CEOS WGCV Meeting 13-17th May 2013, Shangai, China

CNES WGCV-36 Report
Cal/Val Activities

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Summary

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- ***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'*

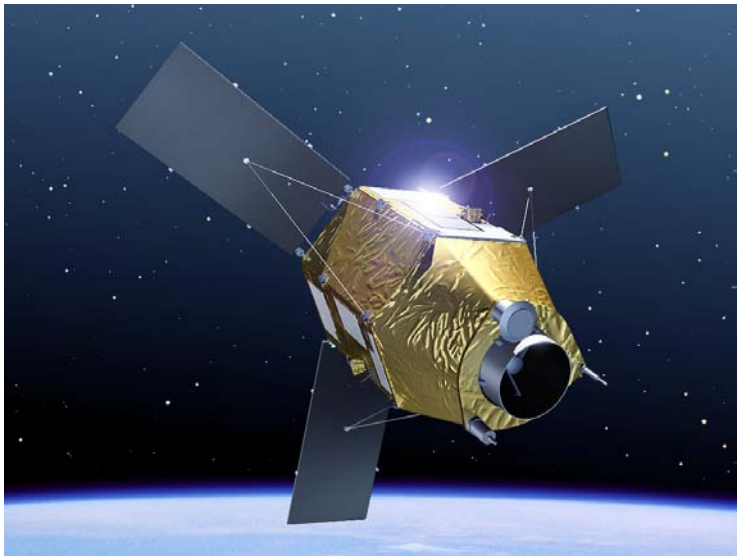
cnes

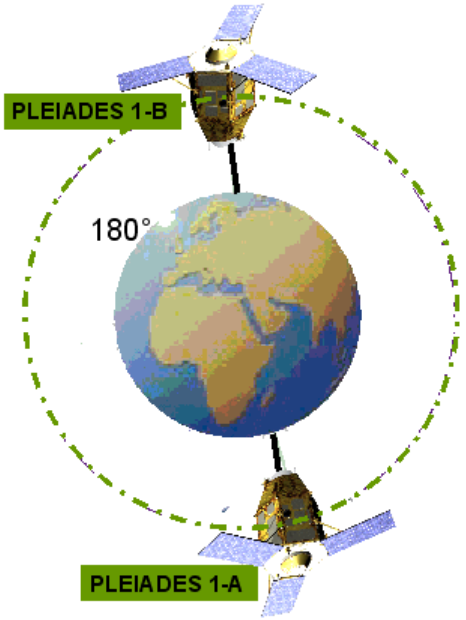
Summary

