CEOS IVOS WG4 intercomparisons

CEOS IVOS Working Group 4:
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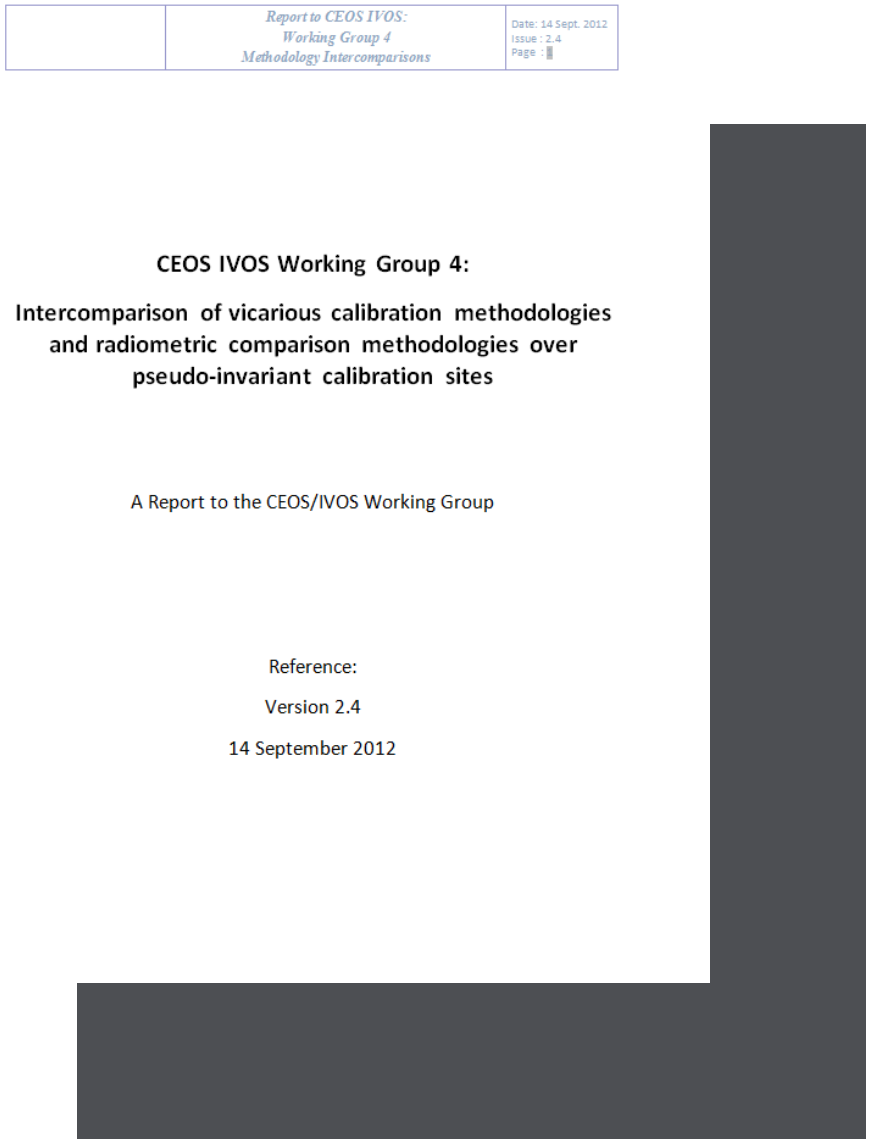
Context

At the CEOS / IVOS workshop in Oct. 2010 it was decided to:

"Set up small working groups … to draft a CEOS endorsable best practice "procedure" for the various vicarious calibration/validation methodologies."

=> WG4 on pseudo-invariant calibration sites was set up



Objective of the intercomparison

- Compare the results of methodologies making use of pseudo-invariant sites for:
  a. Absolute vicarious calibration
     - Compare observed signal with signal elaborated using measurements from a reference sensor
  b. Radiometric intercomparison
     - Directly compare observed signal with a signal from a reference sensor
- Understand the differences between the results of the methodologies.

