A shell script named "compile_dimitri" is included, which recompiles all routines.
- Users can generate a compiled SAV file by executing the following command three times in the IDL environment:

IDL> @compile_dimitri

The created save file can then be used by the IDL runtime version without IDL license.

5.2 Folder Structure

The installed DIMITRI directory has the following folder structure:

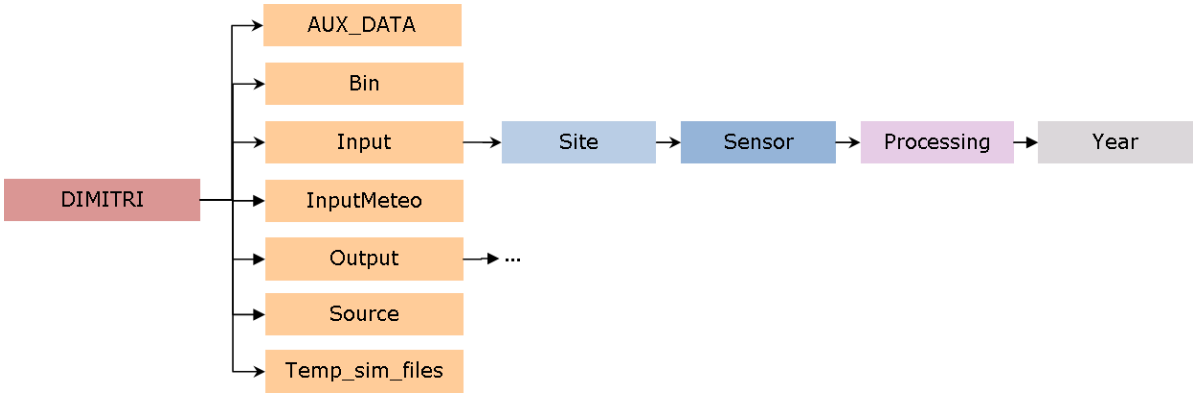


Figure 5-1: Schematic diagram of the DIMITRI folder structure

The output directory has the structure indicated in Figure 5-2.

- The **AUX_DATA** folder contains the auxiliary data used for the processing (LUTs, SMAC coefficients, spectral response, 6S solar irradiances…).
- The '**Bin**' folder contains the DIMITRI configuration and database files and Site, Sensor and Bands information files.
- The '**Input**' folder will contain all of the Level 1 data for all sensors across all sites (please note, for distribution and size restrictions only the quicklooks and stored TOA reflectance data are available for download).
  - All site folders will be identified through the syntax 'Site_*', (e.g. 'Site_Libya4') and allows User-defined sites to be added to DIMITRI. It is recommended that all new sites are generated using the DIMITRI HMI "New Site" module. In the case of the L1 product meant to be used with the sun glint methodologies, a site called 'Site_SUNGLINT' must be created.

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- All sensor folders will be identified through the defined values such as 'MERIS', 'MODISA' and 'AATSR'.
- All processing versions will be identified through the syntax 'Proc_*', for example 'Proc_1st_Reprocessing' for the 1st reprocessing.

- The '**InputMeteo**' folder contains the meteorological auxiliary data files needed by the calibration processes (Water vapour, Ozone, Wind speed, Pressure, Chlorophyll) sorted by years.
- The **'Output'** folder contains output files produced from ingestion and calibration processes. The ingestion output files are sorted by site, sensor, collection and year folders. The calibration output files are sorted at first by calibration process type and date, and in second step by site, sensor, collection and year folders

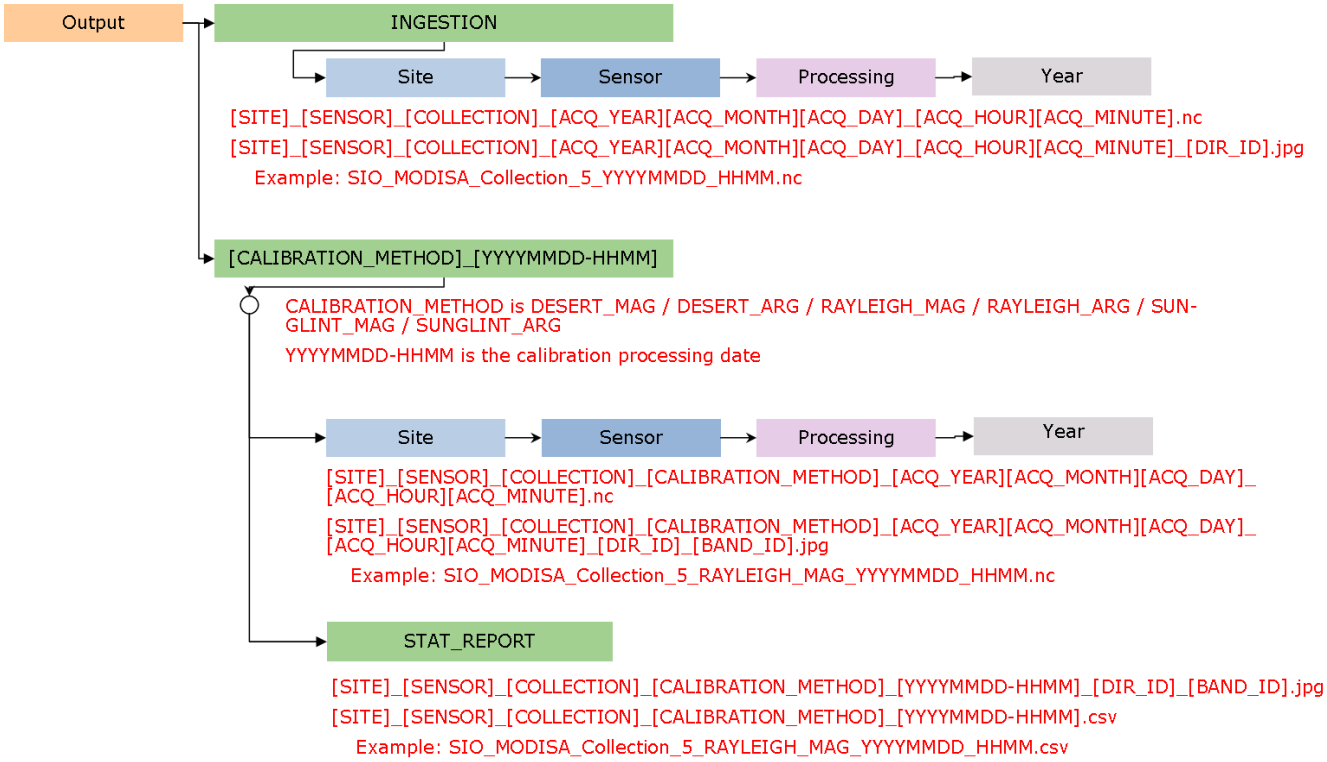


Figure 5-2: Schematic diagram of the DIMITRI output folder structure

- The '**Source**' folder contains all the DIMITRI routines developed by ESA, MAGELLIUM and ARGANS. Each file contain a code header providing information on what the routine does, how it is called, what are the outputs, and the modification history.
- The '**Temp_sim_files**' folder contains the LibRadTran temporary input files. It is necessary for the ARGANS desert/snow calibration function described above.

Important: A number of routines requires the explicit syntax of certain files and folders. It is therefore critical that the folder names are NOT modified as this will result in a loss of functionality.

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5.3 Ingestion Process

Figure 5-3 shows the summary diagram of the ingestion process with the input data needed (auxiliary data and product data) and the output data created during the process.