PLEIADES Calibration

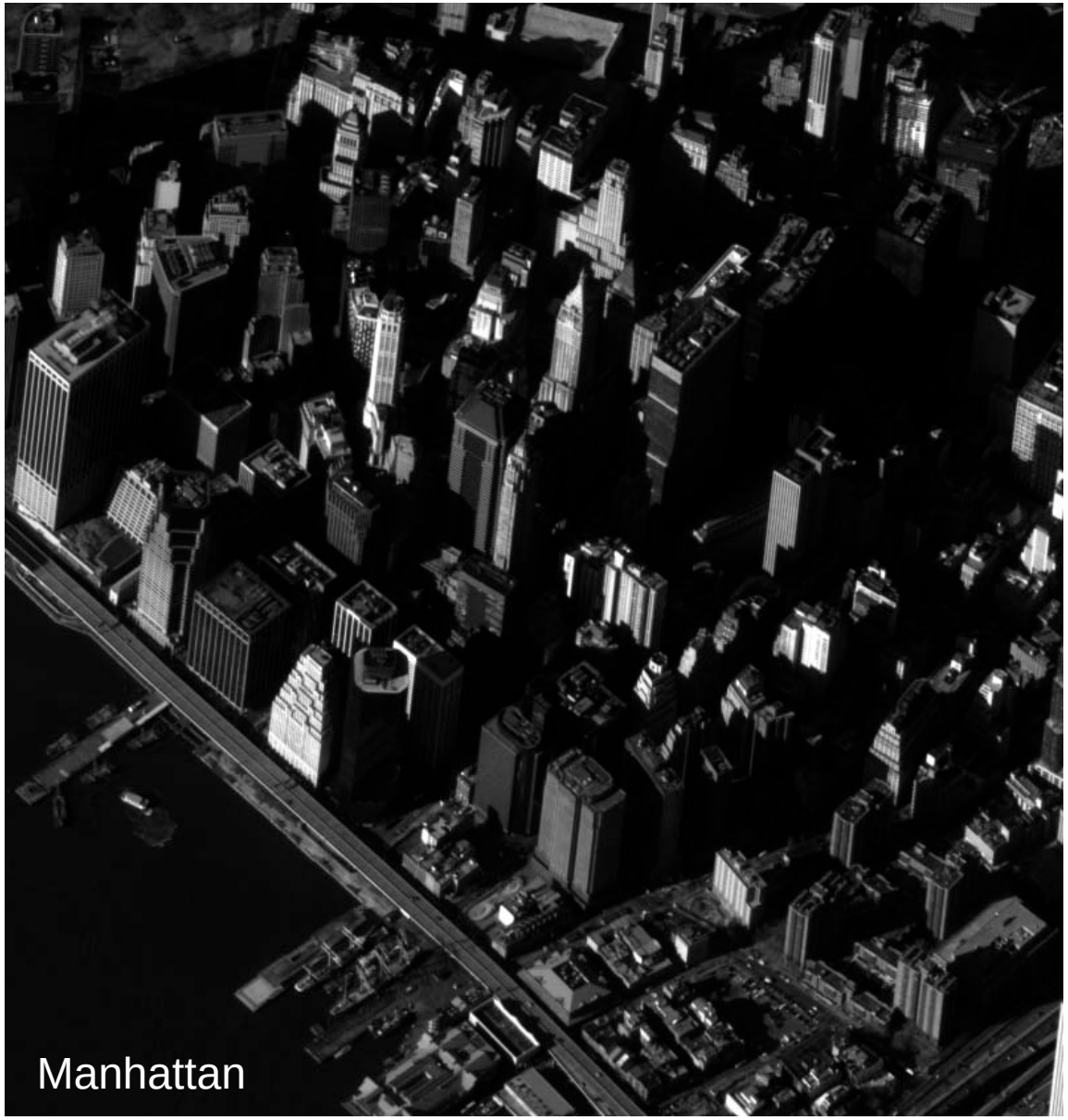
PLEIADES: Main Mission Features

- 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 km^2 (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

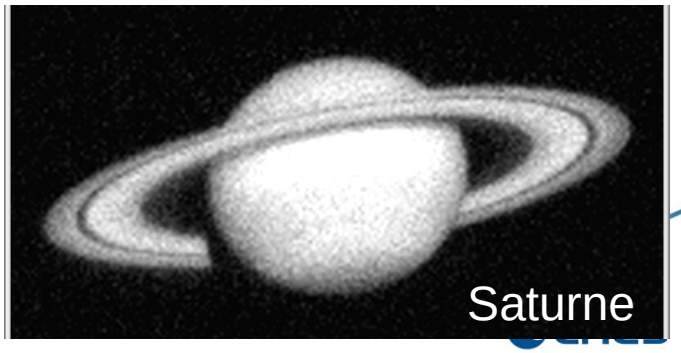




The PLEIADES system



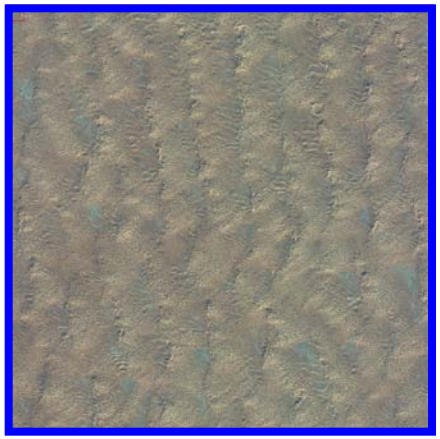
System with a very high level of agility !