*The sensors considered in this work are space borne **medium resolution** sensors with **multi-spectral** capabilities operating in the **visible to near infrared**.*

The objective of this work was NOT to derive absolute radiometric calibration coefficients for further operational use.

Overview of the approach

- 1/ A reference dataset is defined and generated
  - made of cloud free mean TOA reflectance
  - auxiliary data
- 2/ Statistical indicators were defined on the basis of which methodologies should be compared
- 3/ The methodologies were applied to the reference dataset
- 4/ Results were compared

The methodologies

6 algorithms were tested

1. **DIMITRI (ESA):** run in this study by L. Bourg (ACRI-ST), D. Smith (RAL) and C. Kent (ARGANS Ltd).
2. **MUSCLE/SADE (CNES):** run in this study by P. Henry and B. Fougnie (CNES);
3. **Drift Monitoring approach (RAL):** run in this study by D. Smith (RAL); This comprises comparisons via a
   a. a near nadir BRF reference model,
   b. a full BRF reference model
   c. simultaneous nadir observations (for MERIS and AATSR only).
4. **OSCAR (Optical Sensor Calibration with Simulated Radiances):** run in this study by Y. Govaerts, S. Sterckx, S. Adriaensen (all VITO).

NB: While MUSCLE and OSCAR do explicitly account for sensor spectral response differences when comparing two sensor radiometry, DIMITRI and the Drift Monitoring methodologies do not.

The reference dataset

- A reference dataset has been produced by ARGANS, CNES and RAL :
  - consisting of extractions in a predefined format
  - from 3 sites, 5 sensors and over 4 consecutive years.
- The common reference dataset consists of:
  - the mean and standard deviation of cloud screened TOA reflectances over pre-defined regions of interest
  - the associated viewing and solar geometries
  - the associated meteorological parameters extracted

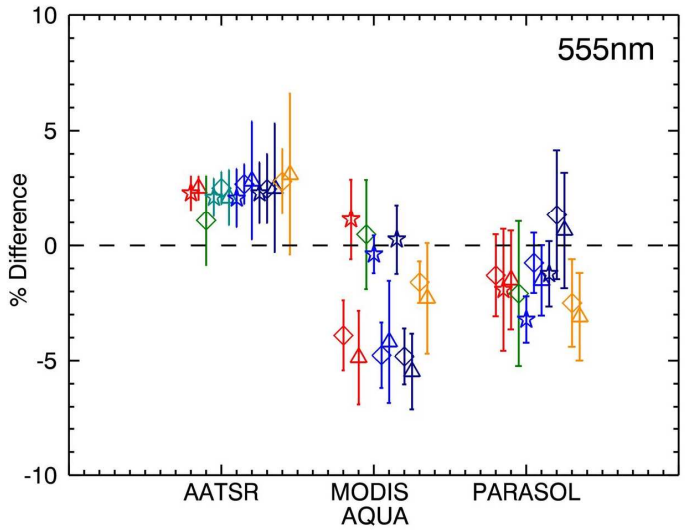
Sites	Sensors	Years
Libya-4 Niger-2 Dome-C	POLDER-3 AATSR MERIS VEGETATION-2 MODIS-A	2006 2007 2008 2009

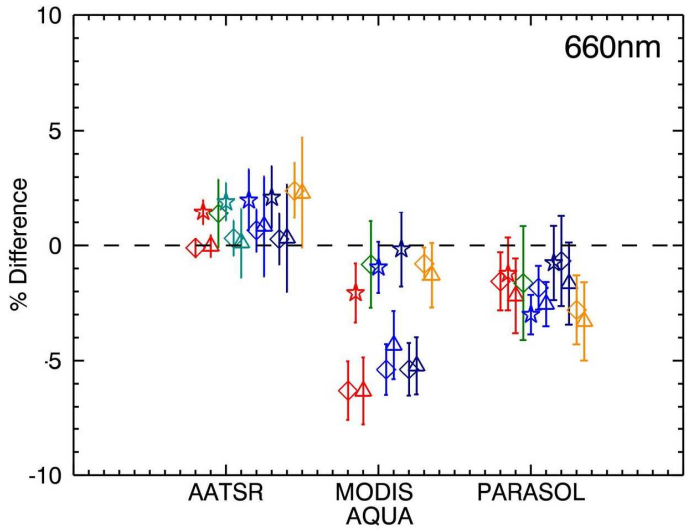
Few more details on the intercomparison approach

