Libya 4 and DIMITRI

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DIMITRI: history and purpose

- ESA EO data quality control tool
- Radiometric monitoring of ESA sensors but NOT their operational calibration

- Started as proto tool at ESA/ESTEC (2006)
- Reengineered by ARGANS and recently tested/exploited by RAL/ARGANS/ONERA/ACRI (2012)
- Made freely available: data + tools

DIMITRI : a database

Sites	Sensors	Years
Amazon forest BOUSSOLE Dome-C Libya-4 South Indian Ocean South Pacific Ocean Tuz Golu Uyuni	AATSR ATSR-2 MERIS MODIS-A POLDER-3 VEGETATION-2	2002 to 2012

120,738 L1 native products = 1.2 Tb of data

=> 5 Gb of extracted L1 (averaged over ROI TOA reflectance)

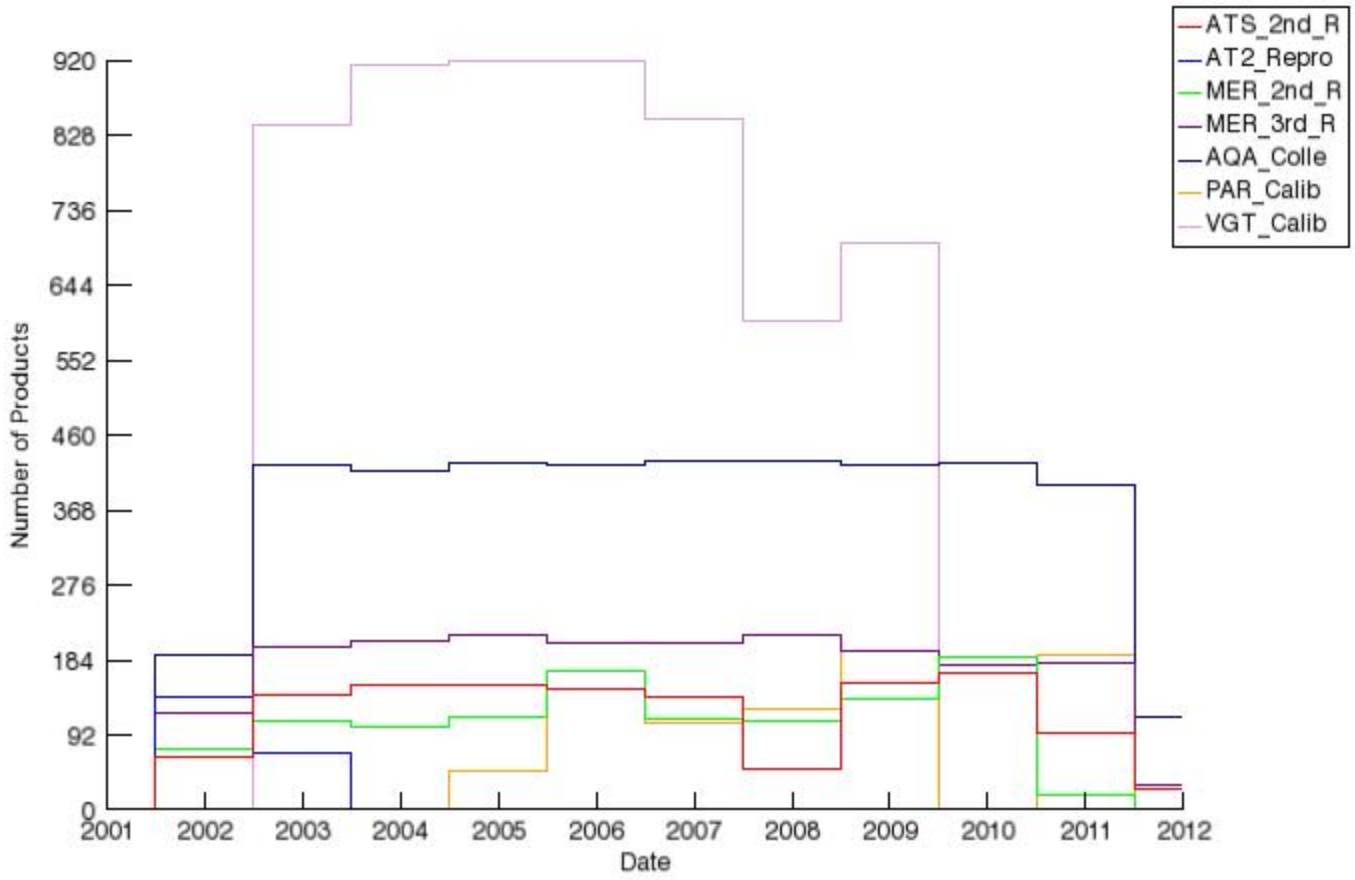
Libya-4 definition in DIMITRI

A lat/long box defined by:

- [29.05 N, 28.05N]
- [22.89 W, 23.89 W]

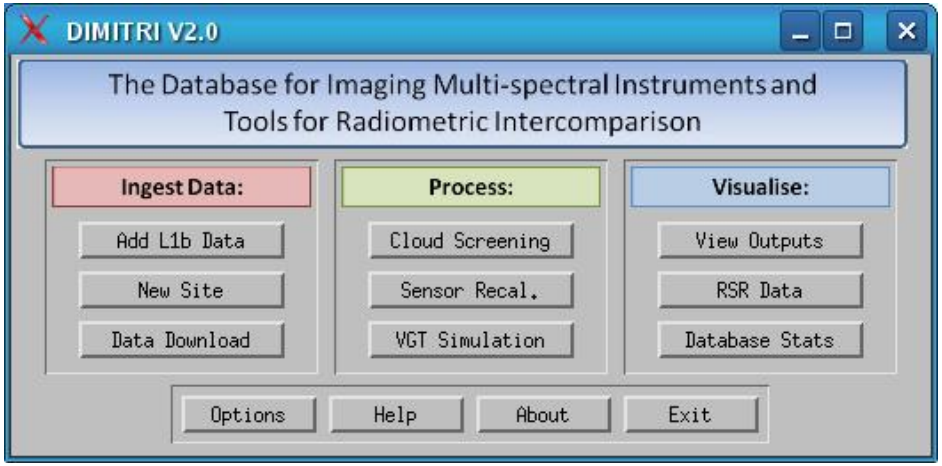
How much data does DIMITRI holds over Libya-4?