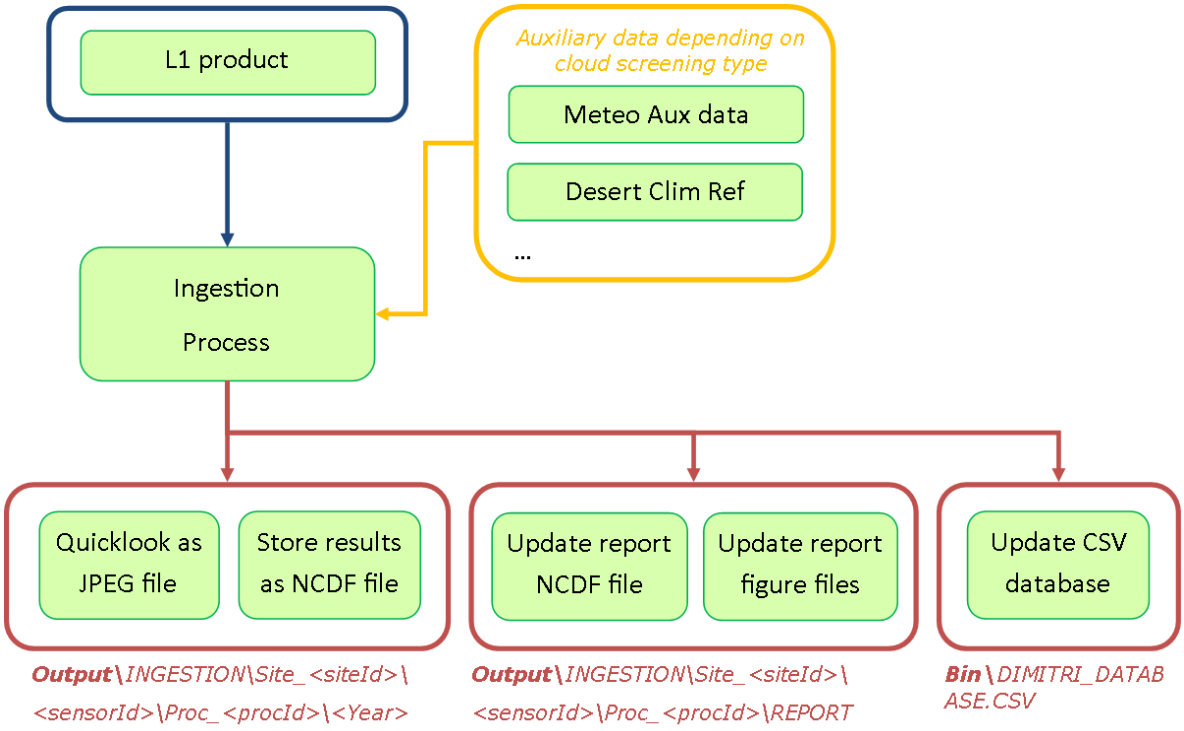


Figure 5-3: L1 product ingestion summary diagram.

As a result of the ingestion of new L1 products, a number of files are produced at different level:

1) At product level: for each L1 product ingested, a netCDF product gathering all information relevant to DIMITRI will be generated.
2) For a given sensor, site and processing version of this sensor L1 products: the full time series of acquisitions is stored in a single netCDF file and plots of this data are generated (TOA reflectance and geometry of observations)
3) At the level of the DIMITRI tool: a database (csv format) is updated.

There are two types of files produced for each L1 ingested:

- A netCDF file: one file created for each product (description on section 6.2.2.1).
- A set of quicklook files (JPG format): one file created per product and viewing direction. The ROI is highlighted with red colour.

These files are stored under 'Output/INGESTION' folder and sorted by site, sensor, collection and year in sub-folders. Their names observe the following rules:

- [SITE]_[SENSOR]_[COLLECTION]_[ACQ_YEAR][ACQ_MONTH][ACQ_DAY]_[ACQ_HOUR][ACQ_MINUTE].nc

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- [SITE]_[SENSOR]_[COLLECTION]_[ACQ_YEAR][ACQ_MONTH][ACQ_DAY]_[ACQ_HOUR][ACQ_MINUTE]_[DIR_ID].jpg

With [SITE] : Site name

[SENSOR] : Sensor name

[COLLECTION] : Collection or processing version of the L1 product

[ACQ_YEAR][ACQ_MONTH][ACQ_DAY] : Acquisition date (YYYYMMDD format)

[ACQ_HOUR][ACQ_MINUTE] : Acquisition time (HHmm format)

[DIR_ID] : Viewing direction identifier



Figure 5-4: Quicklook example (OLCI_A product over Libya4 site)

There are two types of output files produced for each sensor, on each site and for each L1 processing version:

- A netCDF file: one file created for all products from a given sensor over a given site with the same L1 processing version.
- A number of figure files (JPG format) corresponding to plots of the of the following parameters against the decimal year:
  - The mean sensor zenith angle over the ROI,
  - The mean solar zenith angle over the ROI,
  - The mean of the Top Of Atmosphere Reflectance over the ROI in each spectral band,

These files are updated after each new ingestion of the associated sensor and processing version and located under the corresponding 'REPORT' folder. Their names follow the following rules:

- [SITE]_[SENSOR]_[COLLECTION].nc
- [SITE]_[SENSOR]_[COLLECTION]_[GRAPH_TYPE].jpg

With [SITE] : Site name

[SENSOR] : Sensor name

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[COLLECTION] : Collection or processing version of the L1 product

[GRAPH_TYPE] : One of the three graph types: 'SENSOR_ZENITH_ANGLE', 'SOLAR_ZENITH_ANGLE', 'TOA_REFLECTANCE'.

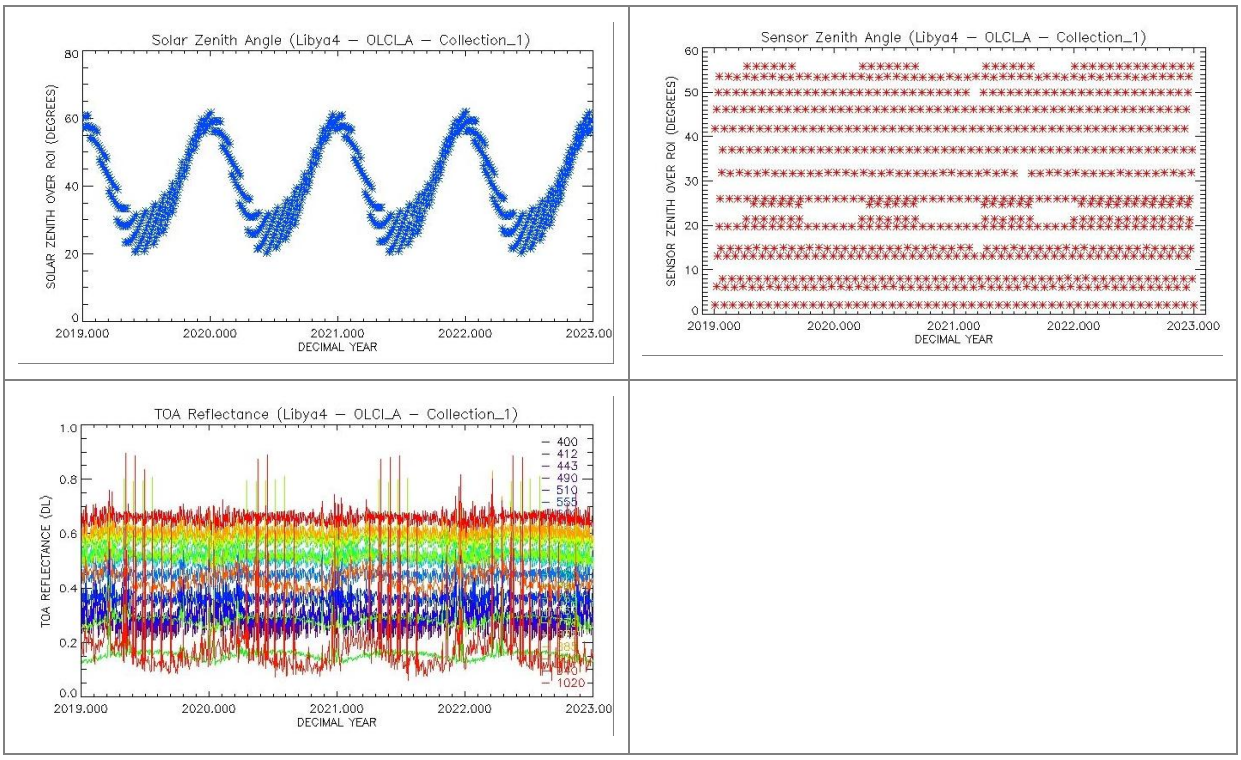


Figure 5-5: Ingestion process graphs example

There is one file updated after ingestion at the DIMITRI tool level:

- The DIMITRI database which provides reference to all products ingested and their main characteristics (description on Section 6.2.1). This database is stored under 'DIMITRI_x.y/Bin' folder and is named 'DIMITRI_DATABASE.CSV'.

5.4 Sensor to Simulation Comparison Process

5.4.1 Overview

Figure 5-6 shows the summary diagram of the sensor to simulation comparison process with the input data needed (auxiliary data and product data) and the output data created during the process.