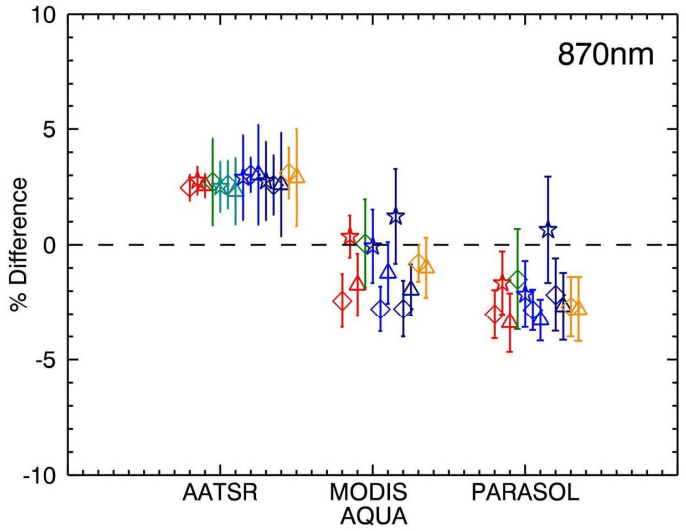
- Intercomparisons were restricted to 3 regions centered around 560 nm, 660 nm and 860 nm
- The MERIS 2nd reprocessing data were chosen as reference to which AATSR, MODIS-A and POLDER-3 were compared
- VEGETATION-2 was excluded from the intercomparison because not all methodologies have the capability to cope with its wide band

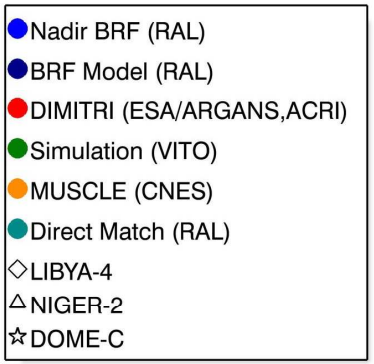
NB: One can find more results than here indicated in the report

