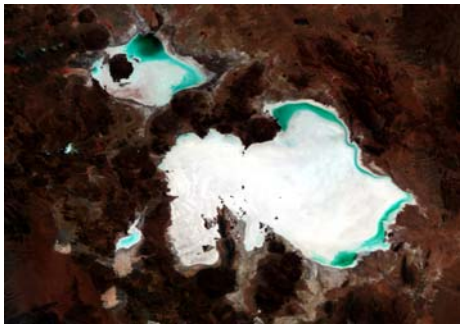
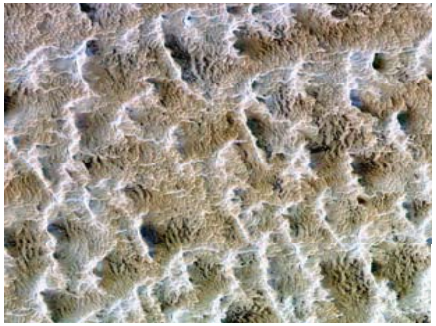
Database for Imaging Multi-spectral Instruments and Tools for Radiometric Intercomparison


Marc Bouvet

22/03/2010

What are the objectives of DIMITRI?

Today:

- Verify the radiometric stability of MERIS and AATSR (as done by RAL and CNES)
- Prototype radiometric corrections (e.g.: MERIS equalisation)

In the coming years:

- Support commissioning phases (e.g.: ALOS in 2006) of future ESA optical sensors (e.g.: Sentinel-2, Sentinel-3, Proba-V)

DIMITRI is NOT an operational system

What is DIMITRI? : a database

A database of remote sensing data hosted at ESA/ESTEC:

- Sensors: AATSR, A-MODIS, MERIS and POLDER-3
- 3 sites : Libyan desert (Libya), Salar Uyuni (Bolivia) and Dome-C (Antarctica)
- Temporal coverage: 2002 to 2010

What is DIMITRI? : tools

Two methodologies for radiometric intercomparisons:

- Methodology 1: Temporal and angular matching of observations between 2 sensors
- Methodology 2: TOA BRDF reconstruction using ‘super sensor’ observations
  - Using a), recalibration of a sensor i, j, k to sensor ref to create super sensor time series over a given site.
  - 5-day TOA BRDF model fitting using super sensor observations.
  - TOA signal prediction for any geometry and any band (after spectral interpolation)

A methodology for radiometric equalisation of MERIS over Dome C

Methodology 1: temporal and angular matching

Objective: Sensor to sensor radiometric comparison

Methodology:

- Cloud screening
- Averaging of a spatially homogeneous region of interest
- Direct comparison of TOA reflectances: nearly simultaneous observations (+/-1 day) in nearly identical geometries (+/- ~5 degree VZA, SZA and +/- 10 degrees RAA) in spectral bands with similar RSR

Assumption: symmetry of TOA BRDF across the principal plane and principle of reciprocity

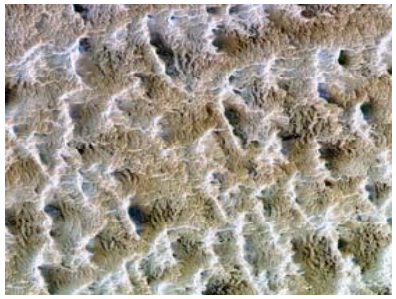
Methodology 1: temporal and angular matching

Examples of approaches sharing similarities with methodology 1

	Temporal matching	Geometrical matching	Atmospheric correction / TOA signal simulation	Remark
Bouvet et al. (2006)	Near simultaneous (+/- 1 day)	Nearly identical geometries (~few degrees)	NO	
Cabot et al. (1999)	Non simultaneous	Nearly identical geometries (~few degrees)	YES	Pseudo invariant sites
Cao et al. (2004)	Simultaneous (+/- ~seconds)	Identical geometries	NO	Restricted to nadir observations and polar sites
Smith et al. (2008)	No matching	Normalised geometry with BRDF=f(scatt. angle)	NO	Long term drift monitoring No direct sensor-to-sensor comparison

•Bouvet M. 2006. Intercomparison of imaging spectrometers over the Salar de Uyuni (Bolivia), *Proceedings of the MERIS AATSR Validation Team workshop 2006*
•Cabot F., O. Hagolle, C. Ruffel, and P. Henry . 1999. Remote sensing data repository for in-flight calibration of optical sensors over terrestrial targets, in *Earth Observing Systems IV, Proc. SPIE 3750*, pp. 514–523
•Cao, C., M. Weinreb, and H. Xu. 2004. Predicting Simultaneous Nadir Overpasses among Polar-orbiting Meteorological Satellites for the Intersatellite Calibration of Radiometers, *Journal of Atmospheric and Oceanic Technology*, Vol. 21, pp. 537-542
•Smith D., Poulsen C., Latter, B. 2008. Calibration Status of AATSR and MERIS Reflectance Channels, *proceedings of the MERIS AATSR Validation Team Workshop 2008*