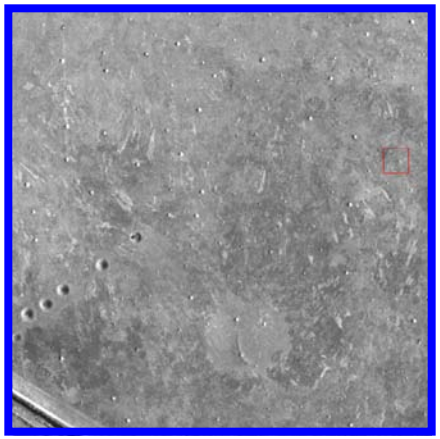
The PLEIADES Calibration

Goal: radiometric absolute calibration better than 5%

Methods:



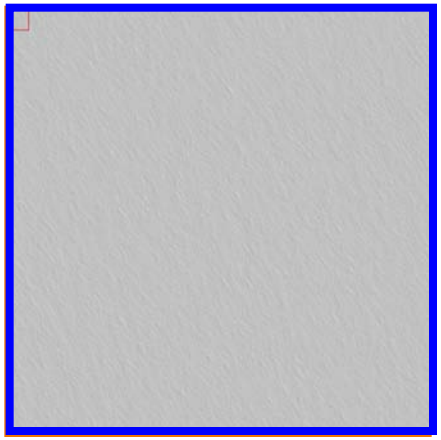