- ATSR-2
- AATSR
- MERIS
- MODIS-A
- PARASOL
- VGT-2



DIMITRI – A collection of tools

- A simple database (.csv) to keep track of ingested products
- Methodologies and data management coded in IDL
- A Graphic User Interface



DIMITRI – Automatic cloud screening

DIMITRI data over Libya 4 are cloud screened.

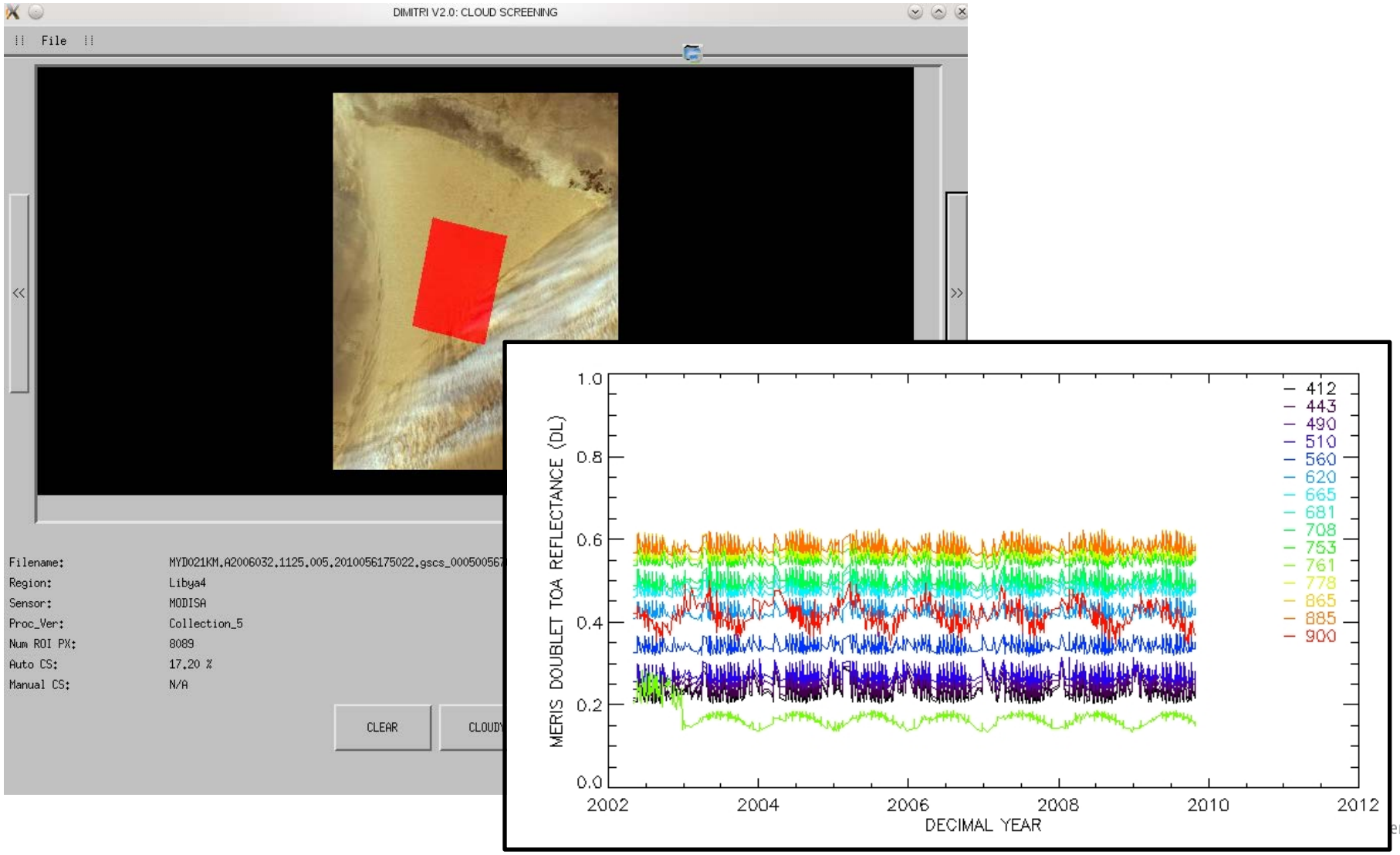
Automatic cloud screening schemes:

- ATSR2, AATSR, MODIS-Aqua => Landsat ACCA [1]
- MERIS, PARASOL => Globcarbon-MERIS [2]
- VEGETATION => VGT-operational

Output of cloud screening is a percentile in cloudiness within the ROI

[1] Irish, R.R. Landsat 7 Automatic Cloud Cover Assessment. See http://landsathandbook.gsfc.nasa.gov/handbook/pdfs/ACCA_SPIE_paper.pdf
[2] 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.

DIMITRI – Visual cloud screening



Comparison of DIMITRI L1 extractions to SADE L1 extractions

Both SADE (CNES) and DIMITRI generate L1 extractions over several sites.

L1 extraction = cloud free TOA reflectance averaged over a pre-defined ROI => input to most vicarious calibration or radiometric comparison methodologies making use of pseudo-invariant sites.