Methodology 1: Libyan desert



Sensor: AATSR, A-MODIS, MERIS, POLDER-3

Bands: 490, 560, 670 and 865 nm

Methodology systematic uncertainty: < 3 %

Methodology random uncertainty: ~3 % (3-sigma)

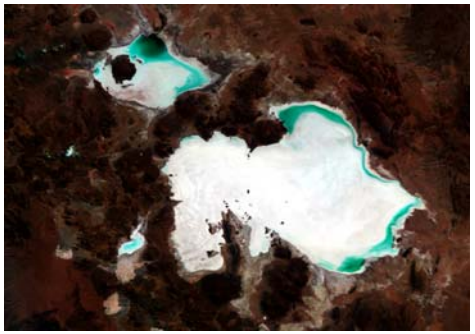
Temporal coverage: 2006

Conclusion: MERIS and AATSR in line within the methodology uncertainty. POLDER-3 and AATSR calibration has been updated since last publish results

Reference:

Bouvet M.(2007), Intercomparison of multispectral imagers over natural targets, Geoscience and Remote Sensing Symposium, 2007. IGARSS 2007. IEEE International, p. 2653 - 2664

Methodology 1: Salar de Uyuni



Sensor: AATSR, A-MODIS, MERIS, POLDER-3

Bands: 490, 560, 670 and 865 nm

Methodology systematic uncertainty: < 3 %

Methodology random uncertainty: ~3 % (3-sigma)

Temporal coverage: 2002 – 2009

Conclusion: all sensors in line within methodology uncertainties

Reference:

Bouvet M. (2006), INTERCOMPARISON OF IMAGING SPECTROMETERS OVER THE SALAR DE UYUNI (BOLIVIA), MERIS/AATSR workshop proceedings

Methodology 1: Dome C

Sensor: AATSR, A-MODIS, MERIS

Bands: 560, 670 and 865 nm

Methodology systematic uncertainty: < 3 %

Methodology random uncertainty: ~3 % (3-sigma)

Temporal coverage: 2002 – 2009

Conclusion: all sensors in line within methodology uncertainties besides AATSR vs. MERIS and AATSR vs. MODIS at 865 nm (+4 % difference)

Reference:

Bouvet M., Ramoino F., Radiometric Intercomparison of AATSR, MERIS and Aqua MODIS over Dome Concordia (Antarctica), Canadian Journal of Remote Sensing (accepted)

Methodology 2: TOA BRDF reconstruction using ‘super sensor’ measurements

Objective: Predict TOA signal for a given sensor from ‘super sensor’ observations

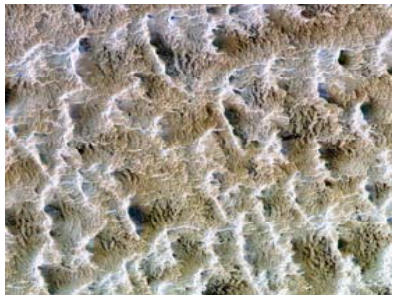
Methodology: TOA BRDF reconstruction using ‘super sensor’ observations

a. Using methodology 1, we recalibrate sensors i, j, k to a reference sensor to create super sensor time series of measurements over a given site.
b. A 5-day TOA spectral BRDF model (Roujean et al.) is fitted using the super sensor observations
c. The TOA signal can be predicted for any time, any geometry and any band (after spectral interpolation)

Assumptions: 5-day invariance of TOA BRDF

Application to AVNIR-2, using AATSR, MERIS, A-MODIS and POLDER-3 data over the Libyan desert rescaled to MERIS radiometric scale

Methodology 2: TOA signal simulation



Sensor: AVNIR-2 (vs. using AATSR, A-MODIS and POLDER-3 recalibrated on MERIS)

Bands: 460 , 560, 650 and 830 nm

Methodology systematic uncertainty: < 5 %

Methodology random uncertainty: ~5% ?

Temporal coverage: 2006

Conclusion: AVNIR-2 calibration appeared in line with the MERIS calibration to within the methodology uncertainty (~ 5% wrt MERIS radiometric scale). In line with JAXA's results.