African Desert sites



La Crau

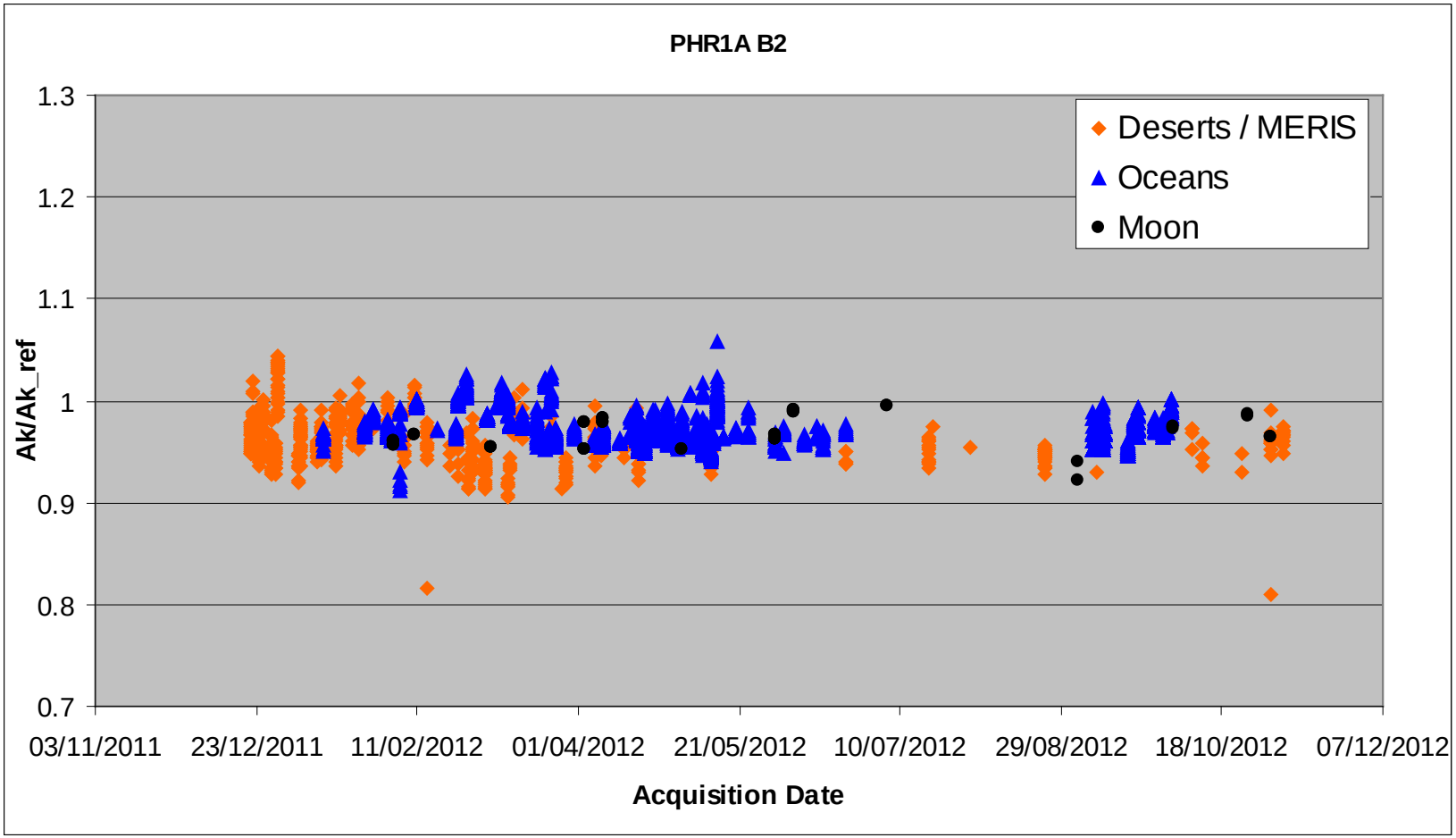
Moon

Ocean

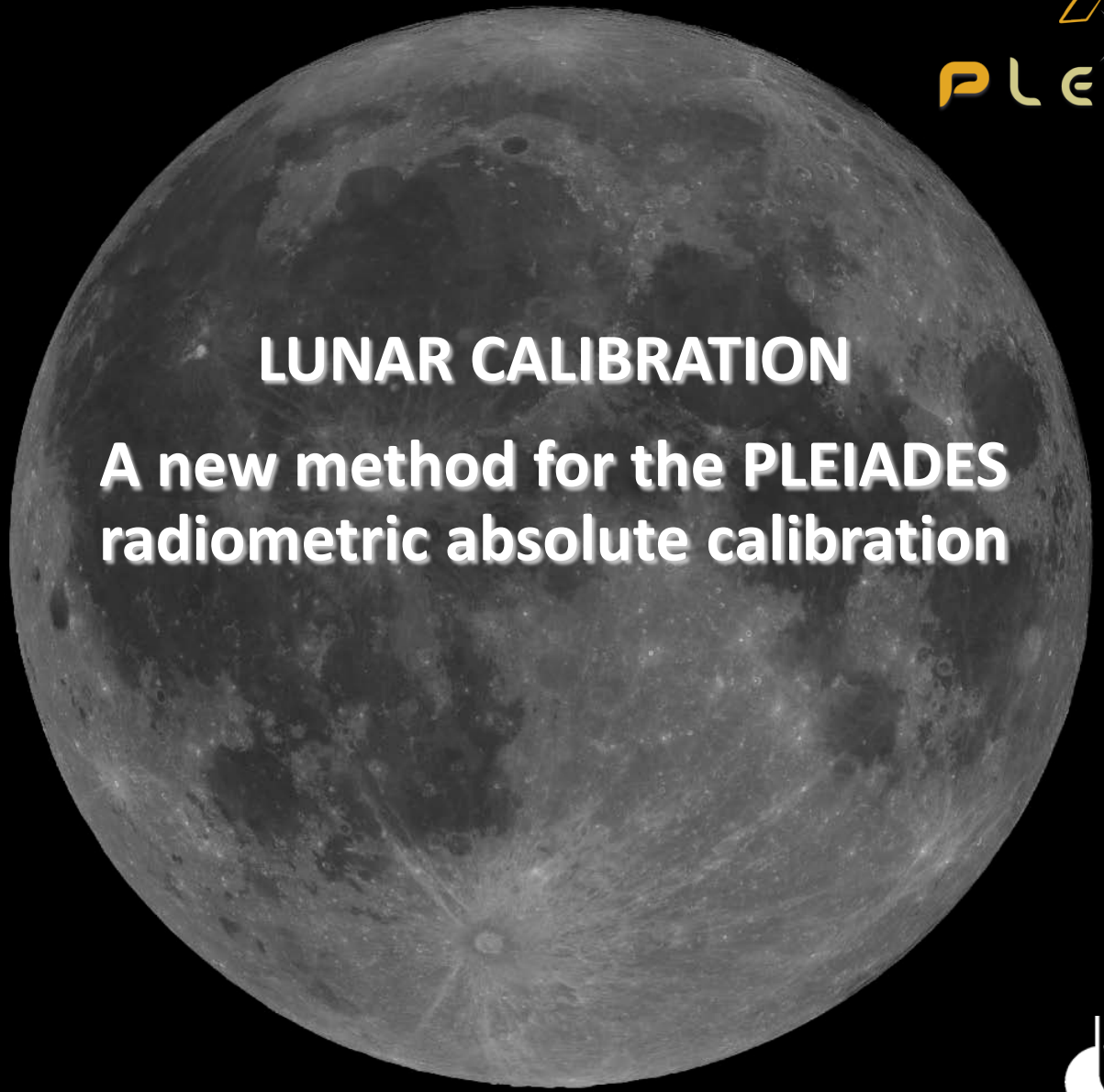


Antarctica

The PLEIADES Calibration