The results: a summary







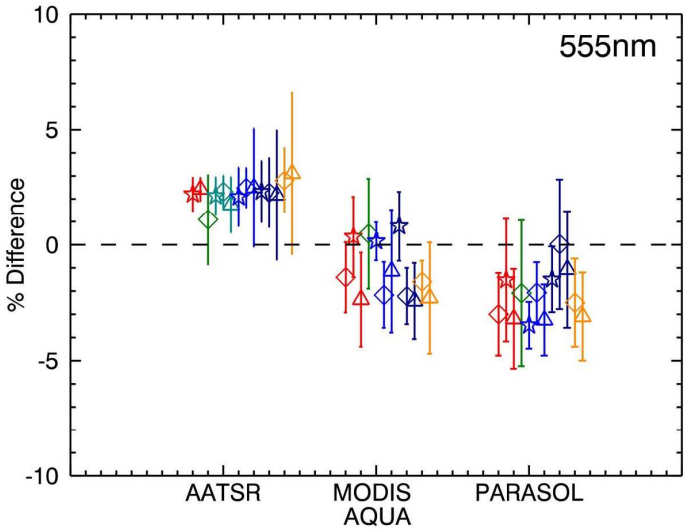


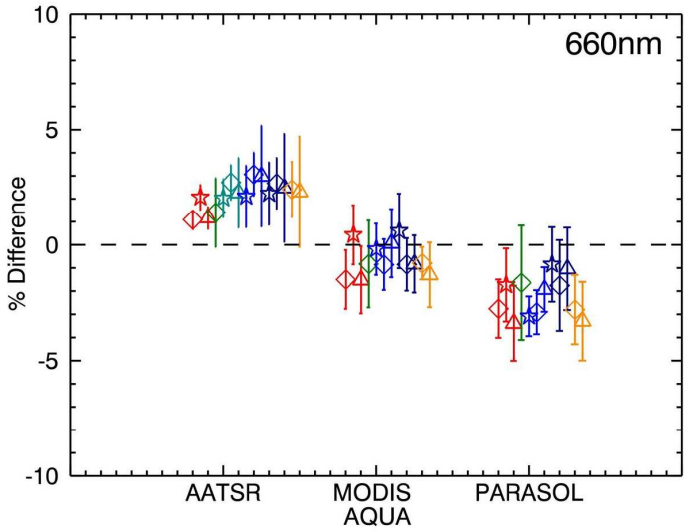
- MERIS 2nd reprocessing used as reference

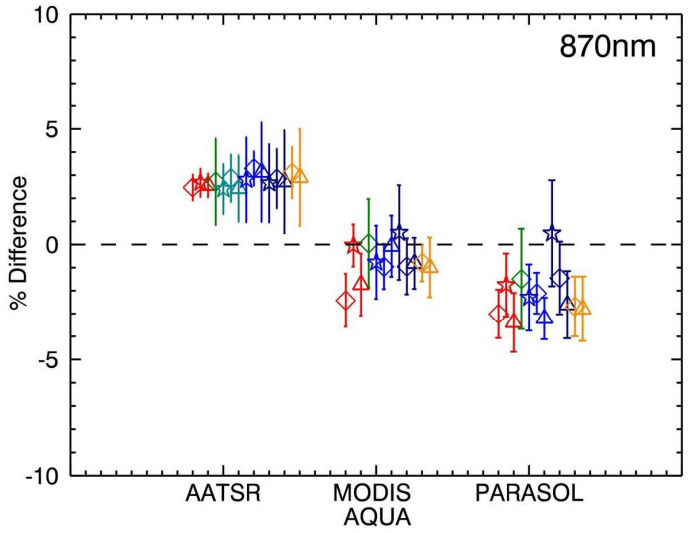
- Error bar = standard deviation associated to the computation of the mean difference (this is NOT the uncertainty)

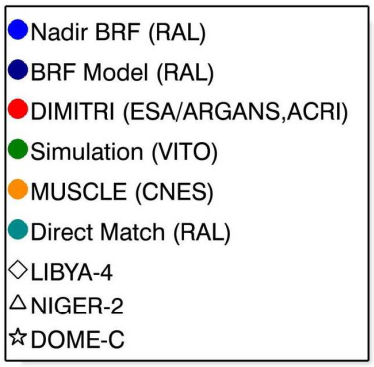
- Site dependant biases are visible for methodology