Reference:

Bouvet M., Goryl P., Chander G., Santer R., Saunier S. (2007): Preliminary radiometric calibration assessment of ALOS AVNIR-2, Geoscience and Remote Sensing Symposium, 2007. IGARSS 2007. IEEE International, p. 2673 - 2676

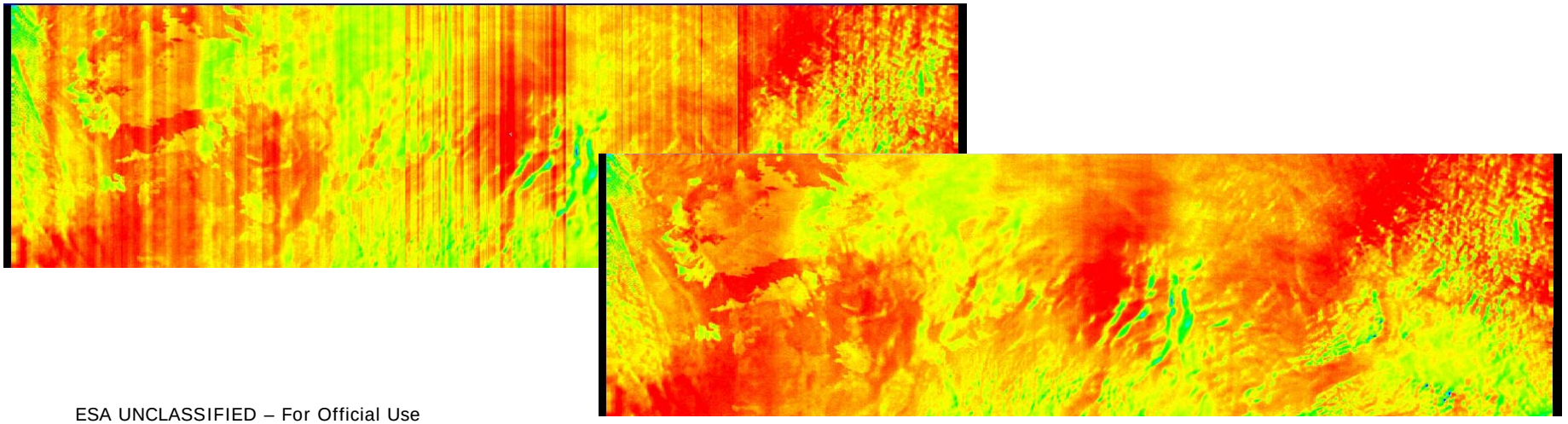
MERIS equalisation at Dome C

Objective: Radiometric equalisation of MERIS

Methodology: Fitting of a radiometric temporal model for each detector (3700 per camera) for each camera (5) to Dome C observations

Application: MERIS

Reference: *Bouvet M., Ramoino F. (2010): Equalization of MERIS L1b products from the 2nd reprocessing, ESA TN TEC-EEP/2009.521/MB (available on demand)*