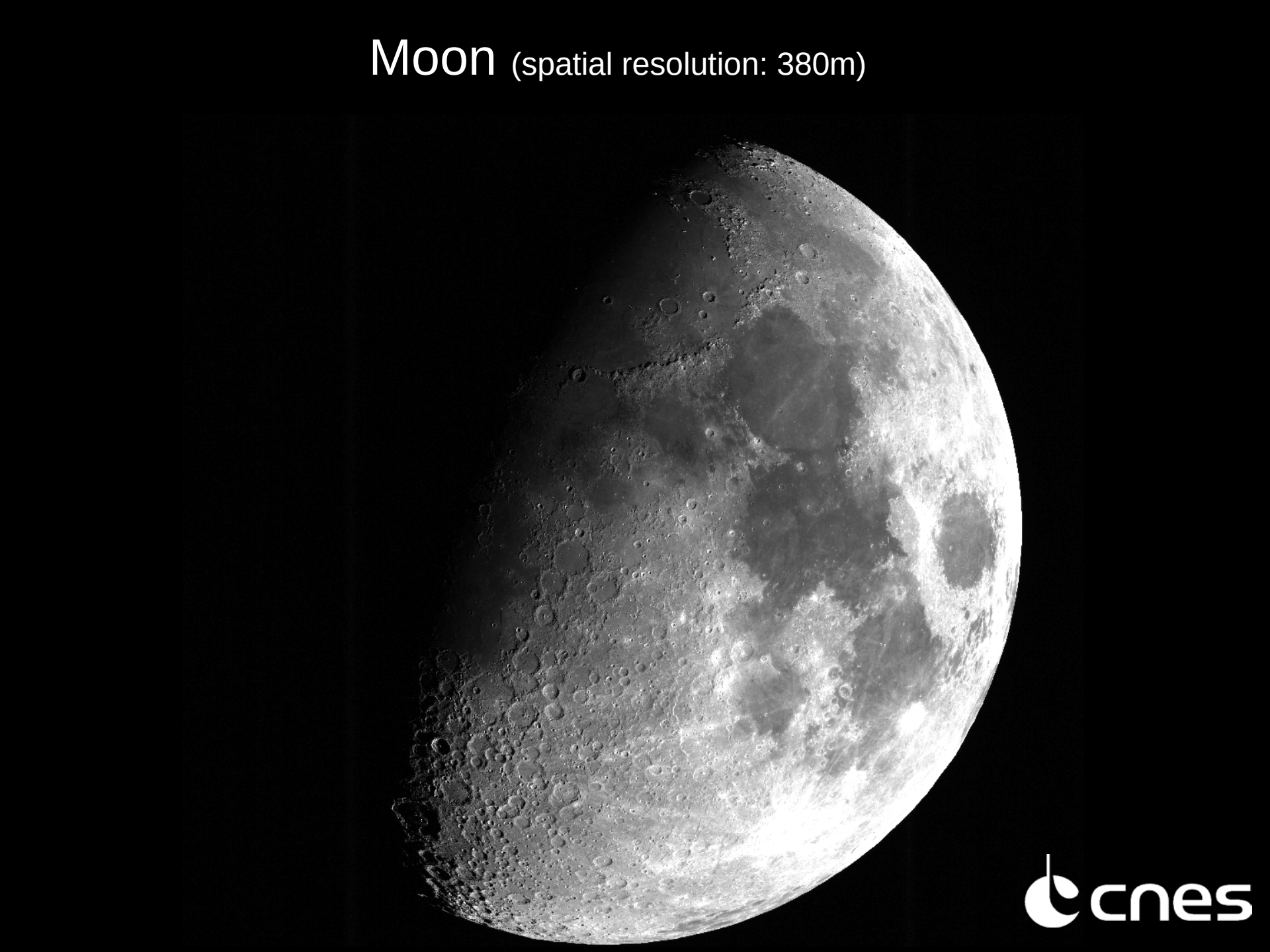
- **Good stability of the Pleiades-1A instrument since the launch**
- **Consistency of 3 methods for the temporal sensor evolution**