SADE and DIMITRI differ in computing L1 extractions in their:

- Source of L1 products (e.g.: CNES starts from uncalibrated L1 for VEGETATION data)
- Radiometric corrections applied to the data (e.g. smile correction for MERIS in DIMITRI)
- Cloud screening schemes

Question: what is the uncertainty associated with the L1 extraction generation process?

Comparison of DIMITRI L1 extractions to SADE L1 extractions

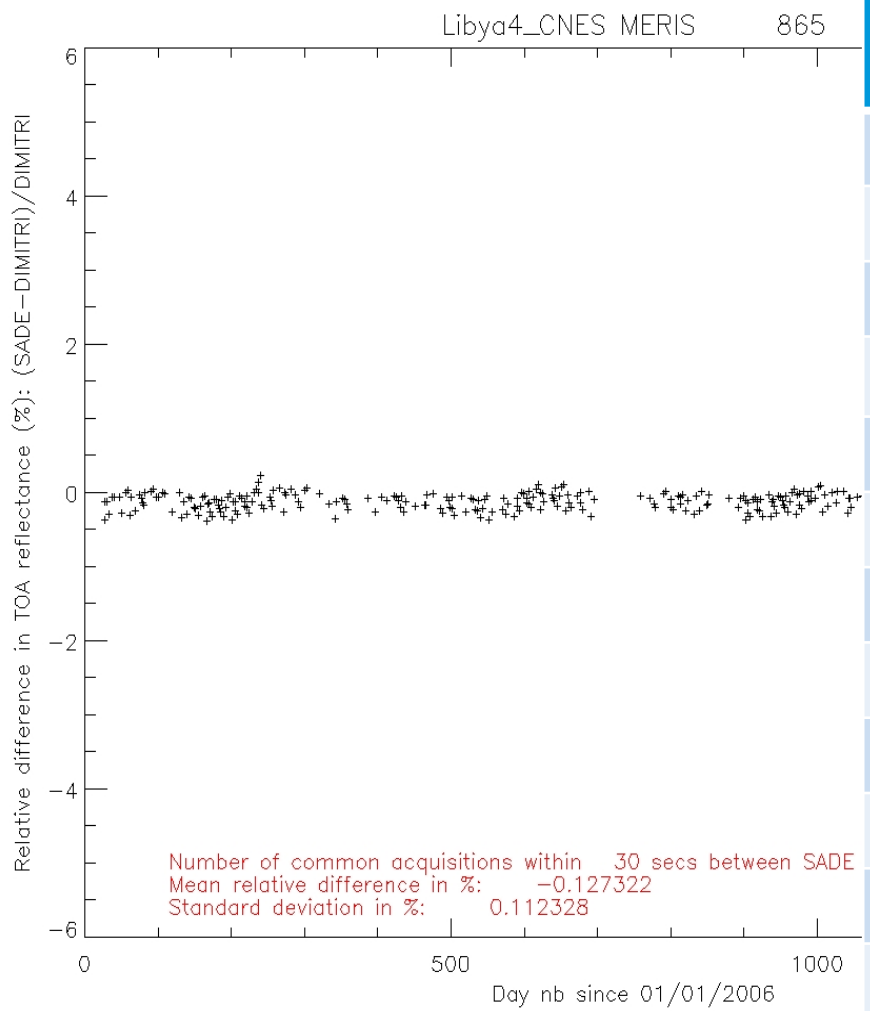
SADE and DIMITRI extractions were compared over **Libya-4** using the CEOS/IVOS WG4 reference dataset (described later on).

Period: 2006-2009

Sensors: MERIS, A-MODIS, PARASOL, VEGETATION-2

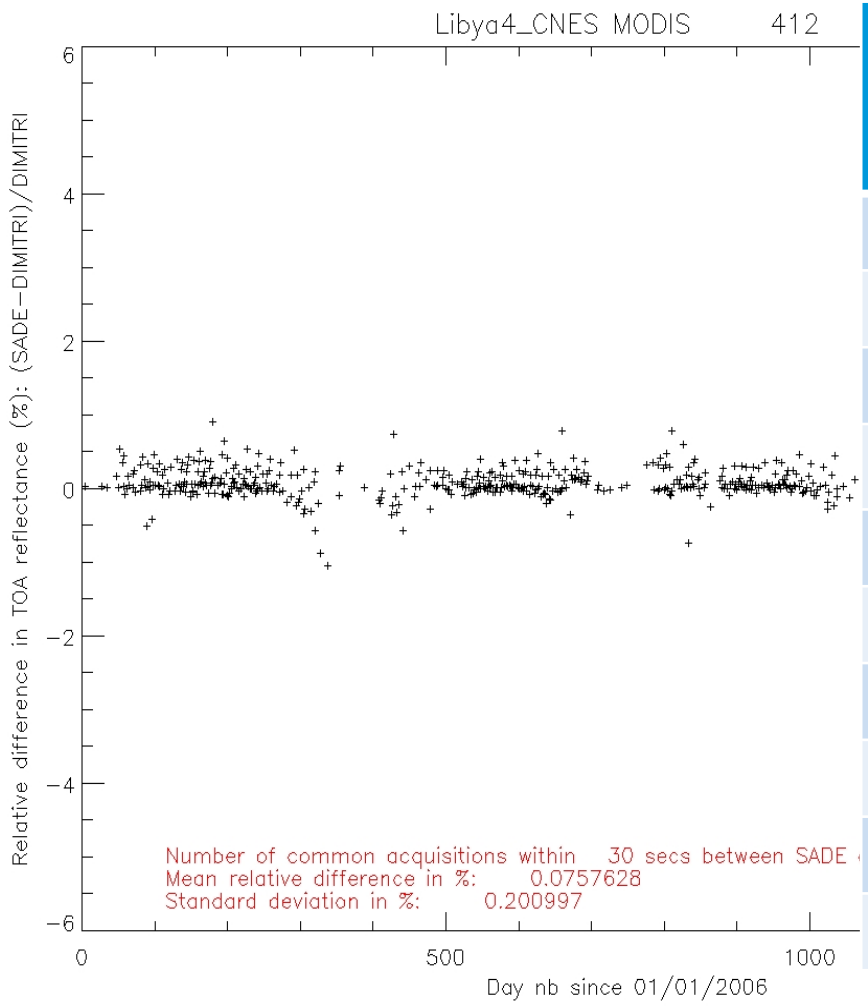
More details in *S. Adriaensen, K. Barker, L. Bourg, M. Bouvet , B. Fougnie, Y. Govaerts, P. Henry, C. Kent, D. Smith, S. Sterckx, CEOS IVOS Working Group 4: Vicarious calibration and radiometric intercomparison over pseudo-invariant calibration sites* (http://calvalportal.ceos.org/cvp/web/guest/ivos/wg4)