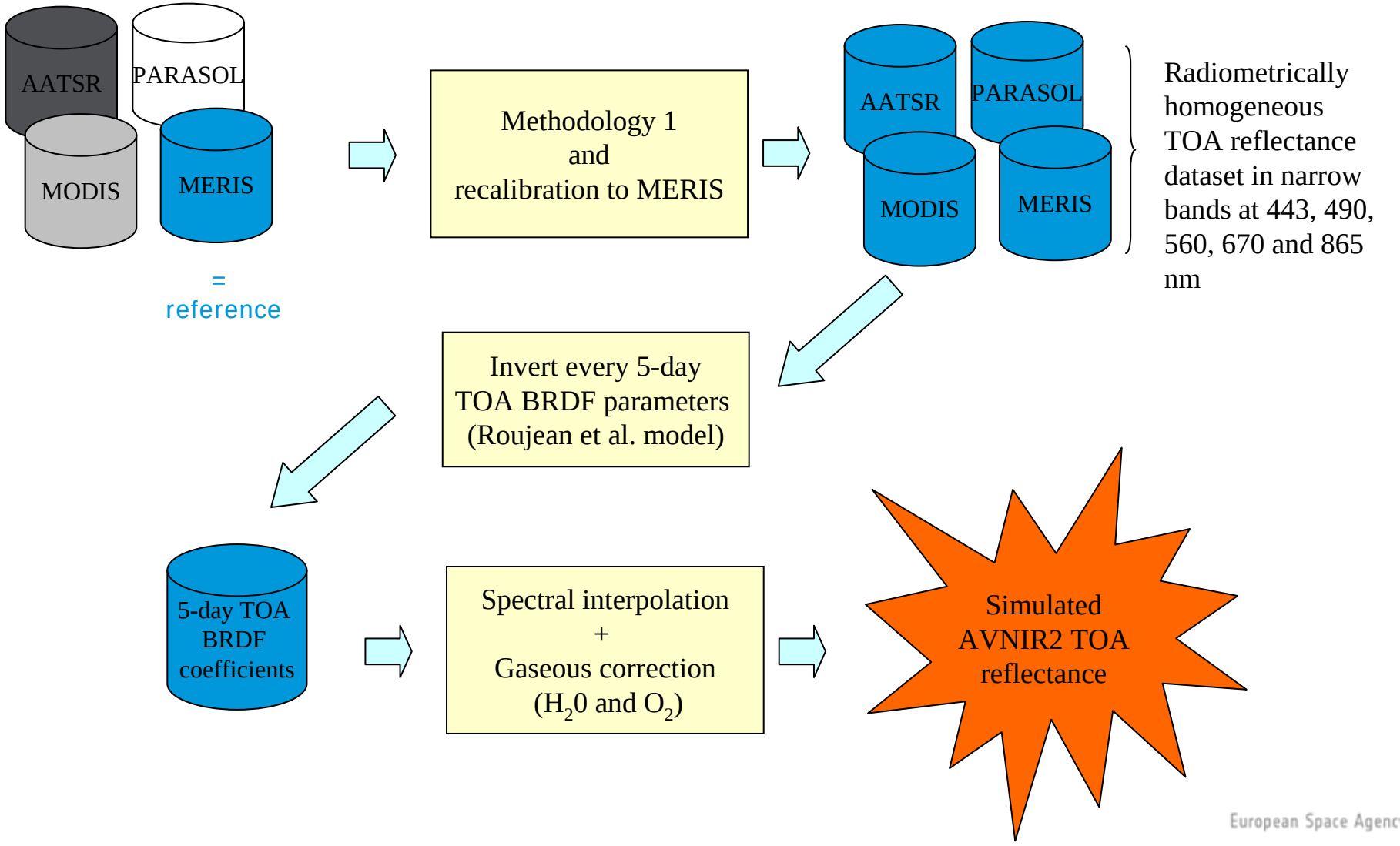


Ongoing developments of DIMITRI

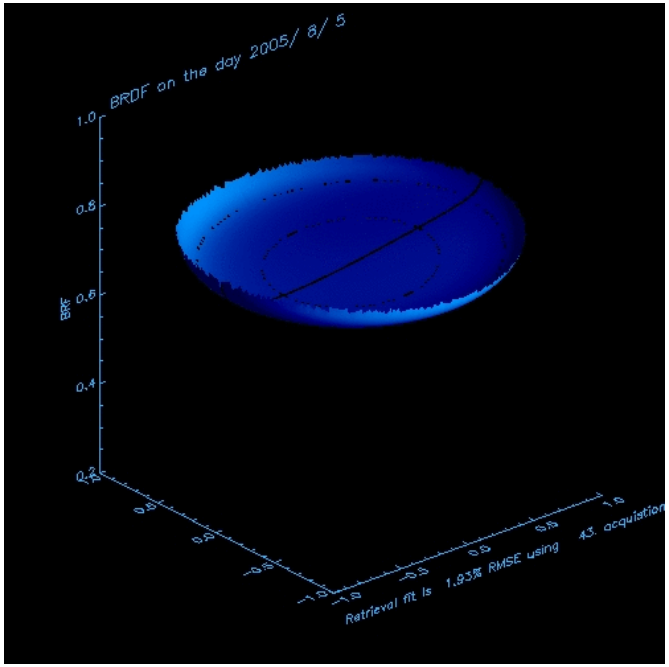
- **KO:** Sept. 2010
- **Sensors:** AATSR, ATSR-2, MERIS, A-MODIS, POLDER-3, VEGETATION
- **Additional sites:** Amazonia, BOUSSOLE, Dome C, Libyan desert, South Indian Ocean, South Pacific Ocean, Tuz Golu, Uyuni
- **Temporal coverage:** 2002 - 2011
- **Software improvement:** readability, robustness, GUI
- **Output:** documented intercomparisons for all sensors and all sites
- **First delivery (partial database):** summer 2011

Thank you

Methodology 2: application to AVNIR-2 support to commissioning phase



Methodology 2: application to AVNIR-2 support to commissioning phase



BRF derived from recalibrated A-MODIS, AATSR, POLDER-3 and MERIS over Libyan desert at 443 nm for sun at nadir