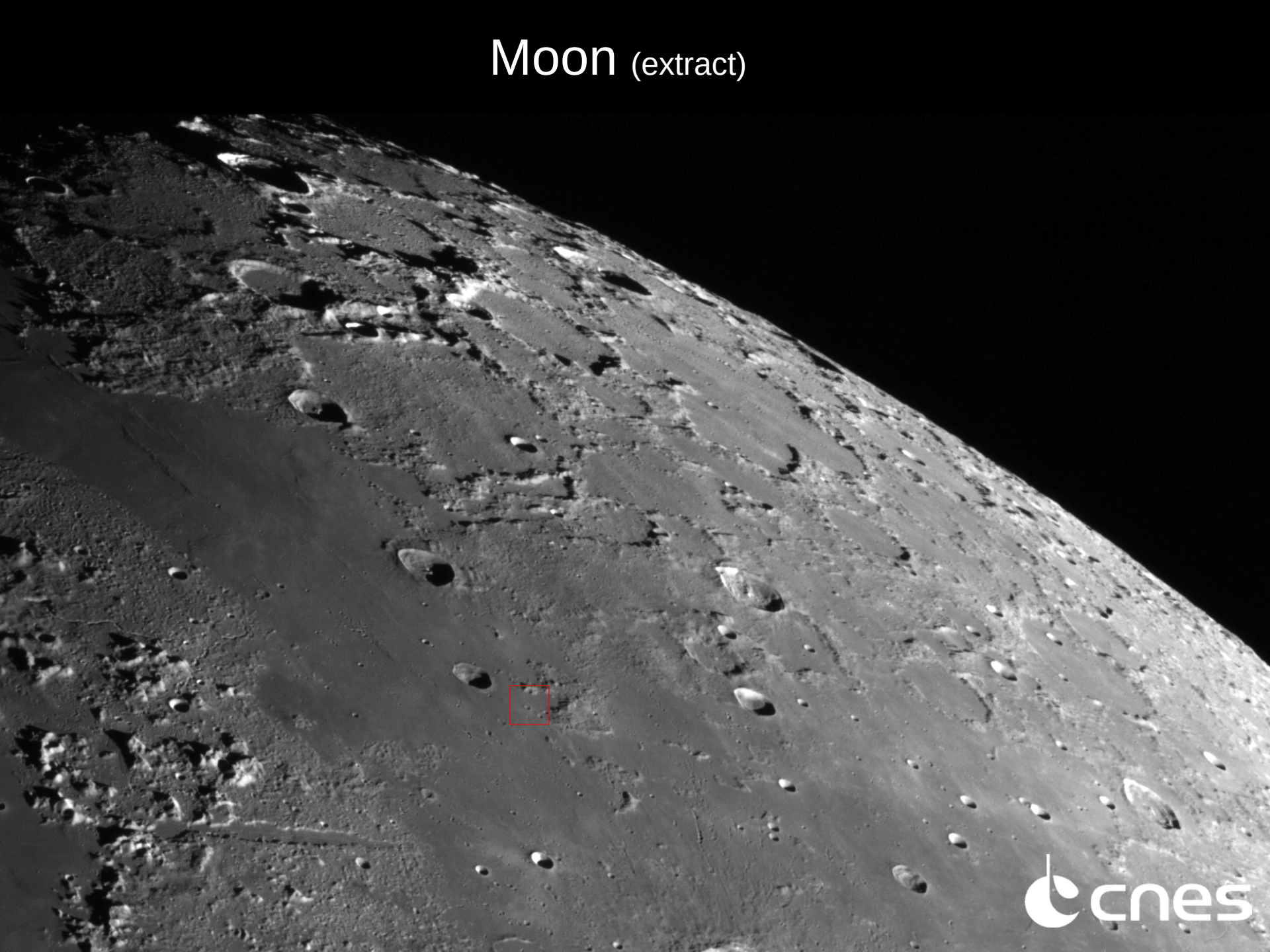
LUNAR CALIBRATION

A new method for the PLEIADES radiometric absolute calibration

Moon (spatial resolution: 380m)