SADE vs. DIMITRI over Libya-4: TOA reflectance



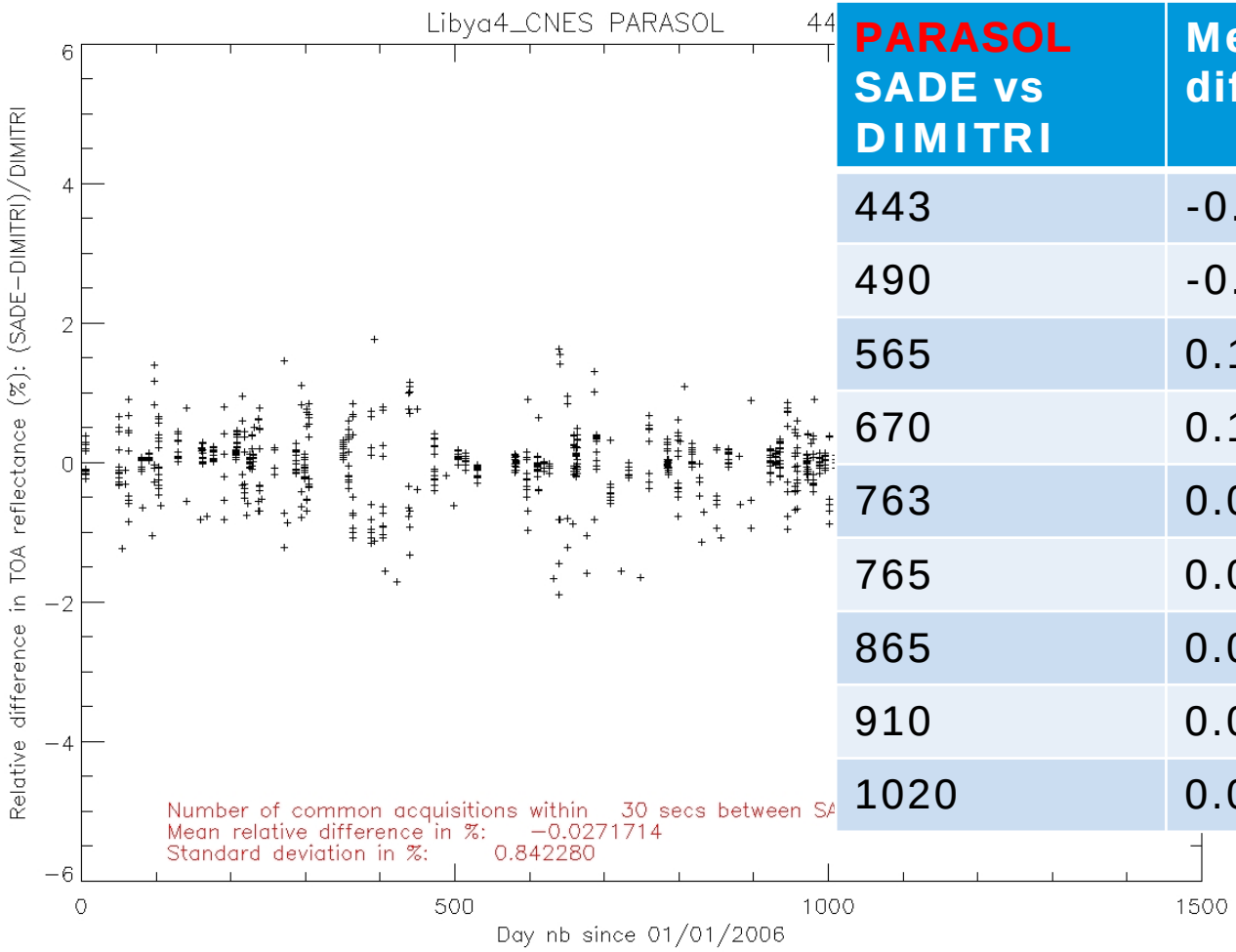
MERIS SADE vs DIMITRI	Mean difference	Coefficient of variation
412	-0.12%	0.10%
443	-0.08%	0.35%
490	-0.05%	0.13%
510	-0.09%	0.17%
560	-0.08%	0.14%
620	-0.08%	0.07%
681	-0.08%	0.1%
709	-0.09%	0.06%
754	-0.08%	0.05%
761	-0.4%	0.07%
778	-0.08%	0.12%
865	-0.12%	0.11%
885	-0.07%	0.06%
900	-0.1%	0.05%