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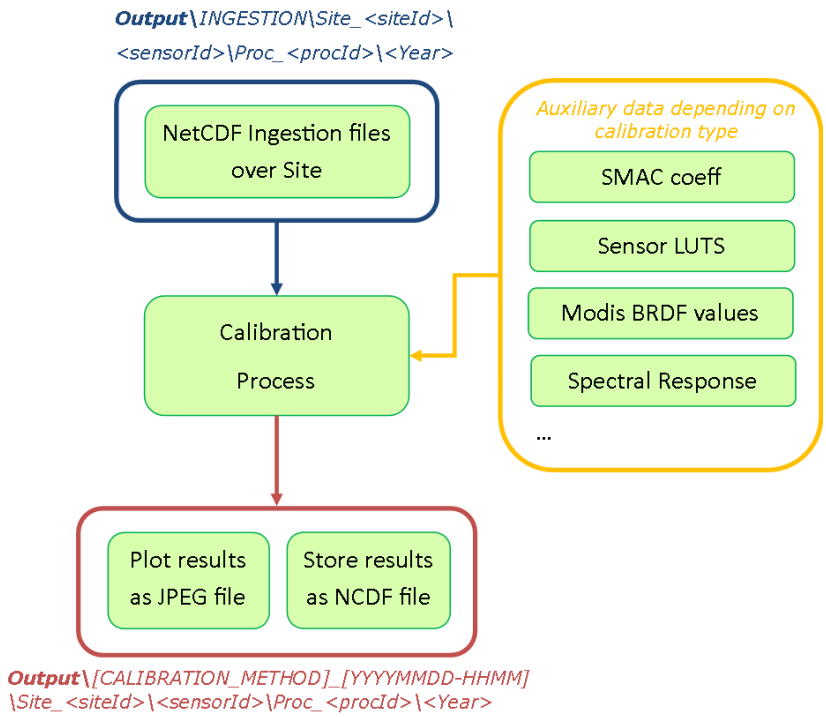


Figure 5-6: Summary diagram of sensor to simulation comparison process

There are two types of output files:

- The netCDF file: one file created for each product (description on Section 6.2.2.1).
- The figure files (JPG format): one file created for each triplet [product, viewing direction, band], (Band number x Viewing direction number) figure files per product. Two graphs are provided within Figure 5-7.
  - The scatterplot RTOA sensor versus RTOA simulation,
  - The histogram of the ratio RTOA sensor / RTOA simulation.

The output files are stored under the 'Output/[CALIBRATION_METHOD]_[YYYMMDD-HHMM]' folder and sorted by site, sensor, collection and year in sub-folders.

- The CALIBRATION_METHOD value is one of the following keywords: DESERT_MAG, DESERT_ARG, RAYLEIGH_MAG, RAYLEIGH_ARG, SUNGLINT_MAG, SUNGLINT_ARG, SNOW_ARG, DCC_ARG and DCC_MAG.
- The YYYMMDD-HHMM date is the calibration processing date.

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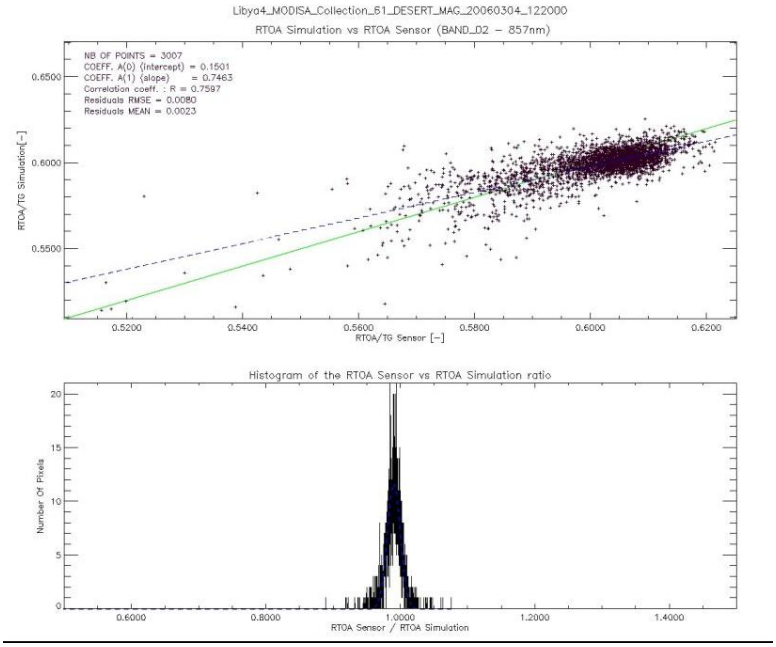


Figure 5-7: Calibration process graphs example

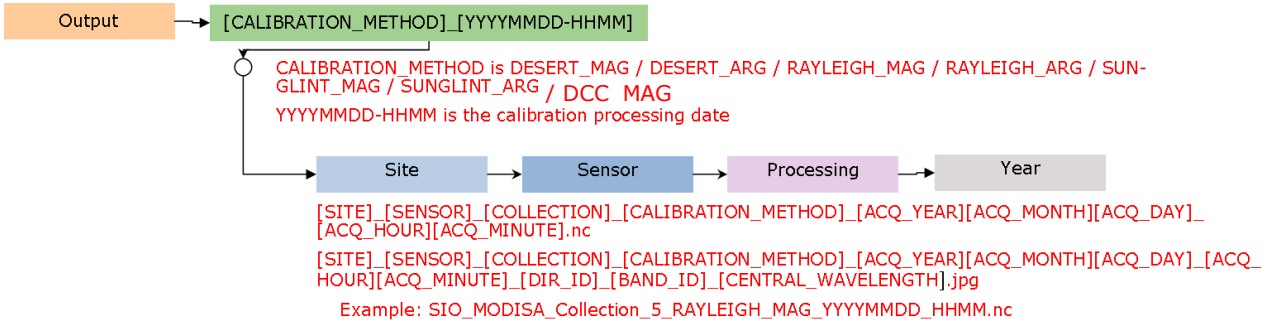


Figure 5-8: Schematic diagram of the calibration output folder structure and content

The name of the netCDF file and figure files (JPG format) observes the following rules:

- [SITE]_[SENSOR]_[COLLECTION]_[CALIBRATION_METHOD]_[ACQ_YEAR][ACQ_MONTH][ACQ_DAY]_[ACQ_HOUR][ACQ_MINUTE].nc
- [SITE]_[SENSOR]_[COLLECTION]_[CALIBRATION_METHOD]_[ACQ_YEAR][ACQ_MONTH][ACQ_DAY]_[ACQ_HOUR][ACQ_MINUTE]_[DIR_ID]_[BAND_ID]_[CENTRAL_WAVELENGTH].jpg

With [SITE]: Site name

[SENSOR]: Sensor name

[COLLECTION]: Collection or processing version of the L1 product

[CALIBRATION_METHOD]: Calibration method name (DESERT_MAG, DESERT_ARG, RAYLEIGH_MAG, RAYLEIGH_ARG, SUN GLINT_MAG or SUN GLINT_ARG, DCC_MAG)

[ACQ_YEAR][ACQ_MONTH][ACQ_DAY]: acquisition date (YYYYMMDD format)

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[ACQ_HOUR][ACQ_MINUTE]: Acquisition time (HHmm format)

[DIR_ID]: Viewing direction identifier

[BAND_ID]: Band identifier (order number of the band in the L1 product)

[CENTRAL_WAVELENGTH]: Central wavelength of band

5.4.2 Processing by command line

The sensor to simulation comparison processes could be activated by command line.

5.4.2.1 Desert / Rayleigh / SunGlint/ DCC/ Snow ARG process

Command lines:

Method	Command line
Desert ARG	STATUS = **DIMITRI_INTERFACE_DESERT_ARG** (SITE_NAME, SENSOR, PROC_VERSION, YEAR, PHOTON_NB, CPU_NB, VERBOSE=VERBOSE SITE, SENSOR, PROC_VER, YEAR, PHOTON_NB, CPU_NB, VERBOSE=VERBOSE, CALIBRATION_OUTPUT_FILENAME=CALIBRATION_OUTPUT_FILENAME)
Rayleigh ARG	STATUS = **DIMITRI_INTERFACE_RAYLEIGH_ARG** (SITE_NAME, SENSOR, PROC_VERSION, YEAR, CLOUD_PERCENTAGE, ROI_PERCENTAGE, WS_MAX, CHL, THRESH_RHORC_865, AER, CLIM=CLIM, HS147V3=HS147V3, VERBOSE=VERBOSE, CALIBRATION_OUTPUT_FILENAME=CALIBRATION_OUTPUT_FILENAME)
Sun Glint ARG	STATUS = **DIMITRI_INTERFACE_SUNGLINT_ARG** (SITE_NAME, SENSOR, PROC_VERSION, YEAR, CLOUD_PERCENTAGE, ROI_PERCENTAGE, WS_MAX, CONE_MAX, BREF, ABS_CALREF, CHL, TAUA_865_CLIM, AER, CLIM=CLIM, HS147V3=HS147V3, VERBOSE=VERBOSE, CALIBRATION_OUTPUT_FILENAME=CALIBRATION_OUTPUT_FILENAME)
Snow ARG	STATUS = **DIMITRI_INTERFACE_SNOW_ARG** (SITE, SENSOR, PROC_VER, YEAR, PHOTON_NB, CPU_NB, VERBOSE=VERBOSE, CALIBRATION_OUTPUT_FILENAME=CALIBRATION_OUTPUT_FILENAME)
DCC ARG	STATUS = **DIMITRI_INTERFACE_DCC_ARG** (SITE_NAME, SENSOR, PROC_VERSION, YEAR, CLOUD_PERCENTAGE, ROI_PERCENTAGE, BREF, ABS_CALREF, MACROPIX, VERBOSE=VERBOSE, CALIBRATION_OUTPUT_FILENAME=CALIBRATION_OUTPUT_FILENAME)