The results: including a correction for Type B uncertainties identified



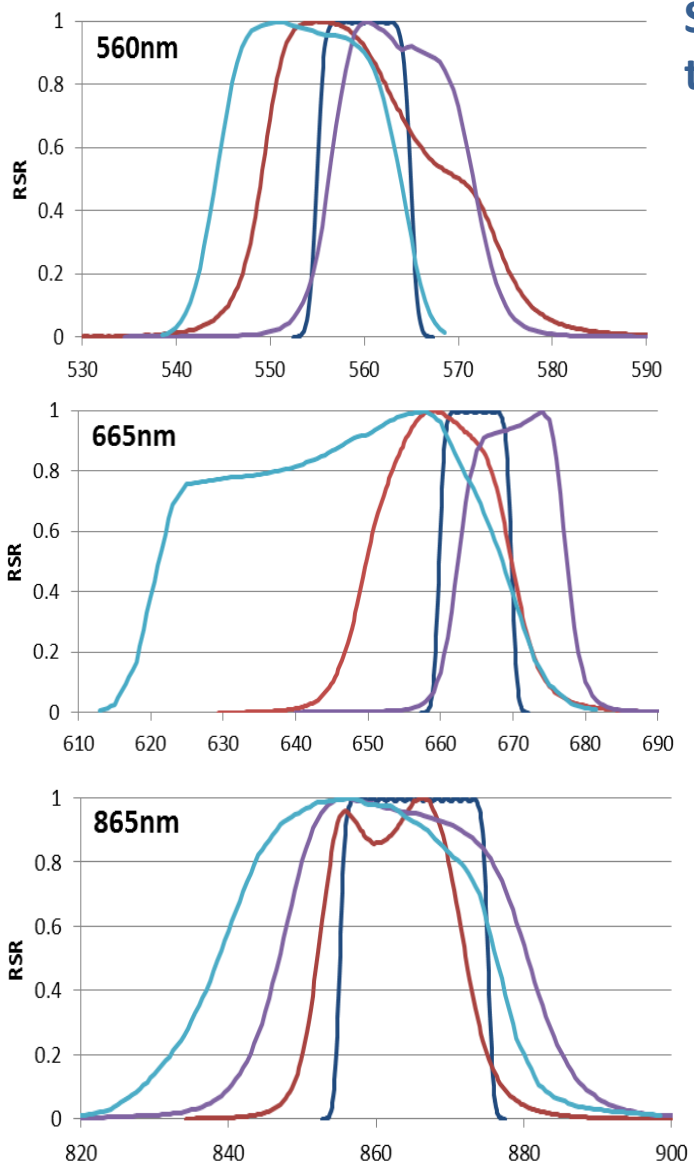






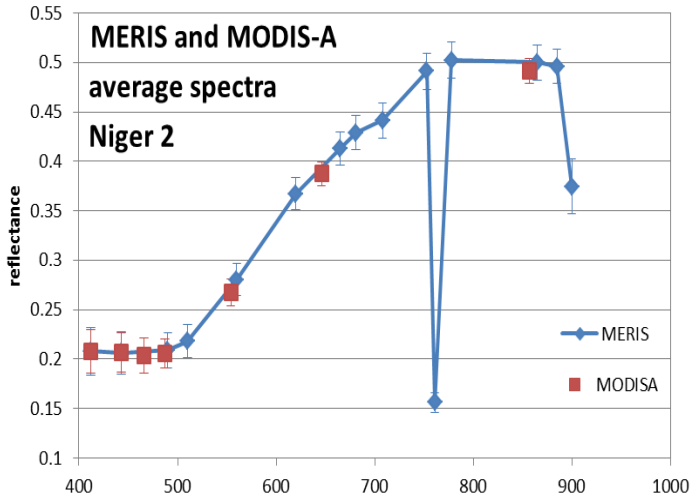
- some Type B (=systematic) uncertainties identified
- a correction is added to the results from DIMITRI and RAL

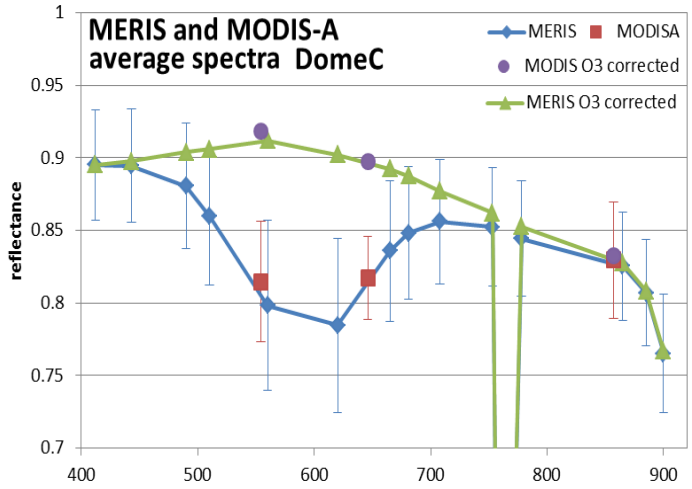
Differences in spectral response between sensors



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

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





The conclusion

- The use of different scene types with different spectral characteristics (ice, snow) is beneficial to test assumptions embedded in vicarious calibration and radiometric intercomparison methodologies.