SADE vs. DIMITRI over Libya-4: TOA reflectances



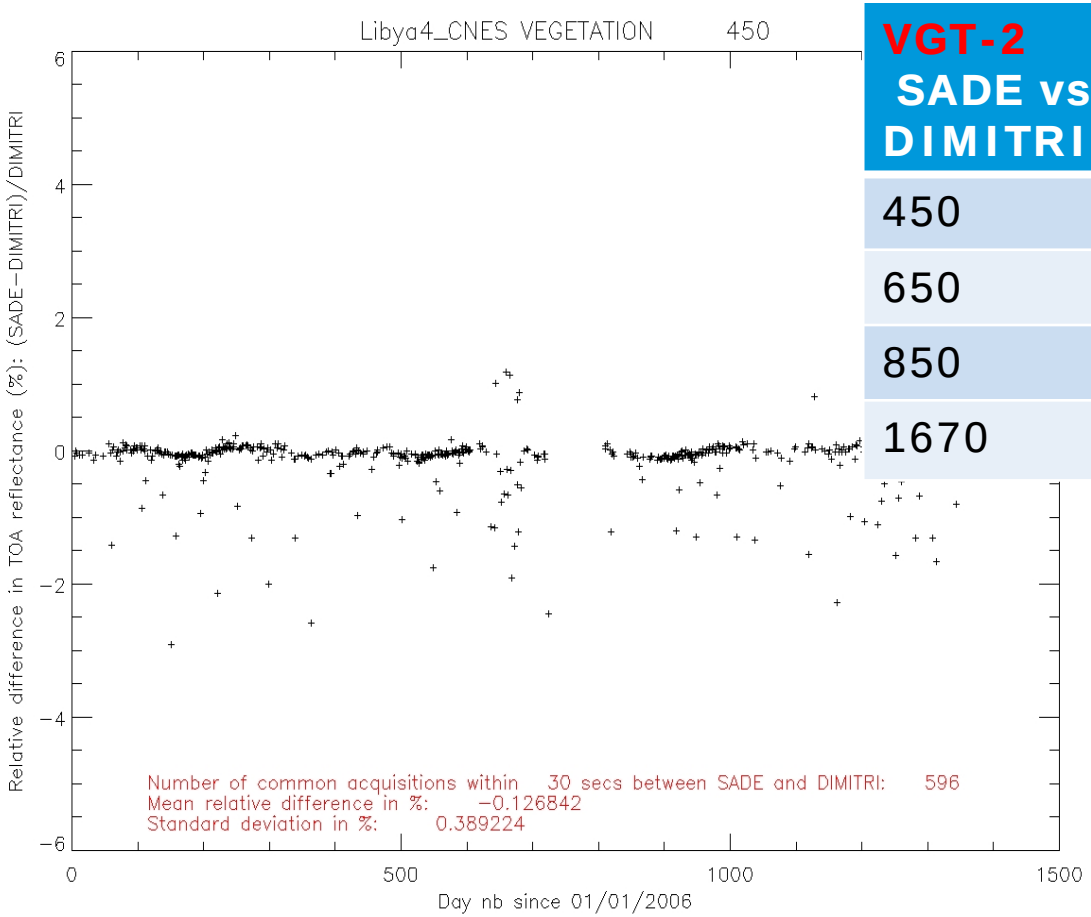
MODIS SADE vs DIMITRI	Mean difference	Coefficient of variation
412	0.08%	0.20%
443	0.13%	0.17%
469	0.18%	0.15%
488	0.02%	0.19%
555	0.17%	0.08%
645	0.09%	0.07%
858	0.08%	0.07%
1240	0.00%	0.07%
1640	0.01%	0.1%
2130	0.03%	0.14%

SADE vs. DIMITRI over Libya-4: TOA reflectances



PARASOL SADE vs DIMITRI	Mean difference	Coefficient of variation
443	-0.03%	0.84%
490	-0.07%	0.51%
565	0.14%	0.35%
670	0.1%	0.27%
763	0.08%	0.27%
765	0.06%	0.26%
865	0.06%	0.25%
910	0.09%	0.37%
1020	0.01%	0.25%

SADE vs. DIMITRI over Libya-4: TOA reflectances



VGT-2 SADE vs DIMITRI	Mean difference	Coefficient of variation
450	-0.12%	0.39%
650	0.16%	0.32%
850	0.16%	0.26%
1670	0.05%	0.13%

Conclusion of intercomparison

- On a L1-by-L1 basis, radiometric differences can be significant (few %)
- Mean radiometric differences between SADE and DIMITRI extractions over Libya 4 for MERIS, A-MODIS, PARASOL, VEGETATION-2 are below 0.2%, i.e., one order of magnitude below vicarious calibration methodologies claimed uncertainties.

PS: This intercomparison was a useful exercise that allowed to identify and understand issues related to the extraction process in SADE and DIMITRI

Methodology 1: temporal and angular matching for radiometric intercomparisons

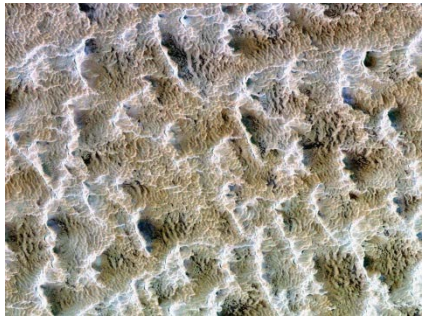
Methodology 1 : sensor-to-sensor radiometric intercomparison

- Cloud screening
- Direct comparison of TOA reflectance observations from 2 sensors temporally matched and angularly matched (matching criteria a user defined)
- Bands from 2 sensors with similar RSR are matched

Assumption:

- Symmetry of TOA BRDF across the principal plane
- Principle of reciprocity

Methodology 1: Intercomparison over Dome C, Libya-4 and Niger-2 (L. Bourg)



Sensor: AATSR, A-MODIS, MERIS, PARASOL

Bands: 560, 670 and 865 nm

Methodology systematic uncertainty: < 5 %

Methodology random uncertainty: < 2 %

Temporal coverage: 2006 – 2009

Temporal matching: 10 days

Conclusion: All sensors within +/- <5 % of the MERIS 2nd reprocessing data used as reference.