Parameter description:

Parameter	Description
SITE_NAME	ROI folder User placed product (‘Uyuni’)
SENSOR	Product Sensor (‘ATSR2’)

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Parameter	Description
PROC_VERSION	User defined processing version of product (‘2nd_Reprocessing’)
YEAR	Year of product acquisition (2002)
PHOTON_NB	Number of photons
CPU_NB	Number of Jobs/CPUS
CLOUD_PERCENTAGE	Cloud coverage percentage; note that scenes having a manual cloud screening set to 0 will be selected whatever the automated cloud screening value
ROI_PERCENTAGE	ROI coverage percentage
WS_MAX	Maximum wind speed
CHL	Chlorophyll concentration (fixed values)
AER	Aerosol model, among an automated list built on all models existing in DIMITRI auxiliary folder, sensor per sensor
CLIM	If keyword set, the chlorophyll concentration is estimated by monthly climatology put in the DIMITRI auxiliary folder
THRESH_RHORC_865	Maximum Rayleigh corrected normalised radiance at 865 nm
MACROPIX	The number of pixels within a macropixel
CONE_MAX	Maximum angle between viewing and specular directions for Sun Glint condition
BREF	Reference band for the Sun Glint methodology
ABS_CALREF	Absolute calibration coefficient for the reference band in the frame of the Sun Glint methodology; this coefficient must be understood as in the Rayleigh methodology
TAUA_865_CLIM	Aerosol optical thickness at 865 nm
HS147V3	If keyword set, the Hyperspectral LUTs are used
VERBOSE	If keyword set, verbose mode activated
CALIBRATION_OUTPUT_FILENAME	Name of the calibration file

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5.4.2.2 Desert / Rayleigh / Sunglint / DCC MAG process

Command lines:

Method	Command line
Desert MAG	STATUS = **DIMITRI_INTERFACE_DESERT_MAG**(SITE_NAME, SENSOR, PROC_VERSION, ALL=ALL, YEAR=YEAR, VERBOSE=VERBOSE)
Rayleigh MAG	STATUS = **DIMITRI_INTERFACE_RAYLEIGH_MAG**(SITE_NAME, SENSOR, PROC_VERSION, ALL=ALL, YEAR=YEAR, VERBOSE=VERBOSE)
Sun Glint MAG	STATUS = **DIMITRI_INTERFACE_SUNGLINT_MAG**(SITE_NAME, SENSOR, PROC_VERSION, ALL=ALL, YEAR=YEAR, VERBOSE=VERBOSE)
DCC MAG	STATUS = **DIMITRI_INTERFACE_DCC_MAG**(SITE_NAME, SENSOR, PROC_VERSION, ALL=ALL, YEAR=YEAR, VERBOSE=VERBOSE)

Parameters description:

Parameter	Description
SITE_NAME	ROI folder User placed product (‘Libya4)
SENSOR	Product Sensor (‘OLCI_A)
PROC_VERSION	User defined processing version of product (‘4th_Reprocessing’)
YEAR	Year of product acquisition (2002)
ALL	If keyword set, all products are processed whatever their acquisition year
VERBOSE	If keyword set, verbose mode activated
CALIBRATION_OUTPUT_FILENAME	Name of the calibration file

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5.4.3 Report

The Figure 5-9 shows the summary diagram of the time series calibration reporting process with the input data needed and the output data created during the process.

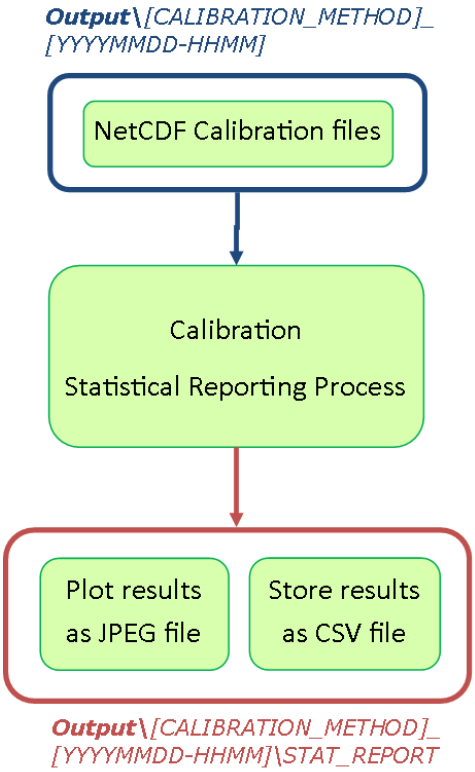


Figure 5-9: Time series report summary diagram

There are two types of output files:

- The CSV statistical report database common to all products.
- The figures files (JPG format): one file created for each triplet [product, viewing direction, band], (Band number x Viewing direction number) figure files per product. The figure contains the temporal variability of the ratio RTOA measured / RTOA simulated graph.

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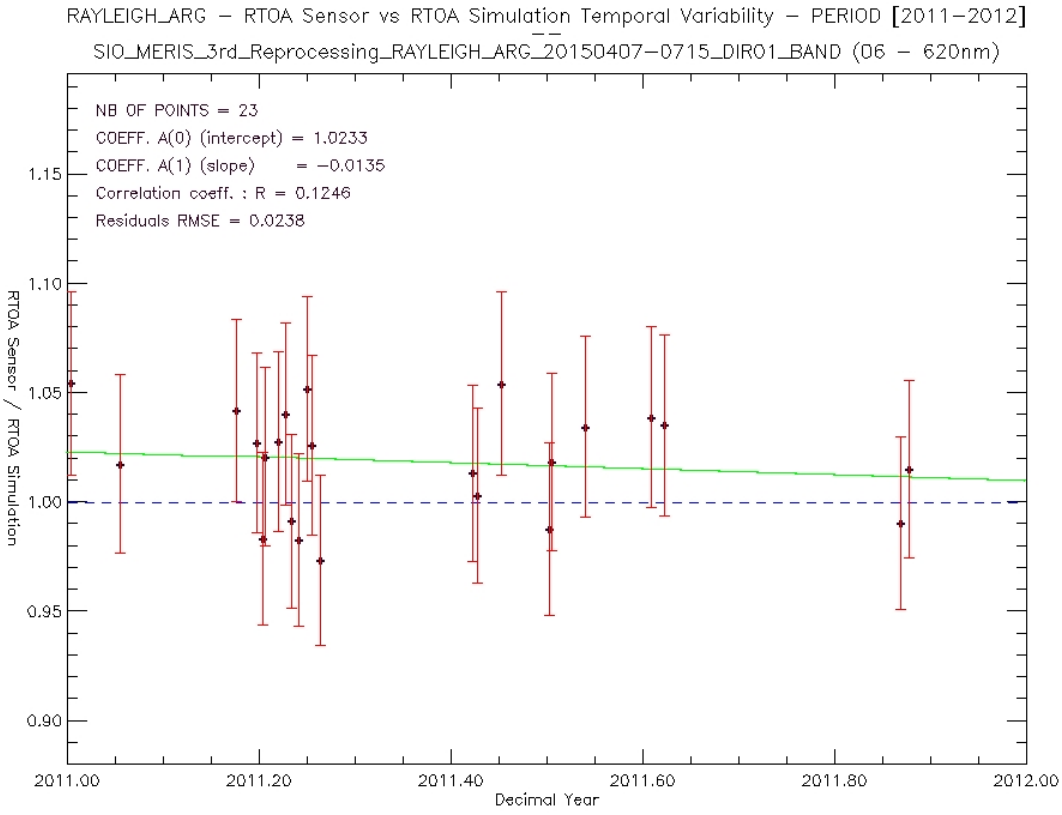


Figure 5-10: Time series rho_TOA_sensor / rho_simulated reporting graphs example

The output files are stored under the 'Output/[CALIBRATION_METHOD]_[YYYMMDD-HHMM]\STAT_REPORT' folder.

- The CALIBRATION_METHOD value is one of the following keywords: DESERT_MAG, DESERT_ARG, RAYLEIGH_MAG, RAYLEIGH_ARG, SUN GLINT_MAG or SUN GLINT_ARG.
- The YYYMMDD-HHMM date is the calibration processing date.