- No significant differences between results over Niger-2 and Libya-4 were found although the dunes structure at Libya-4 are larger than at Niger-2 thus possibly leading to violations of symmetry wrt to principal plane of BRDF

- When the differences between a given sensors spectral response and the corresponding MERIS band spectral response have a marginal impact, all methodologies give consistent results to within ~2-3 %.

What else could be done with the reference dataset?

- Because of limited time and resources, the work presented in this document was intentionally restricted.
- From the produced reference dataset one could extend the analysis to:
    - The sensor blue bands
    - The sensor SWIR bands
    - The large spectral bands of VEGETATION
    - Bands that are too far apart from each other to be directly compared without any spectral correction → quite frequent situation
    - The reference dataset could also be used to investigate, for each methodology, what is the shortest time series of data from two sensors required to reach the conclusions elaborated over the full 4-year time series. → relevant feedback on the most appropriate methodologies for the commissioning phase of future instruments.
- Of course, new methodologies can be tested using this reference dataset and in combination with the present report they can be compared to those here presented.

Lessons learnt

1. Generating a reference dataset to intercompare methodologies is key to the success of such type of intercomparison
2. The verification of the reference dataset must be carefully carried out to ensure it doesn’t impact the intercomparison
    a. we used the comparison of DIMITRI and SADE extractions as a verification tool
    b. the extraction step (geographic and radiometric selections, cloud screening) is a crucial part of the calibration performance
3. A clear definition of the protocol of the intercomparison and its outputs must be defined prior to the intercomparisons
4. Participating to such intercomparisons leads to the identification of possible improvements of the respective methodologies

The reference dataset availability

- The generated reference dataset + report are publically available on the CAL/VAL portal: http://calvalportal.ceos.org/cvp/web/guest/ivos/wg4

- Should you extract L1 data from other sensors over the same sites than those present in the reference dataset, please make them available in the reference dataset format together with the results (=data+report) of your analysis to marc.bouvet@esa.int for further inclusion on the CAL/VAL portal.

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CEOS / IVOS Working Group 4 (use of pseudo-invariant sites)
CEOS IVOS Working Group 4: Intercomparison of vicarious calibration methodologies and radiometric comparison methodologies over pseudo-invariant calibration sites
The objective of the CEOS/IVOS WG4 was to compare the results of several methodologies making use of pseudo-invariant sites for vicarious calibration or for radiometric intercomparisons. The work of the WG4 is summarized in the hereafter report. The sensors considered in this work are spaceborne medium spatial resolution sensors with multi-spectral capabilities operating in the visible to thermal infrared. This intercomparison was carried out using a reference dataset which is also available from this page and is described in the same report.
DOWNLOAD:
CEOS IVOS WG4 - Intercomparison on Vicarious Calibration Methodologies - Final Report
Methodology Intercomparisons: Objectives and approach
The intercomparisons study of CEOS/IVOS WG4 focused on four methodologies making use of pseudo-invariant sites for vicarious calibration or for radiometric intercomparisons. The sensors considered in this work were medium spatial resolution sensors with multi-spectral capabilities operating in the visible to thermal infrared.
A report on the methodology intercomparisons will be made available soon .
Time series of cloud screened TOA reflectance averaged over pre-defined regions of interest were generated for tree sites:
i. Libya-4,
ii. Niger-2
iii. Dome-C,
The sensors for which data were extracted are:
i. AATSR,
ii. MERIS,
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