Reference:

S. Adriaensen, K. Barker, L. Bourg, M. Bouvet, B. Fougnie, Y. Govaerts, P. Henry, C. Kent, D. Smith, S. Sterckx, CEOS IVOS Working Group 4 Report: Vicarious calibration and radiometric intercomparison over pseudo-invariant calibration sites (http://calvalportal.ceos.org/cvp/web/guest/ivos/wg4)

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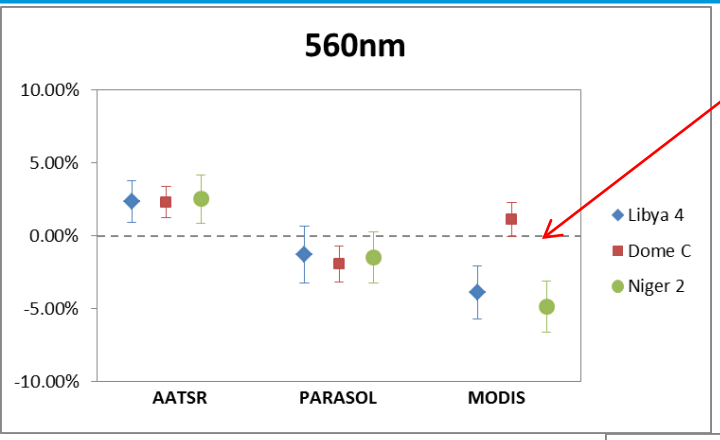
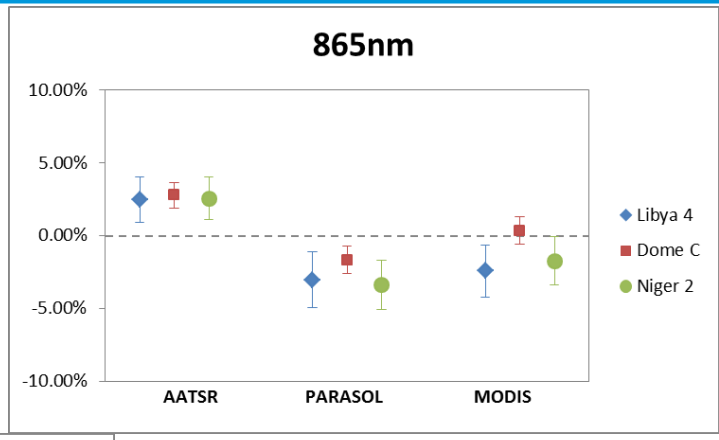
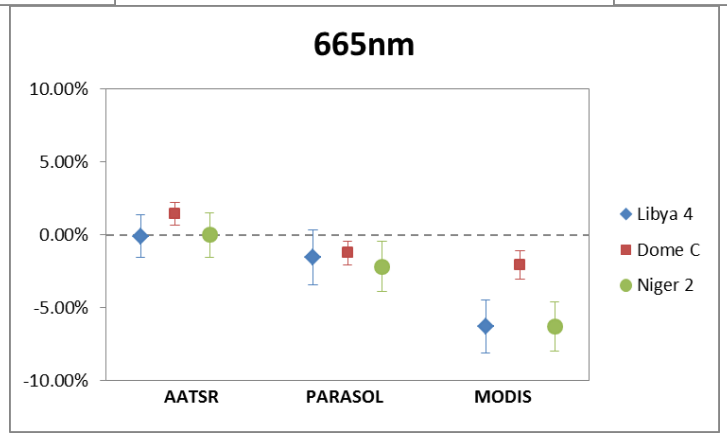