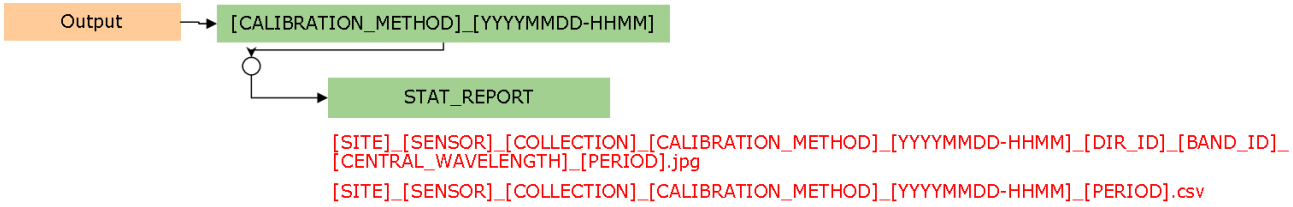


Figure 5-11: Schematic diagram of the calibration output folder structure and content

The name of the CSV file and figure file (JPG format) observes the following rules:

- [SITE]_[SENSOR]_[COLLECTION]_[CALIBRATION_METHOD]_[YYYYMMDD-HHMM]_[PERIOD].csv

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- [SITE]_[SENSOR]_[COLLECTION]_[CALIBRATION_METHOD]_[YYYYMMDD-HHMM]_[DIR_ID]_[BAND_ID]_[CENTRAL_WAVELENGTH]_[PERIOD].jpg

With [SITE]: Site name

[SENSOR]: Sensor name

[COLLECTION]: Collection or processing version of the L1 product

[CALIBRATION_METHOD]: Calibration method name (DESERT_MAG, DESERT_ARG, RAYLEIGH_MAG, RAYLEIGH_ARG, SUN GLINT_MAG or SUN GLINT_ARG)

[YYYYMMDD-HHMM]: Calibration date (from calibration folder name)

[DIR_ID]: Viewing direction identifier

[BAND_ID]: Band identifier (order number of the band in the L1 product)

[CENTRAL_WAVELENGTH]: Central wavelength of band

[PERIOD]: Time period selected for statistical report process

5.5 External Routines

The DIMITRI software package has been developed by ESA, ARGANS and MAGELLIUM using IDL. However, some functions have been included which were developed by other people. These include:

- **FSC_field.pro**

↳ Created by David Fanning, http://www.idlcoyote.com/ – a must see website containing many pages of useful IDL hints and tips.

- **Mpfit.pro and mpcurvefit.pro**

↳ Created by Craig B. Markwardt (http://www.physics.wisc.edu/~craigm/idl/fitting.html)

- **AATSR/ATSR2 product reader routines**

↳ Created by Dave Smith, RAL (http://www.aatsrops.rl.ac.uk/)

- **FILEINFO.pro**

↳ Created by Liam Gumley (http://cimss.ssec.wisc.edu/~gumley**).**

- **ninterpolate.pro**

↳ Created by J.D. Smith (2003)

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6 DIMITRI Data Files

The DIMITRI software package utilises number of different data files. These can be found in the "AUX_DATA", "Bin" and "Output" folders, and include database files, netCDF output files, internal IDL binary files and auxiliary data files, each outlined below.

6.1 DIMITRI Input Data Files

6.1.1 Auxiliary data files

A number of auxiliary data files are used by the DIMITRI software package. The main auxiliary files are available under 'DIMITRI_x.y/Bin' folder.

1. **Sensor info** ('DIMITRI_SENSOR_DATA.txt')**:** this file contains information on the available satellite sensors within the DIMITRI software package.
2. **Band info** ('DIMITRI_Band_Names.txt')**:** this file contains information on the available sensor bands with wavelength values.
3. **Site info** ('DIMITRI_SITE_DATA.txt')**:** this file contains information on each of the DIMITRI validation sites, as well as any user defined sites.
4. **Configuration file** ('DIMITRI_CONFIGURATION.txt')**:** this file contains the user's DIMITRI configuration settings (e.g. plot sizes and RGB quicklooks), and is updated by the configuration HMI module.
5. **Band centre index** ('DIMITRI_Band_Centre_Index.txt')**:** This file contains the relative indexes for each sensor band against the defined DIMITRI wavelengths. It is used throughout a number of DIMITRI functions and should not be modified. There are 30 defined "DIMITRI" bands covering the wavelength range 400-12000nm; for each sensor, the band index is linked with the corresponding DIMITRI band to allow comparison against other sensors that also have bands matching that DIMITRI band. This comparison is performed internally, and allows specification of comparing different bands; for example, MODISA has two band setting, land and ocean, which are defined in the Band centre index auxiliary file.
6. **DIMITRI_Band_Configuration** ('DIMITRI_Band_Configuration.csv')**:** this file contains relative indexes for each sensor band against the defined DIMITRI wavelengths, the band standard label (NIR, SWIR, BLUE…), the reference label (BAND_01, BAND_02, BAND_03…) as ordered in the native product format, the SMAC file names, the Rayleigh, Sunglint, DCC, Desert LUT file names. These file names are used by MAGELLIUM processes.

6.2 DIMITRI Output Data Files

6.2.1 DIMITRI database file

The semi-colon delimited database file contains information regarding all ingested L1 data products. It is used by a number of DIMITRI functions. The database file can be opened in a number of text editors including Microsoft excel to allow further analysis of the ingested product data. A breakdown of the column headers is provided below:

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Fields	Description
DIMITRI_DATE	The calendar date the product was ingested into DIMITRI, DD-MMM-YY (14-Dec-24)
SITE_NAME	ROI folder User placed product (‘Libya4)
SITE_TYPE	Site type (Ocean, Desert, Forest…)
SITE_COORDINATES	Site coordinates (LAT_MAX, LAT_MIN, LON_MAX, LON_MIN)
SENSOR	Product Sensor (‘OLCI_A)
PROCESSING_VERSION	User defined processing version of product (‘4th_Reprocessing’)
YEAR	Year of product acquisition (2002)
MONTH	Month of product acquisition (3)
DAY	Day within month of acquisition (30)
DOY	Day-Of-Year relating to YEAR,MONTH and DAY values (89)
DECIMAL_YEAR	Decimal year of data acquisition (2002.244)
L1_FILENAME	L1 product filename (without path reference)
L1_INGESTED_FILENAME	L1 ingested product filename (without path reference)
ROI_STATUS	Integer, raised if the ROI is covered by the product: -1 = not covered, 0, partially covered, 1 = covered
ROI_PIX_NUM	Number of pixels within the associated ROI (1068)
THETA_N_MEAN	Mean value of the wave angle; this angle is defined as the wave slope that enables having an exact specular reflection given the sun and viewing directions (computed for all products over SUN GLINT or OCEAN sites)
THETA_R_MEAN	Mean value of the sun reflected angle (computed for all products over SUN GLINT or OCEAN sites)
AUTO_CS_1_NAME	Automated ROI Cloud Screening method name (ARGANS)
AUTO_CS_1_MEAN	Automated ROI Cloud Screening result in percent: -1 not done, [0 (clear)…100% (cloudy)]

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Fields	Description
ROI_CS_1_CLEAR_PIX_NUM	Number of clear pixels detected on the ROI
AUTO_CS_2_NAME	Automated ROI Cloud Screening method name (MAGELLIUM)
AUTO_CS_2_MEAN	Automated ROI Cloud Screening result in percent: -1 not done, [0 (clear)…100% (cloudy)]
ROI_CS_2_CLEAR_PIX_NUM	Number of clear pixels detected on the ROI
MANUAL_CS	Manual ROI Cloud Screening status indicating -1: not performed, 0: clear, 1: cloudy, 2: suspect (ie: error product)
ERA_WIND_SPEED_MEAN	Mean value of the meteorological auxiliary data on the ROI from table provided by ESA or ERA.
ERA_WIND_DIR_MEAN	
ERA_OZONE_MEAN	
ERA_PRESSURE_MEAN	
ERA_WATERVAPOUR_MEAN	
ESA_CHLOROPHYLL_MEAN	
AUX_DATA_1_NAME	A string of auxiliary data used to process the L1 product
AUX_DATA_2_NAME	
AUX_DATA_3_NAME	
AUX_DATA_4_NAME	
AUX_DATA_5_NAME	
AUX_DATA_6_NAME	
AUX_DATA_7_NAME	
AUX_DATA_8_NAME	
AUX_DATA_9_NAME	
AUX_DATA_10_NAME	

6.2.2 DIMITRI netCDF files

A netCDF files is split in three parts as follow:

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- Global attributes part,
- Dimensions part,
- Variables part.

6.2.2.1 Ingestion output file

The global attributes and the dimensions are described in Table 6-1 and the variables are described in Table 6-2.

The example on Figure 6-1 presents the netCDF file structure of an ingested product with 2 available viewing directions (as AATSR and ATSR2).

Some variables are expanded to show their dedicated attributes.

