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CNES WGCV-36 Report
Cal/Val Activities

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Summary

- **Pleiades calibration**
  - Pleiades Calibration Overview
  - Zoom on Lunar Calibration

- **IASI-B calibration**

- **Libya-4 workshop**

- **Other calibration activities**
  - Cross-calibration over Desert
  - Calibration over Rayleigh Scattering
  - Cross-Calibration LEO/GEO (SEVIRI)
  - PARASOL ‘recalibration’
Summary

PLEIADES Calibration
PLEIADES: Main Mission Features

- **Image characteristics**
  - 0.7 m panchromatic resolution at nadir
  - 4 XS bands (blue, green, red, NIR) at 2.8 m nadir resolution
  - 20 km swath at nadir
  - Data coded on 12 bits

- **Revisit Capability**
  - Daily accessibility with 2 satellites

- **Improved access image delay**
  - Better than 24 hours between image request and image delivery in nominal mode

- **Large coverage capability**
  - In average 140,000 km² (350 images) per satellite and per day

- **2 satellites on the same orbit (180° dephased)**
  - Pleiades 1A launch: 17/12/2011
  - Pleiades 1B launch: 02/12/2012

- **Dual system**
  - Defence use: light but high priority...
  - Commercial use with 40% for Public Service
The PLEIADES system

System with a very high level of agility!

Jupiter and its moon

Saturne
The PLEIADES Calibration

Goal: radiometric absolute calibration better than 5%

Methods:

- African Desert sites
- La Crau
- Ocean
- Antarctica
- Moon
• Good stability of the Pleiades-1A instrument since the launch
• Consistency of 3 methods for the temporal sensor evolution
LUNAR CALIBRATION
A new method for the PLEIADES radiometric absolute calibration
Moon (spatial resolution: 380m)
Moon (extract)
The Moon seen by PLEIADES

→ **140 images** acquired by PLEIADES1A since its launch (12/2011)

→ **390 images** acquired by PLEIADES1B since its launch (12/2012)
Dense lunar cycle acquired in April with PLEIADES 1B (one image every 1h40)

Calibration results obtained for the blue band → important dependency of the method to the phase!
IASI-B Calibration
IASI = « Interféromètre Atmosphérique de Sondage Infrarouge »
but also = « Infrared Atmospheric Sounding Interferometer »

- IASI is a Michelson Interferometer measuring the spectral distribution of the atmospheric radiation and operating in the 3.7-15.5 µm spectral range
- It is a key payload element of the METOP series of European meteorological polar-orbit satellites intensively used in meteo forecasting models
- IASI is a CNES delivery to EUMETSAT and CNES is in charge of:
  - IASI development
  - IASI in orbit calibration and performances monitoring
  - Level 1 processing chain (implemented in the Eumetsat premises)
IASI-B Performances

After 8 months in orbit

- Instrument & interferogram acquisition are very stable and work perfectly
- Space & ground segments are working well with consolidated parameters
- Performances are quite comparable to those of IASI-A
- IASI-B data have been distributed to all users for mid-March 2013
- IASI-B is now the nominal instrument for Eumetsat but IASI-A data are still distributed and assimilated in operational meteo models
IASI-B Commissioning Phase - Key dates

- IASI first interferograms (start of L1 CalVal): 23rd Oct 2012
- IASI first L0 spectra (computed on-board): 24th Oct 2012
- IASI first L1 spectra (calibrated on ground): 25th Oct 2012
- Last configuration update before IASI-B L1C trial dissemination:
  ✦ On-board: 10th Jan 2013
  ✦ Ground: 14th Jan 2013
- IASI-B L1C trial dissemination (CalVal partners) in Near Real Time: 22th Jan 2013
- IASI-B L1C trial dissemination (member states) in Near Real Time: 5th Feb 2013
An inter-comparison operational tool has been developed for 5 couples of sensors:

- IASI-A / IASI-B
- IASI-A / AIRS, IASI-A / CRIS
- IASI-B / AIRS, IASI-B / CRIS

Major result: very accurate cross-calibration!

- Bias between 0K and 0.2K, < radiometric absolute specification of 0.5K
- IASI-B very close to IASI-A (bias ~0.1K) ➔ continuity of the IASI mission

Work on-going:

- Increase the size and relevance of the dataset
- Go further in the interpretation of small differences
- Perform IASI / AIRS and IASI / CRIS at high spectral resolution
- Perform a spectral inter-calibration?

The tool should be operational for a long time (decades for climatic studies)

➔ Inclusion of future sensors (IASI-C, IASI-NG, etc.)
Libya-4 Workshop
CEOS-IVOS Libya-4 Workshop

- CEOS/IVOS Workshop organized by CNES
  - 2 day meeting: 4-5 October 2012 – Paris
  - 25 participants
- Focus technical exchange and experiences on one calibration site
  - one of the most widely used – not the best
  - geographical definition differs in general
- Participants mainly European, but also US (space agencies, labs, industries)
- Site characterization
  - Spectral behavior: to be improved using Hyperspectral / spectral lab + Model
  - BRDF: to be improved – CNES provide their current model for evaluation (Dec. 2012)
  - Atmosphere: statistical approach
  - Improve surface of TOA characterization?
- Intercalibration results if spectrally close channels:
  - cross-calibration within 2-3%
  - multi-date better than 2% for long-term trend
  - absolute calibration: 5% (?)
  - difficulty in the blue
- Paving the way for international collaboration and exchange
Other Calibration Activities
Desert sites – What’s new in CNES?