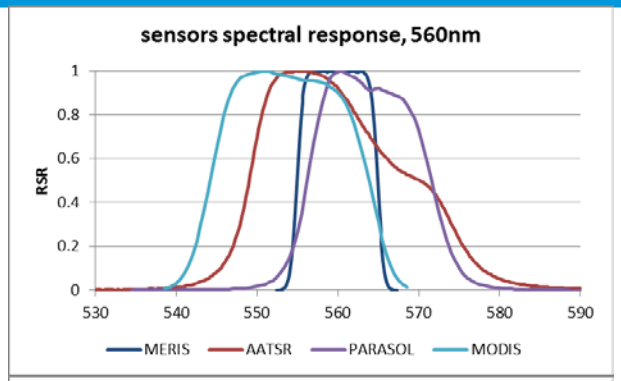
MERIS 2nd reprocessing

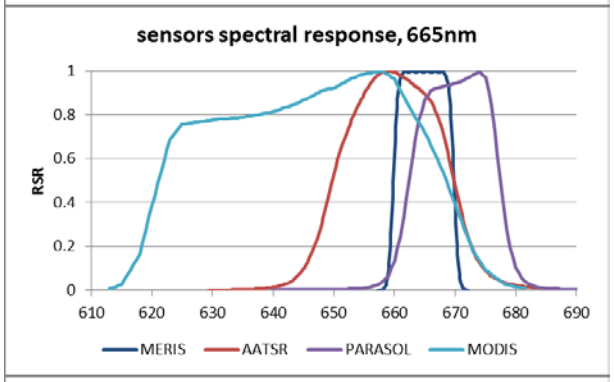


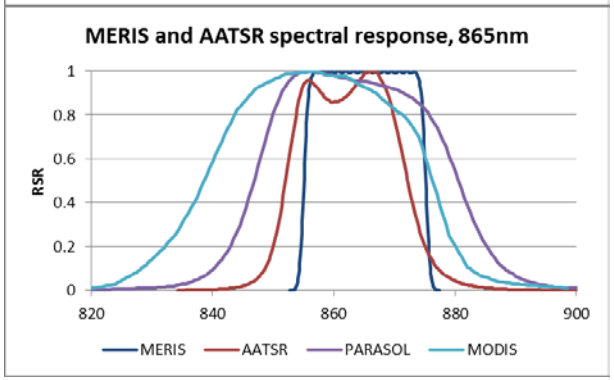


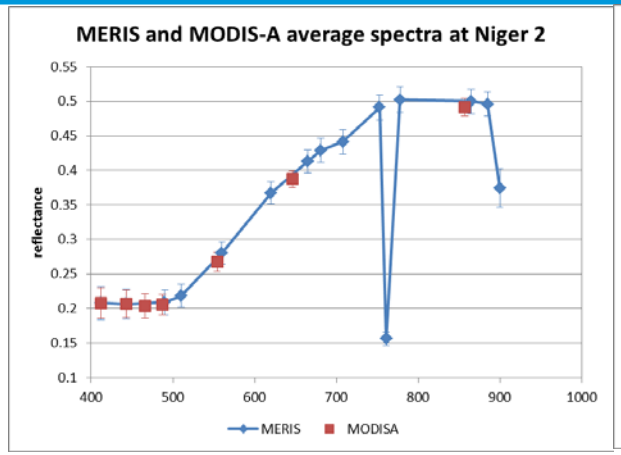
A significant site dependant systematic error due to mismatch in spectral responses between sensors was identified, in particular between MERIS and A-MODIS

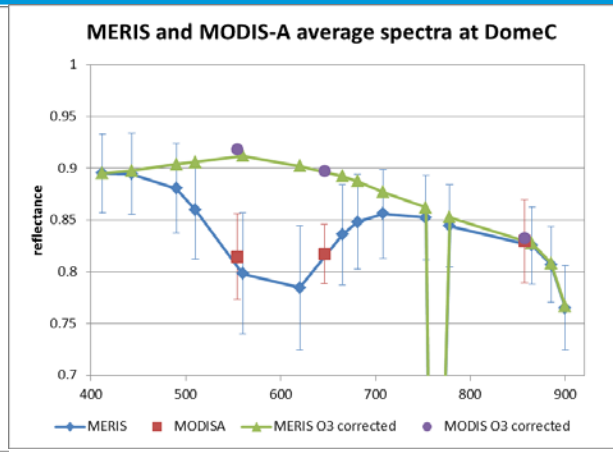
Differences in spectral response between sensors







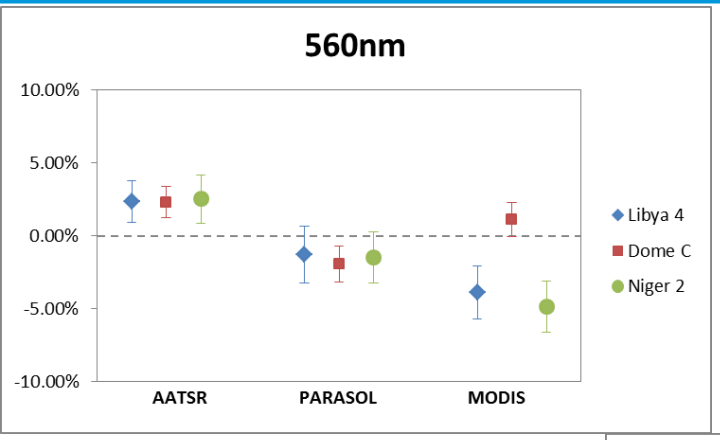


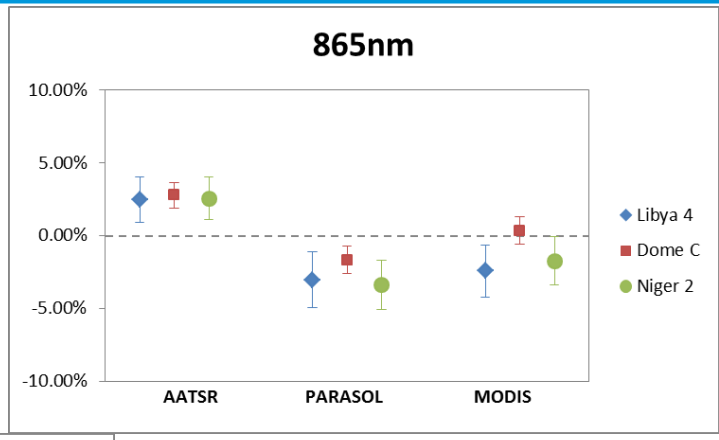


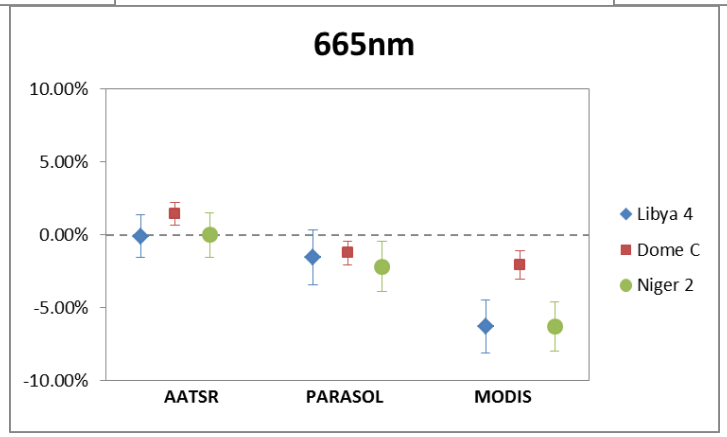
- Spectral responses are a source of Type B (=systematic) uncertainty for methodologies that do not explicitly account for them.

Sensors Relative Spectral Response (RSR) for the three inter-compared channels.