For information, the attributes are the same inside each of the following groups:

- Sun and viewing angles (SAA, SZA, VAA, VZA),
- Reflectance value of each spectral band (REFL_BAND_01, REFL_BAND_02, REFL_BAND_xx),
- Meteorological Auxiliary Data (ERA_WIND_SPEED, ERA_WIND_DIR, ERA_OZONE…).

Table 6-1: netCDF Ingestion output file description (Global attributes and dimensions)

	Fields	Description
GLOBAL Attributes	TOOL	Tool name
	CREATION_TIME	Creation time
	MODIFICATION_TIME	Modification time
	SITE_NAME	ROI folder User placed product
	SITE_TYPE	Site type
	SITE_COORDINATES	Site coordinates (LAT_MAX, LAT_MIN, LON_MAX, LON_MIN)
	SENSOR	Product Sensor
	PROCESSING_VERSION	User defined processing version of product
	ACQUISITION_DATE	Product acquisition date (YYYY-MM-DD HH:MM)
	L1_FILENAME	L1 product filename (without path reference)
	ROI_PIX_NUM	Number of pixels within the associated ROI
	AUTO_CS_1_NAME	Automated ROI Cloud Screening method name (ARGANS)

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	Fields	Description
	AUTO_CS_1_MEAN	Automated ROI Cloud Screening result in percent: -1 not done, [0 (clear)…100% (cloudy)]
	ROI_CS_1_CLEAR_PIX_NUM	Number of clear pixels detected on the ROI
	AUTO_CS_2_NAME	Automated ROI Cloud Screening method name (MAGELLIUM)
	AUTO_CS_2_MEAN	Automated ROI Cloud Screening result in percent: -1 not done, [0 (clear)…100% (cloudy)]
	ROI_CS_2_CLEAR_PIX_NUM	Number of clear pixels detected on the ROI
	MANUAL_CS	Manual ROI Cloud Screening status indicating -1: not performed, 0: clear, 1: cloudy
DIMENSIONS	ROI_PIXEL_NUMBER	Number of pixel of the ROI [ROI_PIX]
	CALIB_PIXEL_NUMBER	Number of pixel selected for the sensor to simulation comparison process [CALIB_PIX]
	VIEWDIR_NUMBER	Number of sensor viewing direction [VIEW_DIR]

Table 6-2: netCDF Ingestion output file description (variables)

	Fields	Size	Description
VARIABLES	ROI_STATUS	[VIEW_DIR]	ROI status for each viewing direction ↳ with attribute 'THETA_R_mean' / 'THETA_N_mean' for SUN GLINT and OCEAN sites
	ROI_PIXEL_NUMBER		Number of pixels of the ROI for each viewing direction
	LAT	[ROI_PIX, VIEW_DIR]	Latitude of each pixel of the ROI
	LON		Longitude of each pixel of the ROI
	SZA		Sun Zenith Angle of each pixel of the ROI ↳ with attribute 'viewDir[xx]_mean' (repeated for each direction)

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	Fields	Size	Description
	SAA		Sun Azimuth Angle of each pixel of the ROI ↳ with attribute 'viewDir[xx]_mean' (repeated for each direction)
	VZA		View Zenith Angle of each pixel of the ROI ↳ with attribute 'viewDir[xx]_mean' (repeated for each direction)
	VAA		View Azimuth Angle of each pixel of the ROI ↳ with attribute 'viewDir[xx]_mean' (repeated for each direction)
	REFL_BAND_[xx]		Values of the band number 'xx' on the ROI ↳ with attributes 'wavelength_mean', 'viewDir[xx]_mean' and 'viewDir[xx]_stdev' (two last repeated for each direction) **All bands of the L1 product**
	PIXEL_COLUMN_INDICE		Column index in the product of each point of the ROI
	PIXEL_ROW_INDICE		Line index in the product of each point of the ROI
	AUTO_CS_1_VALID_INDEX		Index in the ROI of each valid point of the ROI for cloud screening process
	AUTO_CS_2_VALID_INDEX		
	AUTO_CS_1_MASK		Cloud screening mask values on the ROI
	AUTO_CS_2_MASK		
	ERA_WIND_SPEED		Meteo auxiliary data ↳ with attribute 'viewDir[xx]_mean' and 'viewDir[xx]_mean_L1_aux_data' for each of them (repeated for each direction)
	ERA_WIND_DIR		
	ERA_OZONE		
	ERA_PRESSURE		
	ERA_WATERVAPOUR		
	ESA_CHLOROPHYLL		

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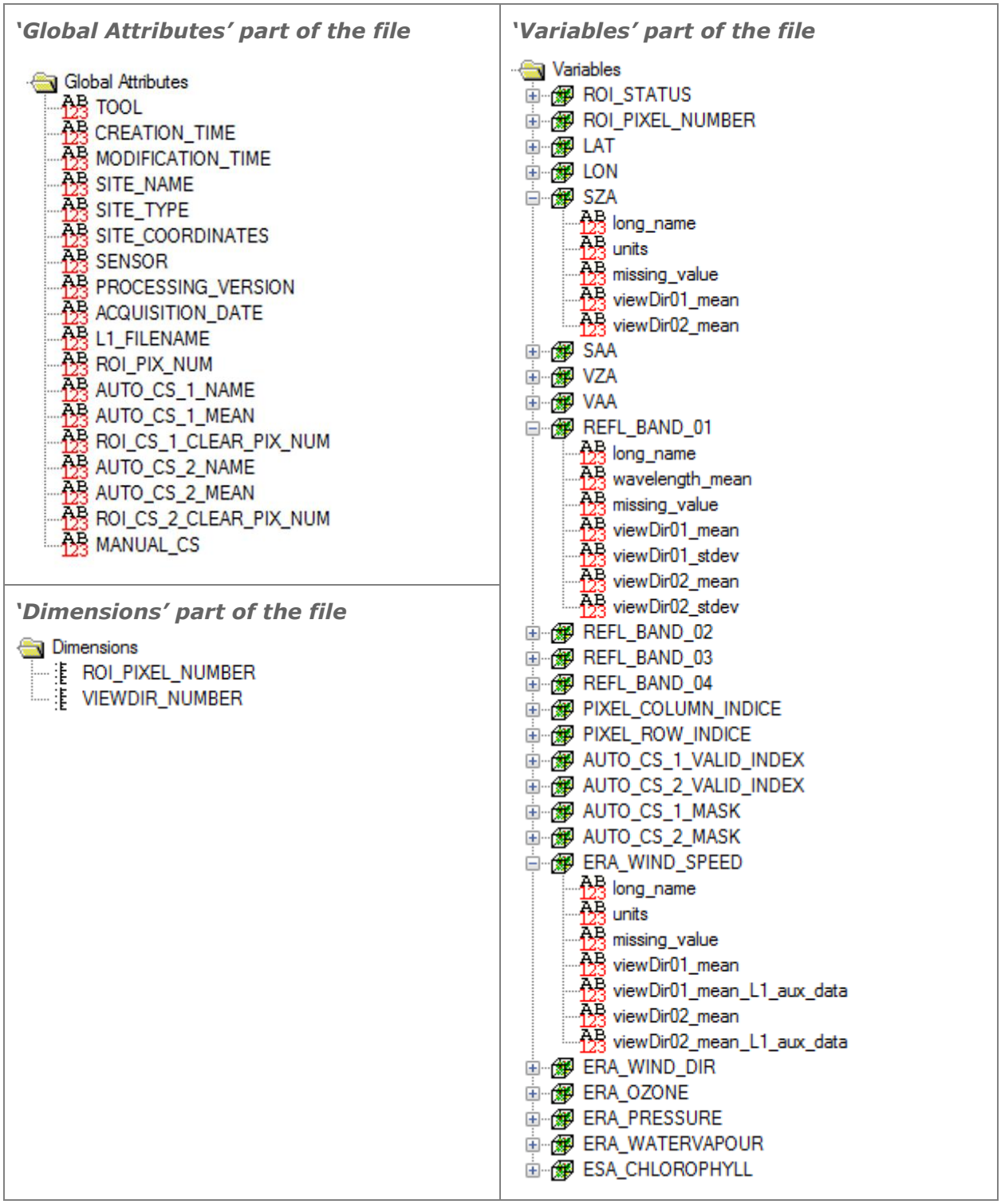


Figure 6-1: netCDF ingestion output file example

6.2.2.2 Sensor to simulation comparison output file

The global attributes and the dimensions are described in Table 6-3 and the variables are described in Table 6-4.

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The example on Figure 6-2 presents the netCDF file structure after sensor to simulation comparison process. In this example, 2 viewing directions are available (as AATSR, ATSR2, SLSTR).

Some variables are expanded to show their dedicated attributes.

For information, the attributes are the same inside each of the following groups:

- Sun and viewing angles (SAA, SZA, VAA, VZA),
- Reflectance value of each spectral band (REFL_BAND_01, REFL_BAND_02, REFL_BAND_[xx]),
- Meteo Auxiliary Data (ERA_WIND_SPEED, ERA_WIND_DIR, ERA_OZONE…),
- Sensor to simulation ratio (BAND_ [xx] _REF_TO_SIM_RATIO).