- **ATBD – The IEEE TGARS Special Issue opportunity**
- **Bidirectional characterization of sites**
  - continuation of modeling using PARASOL data archive (bidirectional sensor)
  - automatic procedure have been operated to generate BRDF models
  - deep evaluation has to be done: made for Libya-4 (see WG)
  - currently not fully satisfying…
- **Prototyping of a new geometrical matching approach**
  - use of BRDF to enlarge the matching on a larger geometrical window
  - Interest = largely increase the number of matchup when necessary
  - to be fully validated and pushed on the operational phase
- **Update of the MERIS archive – now Version 3**
  - confirmation of the consistency with MODIS-Aqua within 1-2%
- **Construction and analysis of a SeaWiFS archive**
  - behavior to be explained
- **Cross-calibration LEO/GEO through SEVIRI data**
  - prototype phase – preliminary results under analysis
  - very preliminary results shown at webmeeting Dec’12
  - Cross-calibration with MODIS not yet available, but very soon….
SEVIRI Time Series over Desert Sites

Time series 1/1/2009 to 1/8/2010 over 20 desert sites

- under sampling: 1 day every 10 days (N=19465)
- VZA < 30° and SZA < 55° (N=7058)
To be extended over the full archive
SEVIRI vs MERIS Intercalibration over Desert Sites

Preliminary results: MERIS as reference

Ak /Aksol = 0.935100  Nbre de points = 98
Ecart_type = 0.0163601

VIS06 – Algeria3


VIS08 – Algeria3

Ak /Aksol = 0.945334  Nbre de points = 98
Ecart_type = 0.0221450

VIS06 – Libya4

09/03/2008 09/03/2009 17/06/2009 25/05/2009 03/01/2010 13/04/2010 22/07/2010 30/10/2010

VIS08 – Libya4

Ak /Aksol = 0.929235  Nbre de points = 281
Ecart_type = 0.0154734

VIS06 – Libya4

Ak /Aksol = 0.934024  Nbre de points = 281
Ecart_type = 0.0232477
Rayleigh Scattering Calibration – What’s new in CNES?

- Historically developed for POLDER and VGT sensors
  - definition, prototyping and improvements between 1998-2003
  - now stabilized on the reference Version 3.5

- Implementation of Version 3.5 for several sensors
  - ocean color sensor considered as radiometric reference
    - SeaWiFS (complete life time)
    - MERIS (operational, reprocessed for data V3) also to prepare OLCI (Sentinel-3)
    - MODIS (soon coming)
  - high-resolution sensors (limited geographical coverage and matchups)
    - SPOT6
    - Pleiades 1A and 1B
  - geostationary sensor
    - SEVIRI
  - future sensors
    - Sentinel-2, Sentinel-3 (OLCI and SLSTR), VENUS, SPOT7…

- Error budget: continuity of efforts
  - Construction of the error tree
  - Construction of the error factors
The reference method is Rayleigh Calibration Version 3.5

- DEV = study & ATBD first definition [resp. SI/MO]
- PROTO = prototype on dedicated test environment on MUSCLE – Final ATBD [resp. SI/MO]
- Pre-OPE = test on the operational MUSCLE [resp. ME/EI]
- OPE = fully operational method / Traceability guaranteed [resp. ME/EI]
SEVIRI Calibration over Rayleigh Scattering

- Preliminary results
  - validation set – Band VIS06
    1/1/2009 to 1/8/2010
    N=2437
  - confirmation of the previous value
    $<\Delta K> \sim 0.92$
  - clear signature with scattering angle
    error in backscattering
    to be investigated
PARASOL end-of-life reCalibration

- **Multi-method Synergic Approach** to derive corrections of:
  1. Variation of calibration inside the field-of-view
  2. Temporal evolution of the mean calibration
  3. Absolute calibration for the entire archive

- Combination of operational calibration method:
PARASOL “in the Field of View” Calibration

- Calibration for the in field-of-view evolution
  - Clouds suppose the reference band is stable (765nm)
  - Desert (reference = POLDER1) suggest it is not the case
  - Rayleigh (absolute reference) confirm that for 75% of the coverage – sufficient to generalize
  - Confirmed also for most of other bands

Calibration result versus pixel on the CCD matrix

- Interband over DCC (ref=765)
- Intercalibration over desert (ref=POL1)
- Absolute calibration over Rayleigh

Band 490nm

The black hole from band 765nm

Black hole – confirmed by Rayleigh → Instrument-765
Bright banner – not confirmed → method artefact
PARASOL Temporal Monitoring of the Calibration

- Comparison of calibration methods for the temporal monitoring
  - 670nm band aging
  - Validated over Rayleigh, Sunglint, Domes, Desert
  - Not the same for 1020 nm band

Calibration versus month
As a conclusion?

- Several calibration methods are operational
  - Statistical approach over natural targets
  - Desert, Rayleigh, Sunglint, Cloud-DCC, Antarctica, Moon

- Each one has its own
  - behavior: magnitude, spectral, angular, polarized...
  - efficiency range

- Different aspects of calibration

- Indicative cartography – range of efficiency for each method

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A last word… SPOT4 Take 5

CNES took the opportunity of the end of SPOT4's life to set up an experiment aiming to simulate Sentinel-2 data time series (revisit every 5 days).

This experiment is named ‘Take 5’.

On January 29, the SPOT4 orbit has been lowered by 3 kilometers to put it on a 5 day repeat cycle orbit.

Until end of June, 42 sites are being observed (chosen after a Call for Proposal)

CNES provides users with orthorectified data

- Mainly French laboratories
- Cooperation with ESA, JRC, NASA, CCRS
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