Methodology 1: Dome C, Libya-4 and Niger-2 (L. Bourg)







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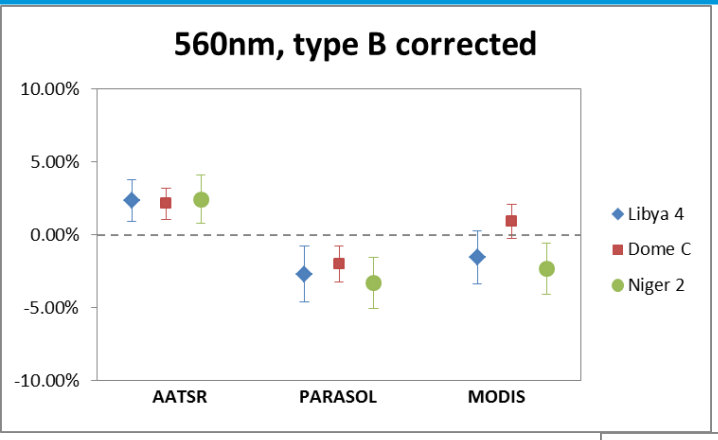

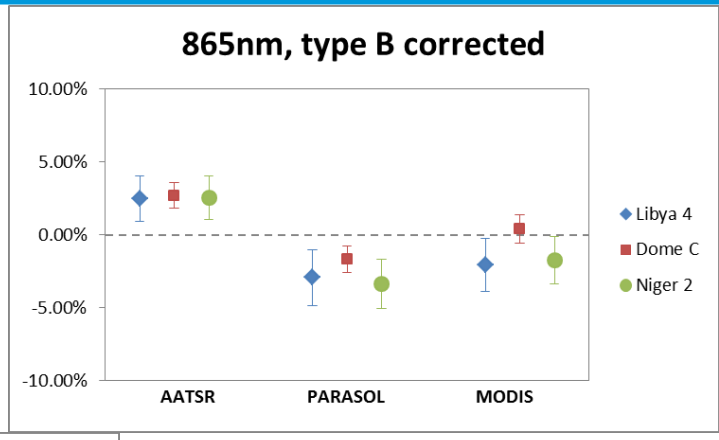

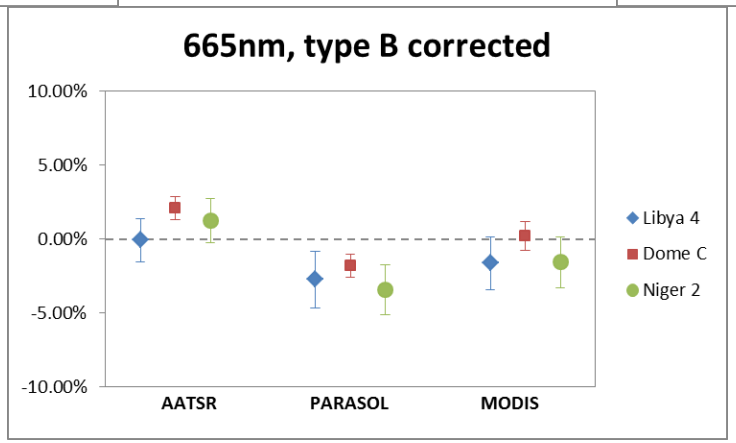

First order correction improves consistency between sites

Methodology 2: VGT-2 TOA reflectance simulation

Methodology: TOA prediction of VGT-2 observation using 'super MERIS' observations

- Using methodology 1, systematic differences between sensors radiometry are corrected. AATSR, MODIS-A, PARASOL aligned to a reference sensors (MERIS) => super MERIS observations
- A daily/weekly/monthly TOA BRDF model (3-parameter Roujean) is fitted using the super MERIS observations at common bands between sensors (e.g.: 443, 490, 560, 665, 865 nm)
- TOA BRDF models at other MERIS bands obtained assuming the 1st parameter of Roujean model follows the mean TOA MERIS reflectance over the site and other 2 parameters of BRDF model are inherited from closest spectral band where available
- Compute TOA reflectance in VGT-2 geometry in 15 MERIS bands
- Simple gaseous absorption correction of 15 bands in VGT-2 geometry (using 6S gaseous transmission and VGT-2 aux met data) -> linear spectral interpolation -> multiply by hyperspectral gaseous transmission added in VGT-2 geometry (using 6S and VGT-2 aux met data) -> convolution with RSR of VGT-2.

Numerous assumptions. Rough estimate of uncertainties:

- Systematic uncertainty > 8 %
- Random uncertainty > 11 %

First assessmemt of the methodology uncertainties done by comparing the VGT-2 simulations (on MERIS radiometric scale) to actual VGT-2 observations: See Francoise's talk

http://calvalportal.ceos.org/cvp/web/guest/tools

DIMITRI : Database for Imaging Multi-spectral Instruments and Tools for Radiometric Intercomparison

Overview

The Database for Imaging Multi-spectral Instruments and Tools for Radiometric Intercomparison (DIMITRI) contains L1 data from various medium resolution imagers over terrestrial targets chosen for their radiometric properties and/or the availability of in-situ radiometric measurements. DIMITRI comes with a suite of tools that allow comparison of the L1 data originating from various sensors in the database at top of the atmosphere (TOA) level.

DIMITRI was initially prototyped at ESA/ESTEC. It is currently maintained by ESA and ARGANS.

You can register to download the DIMITRI software below.

Software Tools

DIMITRI has a user-friendly interface for reading the database and making intercomparisons over these sites based on user-selection of a reference sensor, against which other sensors are compared. The software package contains a suite of IDL routines (it can be run with a free IDL run time license). DIMITRI can be used for the intercomparison of TOA radiance and reflectance values within the 400nm – 4µm wavelength range; this is generally known as Level 1b Earth Observation (EO) satellite data. DIMITRI offers the following capabilities and functionalities:

Sites, Location & Surface Type

Uyuni Salt Lake	Bolivia	Salt Lake
Libya-4	Libya	Desert
Dome-C	Antarctica	Snow
Tuz Golu	Turkey	Salt Lake
BOUSSOLE	Ligurian Sea	Ocean
Amazon Forest	South America	Vegetation
South Pacific Gyre	Pacific	Ocean
South Indian Ocean	Indian Ocean	Ocean