Table 6-3: netCDF sensor to simulation comparison output file description (Global attributes and dimensions)

	Fields	Description
GLOBAL Attributes	TOOL	Tool name
	CREATION_TIME	Creation time
	MODIFICATION_TIME	Modification time
	CALIBRATION_METHOD	Calibration method name
	SITE_NAME	ROI folder User placed product
	SITE_TYPE	Site type
	SITE_COORDINATES	Site coordinates (LAT_MAX, LAT_MIN, LON_MAX, LON_MIN)
	SENSOR	Product Sensor
	PROCESSING_VERSION	User defined processing version of product
	ACQUISITION_DATE	Product acquisition date (YYYY-MM-DD HH:MM)
	L1_FILENAME	L1 product filename (without path reference)
	ROI_PIX_NUM	Number of pixels within the associated ROI
	AUTO_CS_1_NAME	Automated ROI Cloud Screening method name (ARGANS)
	AUTO_CS_1_MEAN	Automated ROI Cloud Screening result in percent: -1 not done, [0 (clear)…100% (cloudy)]

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	Fields	Description
	ROI_CS_1_CLEAR_PIX_NUM	Number of clear pixels detected on the ROI
	AUTO_CS_2_NAME	Automated ROI Cloud Screening method name (MAGELLIUM)
	AUTO_CS_2_MEAN	Automated ROI Cloud Screening result in percent: -1 not done, [0 (clear)…100% (cloudy)]
	ROI_CS_2_CLEAR_PIX_NUM	Number of clear pixels detected on the ROI
	MANUAL_CS	Manual ROI Cloud Screening status indicating -1: not performed, 0: clear, 1: cloudy
DIMENSIONS	ROI_PIXEL_NUMBER	Number of pixel of the ROI [ROI_PIX]
	CALIB_PIXEL_NUMBER	Number of pixel selected for the sensor to simulation comparison process [CALIB_PIX]
	VIEWDIR_NUMBER	Number of sensor viewing direction [VIEW_DIR]

Table 6-4: netCDF sensor to simulation comparison output file description (variables)

	Fields	Size	Description
VARIABLES	ROI_STATUS	[VIEW_DIR]	ROI status for each viewing direction ↳ with attribute 'THETA_R_mean' / 'THETA_N_mean' for SUN GLINT and OCEAN sites
	ROI_PIXEL_NUMBER		Number of pixel of the ROI (for each viewing direction)
	CALIB_PIXEL_NUMBER		Number of pixel of the ROI selected for the sensor to simulation comparison process (for each viewing direction)
	LAT	[ROI_PIX, VIEW_DIR]	Latitude of each pixel of the ROI
	LON		Longitude of each pixel of the ROI
	SZA		Sun Zenith Angle of each pixel of the ROI

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	Fields	Size	Description
			↳ with attribute 'viewDir[xx]_mean' (repeated for each direction)
	SAA		Sun Azimuth Angle of each pixel of the ROI ↳ with attribute 'viewDir[xx]_mean' (repeated for each direction)
	VZA		View Zenith Angle of each pixel of the ROI ↳ with attribute 'viewDir[xx]_mean' (repeated for each direction)
	VAA		View Azimuth Angle of each pixel of the ROI ↳ with attribute 'viewDir[xx]_mean' (repeated for each direction)
	REFL_BAND_[xx]		Values of the band number 'xx' on the ROI ↳ with attributes 'wavelength_mean', 'viewDir[xx]_mean' and 'viewDir[xx]_stdev' (two last repeated for each direction) **Only selected bands for calibration**
	PIXEL_COLUMN_INDICE		Column index in the product of each point of the ROI
	PIXEL_ROW_INDICE		Line index in the product of each point of the ROI
	AUTO_CS_1_VALID_INDEX		Index in the ROI of each selected point of the ROI (check on the reflectance for 'classical' site and on the angles for Sun Glint)
	AUTO_CS_2_VALID_INDEX		
	AUTO_CS_1_MASK		Cloud screening mask values on the ROI
	AUTO_CS_2_MASK		
	ERA_WIND_SPEED	[ROI_PIX, VIEW_DIR]	Meteo auxiliary data ↳ with attribute 'viewDir[xx]_mean' for each of them (repeated for each direction)
	ERA_WIND_DIR		
	ERA_OZONE		
	ERA_PRESSURE		

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	Fields	Size	Description
	ERA_WATERVAPOUR		
	ESA_CHLOROPHYLL		
	CALIB_VALID_INDEX	[CALIB_PIX, VIEW_DIR]	Index in the ROI of each selected points used for sensor to simulation comparison process (pixel selection depends on the method and filtering parameters applied) **Common for all bands**
	WIND_SPEED_ESTIM		Wind speed estimation (available for Sun Glint calibration methods)
	AEROSOL_OT_ESTIM		Aerosol optical thickness estimation (available for Rayleigh calibration methods)
	BAND_[xx]_GAZ_TRANS		Gazeous transmission coefficient for band number 'xx'
	BAND_[xx]_RHO_SIM		Simulated TOA reflectance for band number 'xx'
	BAND_[xx]_RHO_SIM_UNCERT		Uncertainty on the simulated TOA reflectance for band number 'xx'
	BAND_[xx]_REF_TO_SIM_RATIO		TOA reflectance observed to simulated TOA reflectance ratio band number 'xx' ↳ with attributes 'viewDir[xx]_mean' / 'viewDir[xx]_stdev' / 'viewDir[xx]_median' (repeated for each direction)
	BAND_[xx]_VALID_INDEX		Valid indexes for band number 'xx' of the sensor to simulation process results (additional filtering on the validity of the TOA values for the band number 'xx') To apply on the sensor to simulation associated fields to select only valid pixels.

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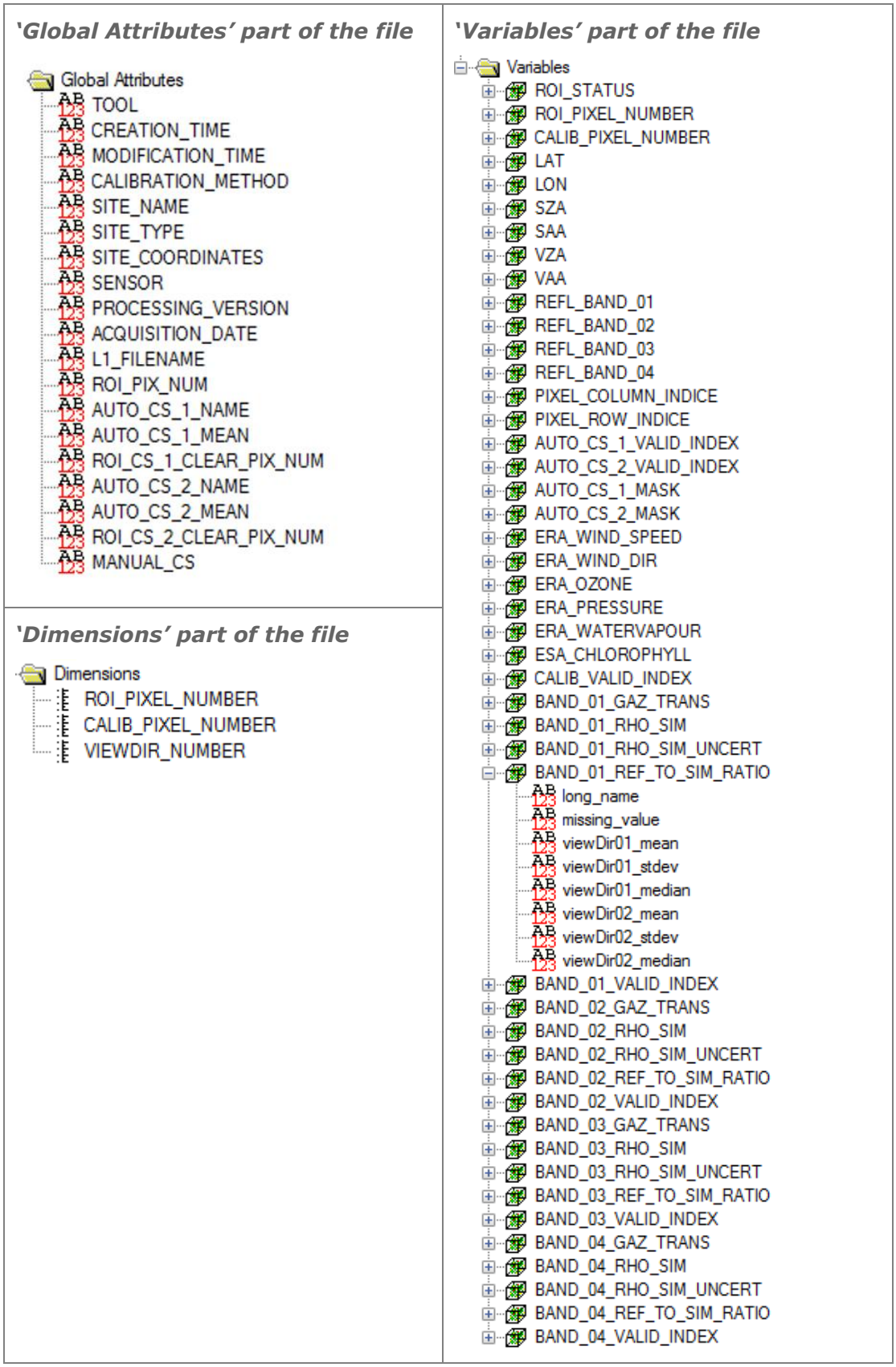


Figure 6-2: netCDF sensor to simulation comparison output file example

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6.2.3 DIMITRI internal binary files

A number of intermediate results are stored as IDL save files which are restored by DIMITRI when required. These files can also be restored by users with full IDL licenses if required by typing:

IDL> restore, sav_filename [, /verbose]

6.2.3.1 Files from sensor-to-sensor comparison

6.2.3.1.1 Extracted doublets

The extracted doublet internal binaries are of the syntax "ED_SITE_SENSOR1_PROCVER1_SENSOR2_PROCVER2.dat", and contain the extracted doublets for SENSOR1 when it has been extracted against SENSOR2, given the User selected matching parameters. These files are of the form:

[num_of_parameters, num_of_observations]

Where the parameters are:

decimal_time, VZA, VAA, SZA, SAA, Ozone*, Pressure*, Humidity*, Zonal_WIND*, Meridional_WIND*, Water_Vapour*, Mean_RHO_Band_0...Band_n, STDEV_RHO_Band_0...Band_n, Number of pixels, automated_cloud_screening, manual_cloud_screening, matching_type, AMC

** Indicates mean value and standard deviation*

Note: MODIS Aqua the reflectance bands are stored with indexes 0:14 as the 1Km bands, 15:19 as the 500m bands, and 20:21 as the 250m bands.

The number of observations is dependent on the matching criteria selected.

6.2.3.1.2 Intercalibration

A number of internal binaries are created during the intercalibration of sensor doublet information. These include:

- **"ICDIF_SITE_SENSOR_PROCVER_REF_SENSOR_PROCVER_BAND.dat"**

This has the dimensions: [num_observations, num_params], where the parameters are decimal_time, reflectance bias to reference sensor, and the polynomial bias to the reference sensor.

- **"ICERR_ SITE_SENSOR_PROCVER_REF_SENSOR_PROCVER_BAND.dat"**

This has the dimensions: [num_observations, num_params], where the parameters are the decimal_time and the error between the actual radiometric differences and the polynomial approximation of the differences.

- **"ICOEF_ SITE_SENSOR_PROCVER_REF_SENSOR_PROCVER_BAND.dat"**

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This binary contains the 3 polynomial coefficients for the specified calibration sensor, reference sensor and band.

- **"IUCRT_SENSOR_PROCVER_REF_SENSOR_PROCVER_BAND.dat"**

This binary contains the uncertainty values associated to the polynomial coefficients and contains the systematic error, the random error, and a flag indicating that the random error has been taken from the polynomial fit rather than the original sensor time series.

6.2.3.1.3 Recalibration

A number of internal binaries are output during the recalibration and super sensor time series generation. These include:

- **"RECAL_ SITE_SENSOR_PROCVER_REF_SENSOR_PROCVER.dat"**

"RECAL_REF_SITE_SENSOR_PROCVER.dat"

These SAV files are of the form: [num_parameters, num_observations], where the parameters are:

decimal_time, VZA, VAA, SZA, SAA, Ozone*, Pressure*, Humidity*, Zonal_WIND*, Meridional_WIND*, Water_Vapour*, Mean_RHO_Band_0...Band_n, STDEV_RHO_Band_0...Band_n, Number of pixels, automated_cloud_screening, manual_cloud_screening, matching_type, AMC

** Indicates mean value and standard deviation*

The observations are the recalibrated and reference sensor reflectances.

- **"SSEN_ SITE_SENSOR_PROCVER _BAND.DAT"**

These files contain the Super Sensor observations generated for the specific band, using the SENSOR value as the reference sensor. These files have the form: [num_parameters, num_observations], where the parameters are:

decimal_time, VZA, VAA, SZA, SAA, Ozone*, Pressure*, Humidity*, Zonal_WIND*, Meridional_WIND*, Water_Vapour*, Mean_RHO_Band, Systematic_uncertainty, Random_uncertainty, Poly_err_flag, and a flag indicating which sensor configuration the observation originates.

6.2.3.1.4 ROUJEAN BRDF

The following internal SAV files are generated during the BRDF computation:

- **"ROUJEAN_ER_SITE_REF_SENSOR_PROCVER.dat"**
- **"ROUJEAN_K1_SITE_REF_SENSOR_PROCVER.dat"**
- **"ROUJEAN_K2_SITE_REF_SENSOR_PROCVER.dat"**
- **"ROUJEAN_K3_SITE_REF_SENSOR_PROCVER.dat"**

These files are all of the form: [num_params, number_bins], where the parameters are: decimal_time, the number of sensor observation within the bin, and the corresponding ROUJEAN coefficient for all bands. The number of bins will depend on the bin size selected for processing.

- **"ROUJEAN_UC_SITE_REF_SENSOR_PROCVER.dat"**

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This file is of the form: [num_params, number_bins], where the parameters are: time, num_sensor observations, VZA min, VZA max, SZA min, SZA max, RAA min, RAA max, poly_err_flag, the systematic uncertainty for each band, and the random uncertainty for each band.

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7 Troubleshooting/FAQ

Q: Why doesn't DIMITRI run when I double click on the SAV file?

A: Please ensure you have correctly unzipped the DIMITRI zip archive and that you are choosing to open the save file with IDL.

Q: The automated cloud screening values seem incorrect when viewing the product quicklooks, why is this?

A: Automated cloud screening of L1 data is very difficult. The results are likely to vary depending on which validation site you are interested in; clouds over ocean are easy to detect however over snow, ice and salt lakes this is very difficult. The performance of the algorithms is also linked to the available wavebands for each sensor; ideally wavebands in the thermal wavelengths are needed for accurate cloud detection.

Q: What is the best tool for reading/utilising the output CSV files?

A: The semi-colon delimited output CSV files can be opened in most text editing software; the data can also be read into Microsoft Excel for further analysis (e.g. plots and statistics).

Q: How do I add extra site spectra?

A: User generated site spectra will be automatically read by DIMITRI if placed in the 'AUX_DATA/spectral_response/DIMITRI_Sites' folder. These files must be semi-colon separated and contain 2 columns containing the wavelength in nm, and the reflectance over the site. Please see the other site spectra files for examples.

Q: Why do no new IDL windows open when DIMITRI generates plots/ I stopped DIMITRI during processing, why can't I generate any new IDL plots?

A: DIMITRI utilises IDL's Z-buffer for generating plots; this buffer does not have a viewable window but is stored in the machines memory. Plots can therefore be saved without displaying multiple IDL windows. If you stop DIMITRI during processing it will still be working in the Z-buffer; to return to your normal IDL graphics display type:

WINDOWS: IDL> set_plot, 'win'

LINUX: IDL> set_plot, 'x' under

Q. Why is the super sensor time series so variable?

A. The super sensor time series includes radiometrically corrected data from a number of different sensors. These sensors all have different viewing and solar geometries over the same location (dependant on your chi value chosen). The greater the range of geometries the better the BRDF fit!

Q: How do I find the details of created sites?

A: The DIMITRI file 'DIMITRI_SITE_DATA.txt' is a semi colon delimited file containing the site information including coordinates and type.

Q: How do I add a new sensor to DIMITRI?

A: DIMITRI has been designed in modules to allow modification by users however adding a new sensor is not a simple task, this requires:

- New IDL product readers located in a new folder under "Source", named after the sensor;
- Updates to the DIMITRI auxiliary data files located in the 'AUX_DATA' and 'Bin' folders (e.g. DIMITRI_SENSOR_DATA.txt, DIMITRI_Band_Names.txt, DIMITRI_Band_Centre_Index.txt and DIMITRI_Band_Configuration.csv)

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- Addition of the sensor and the processing routine to ingest the data to the routine "Source/ingest/DIMITRI_INTERFACE_INGEST.pro"
- Addition of text to compile all the routines to the "Source/compile_dimitri" script file
- Potential modification of the sensor-to-sensor and sensor-to-simulation intercomparison routines

- End of document -

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