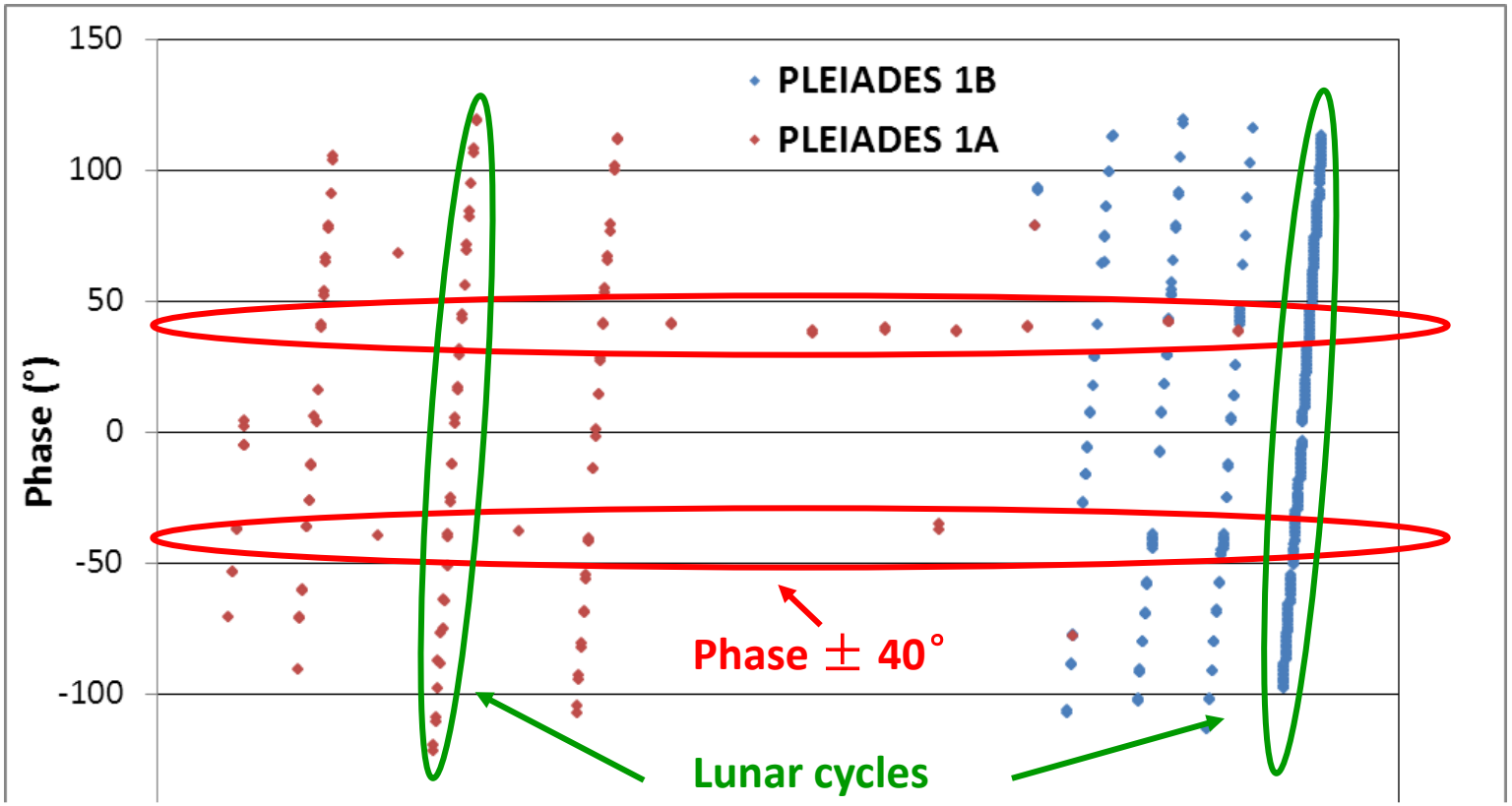
Moon (extract)



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)

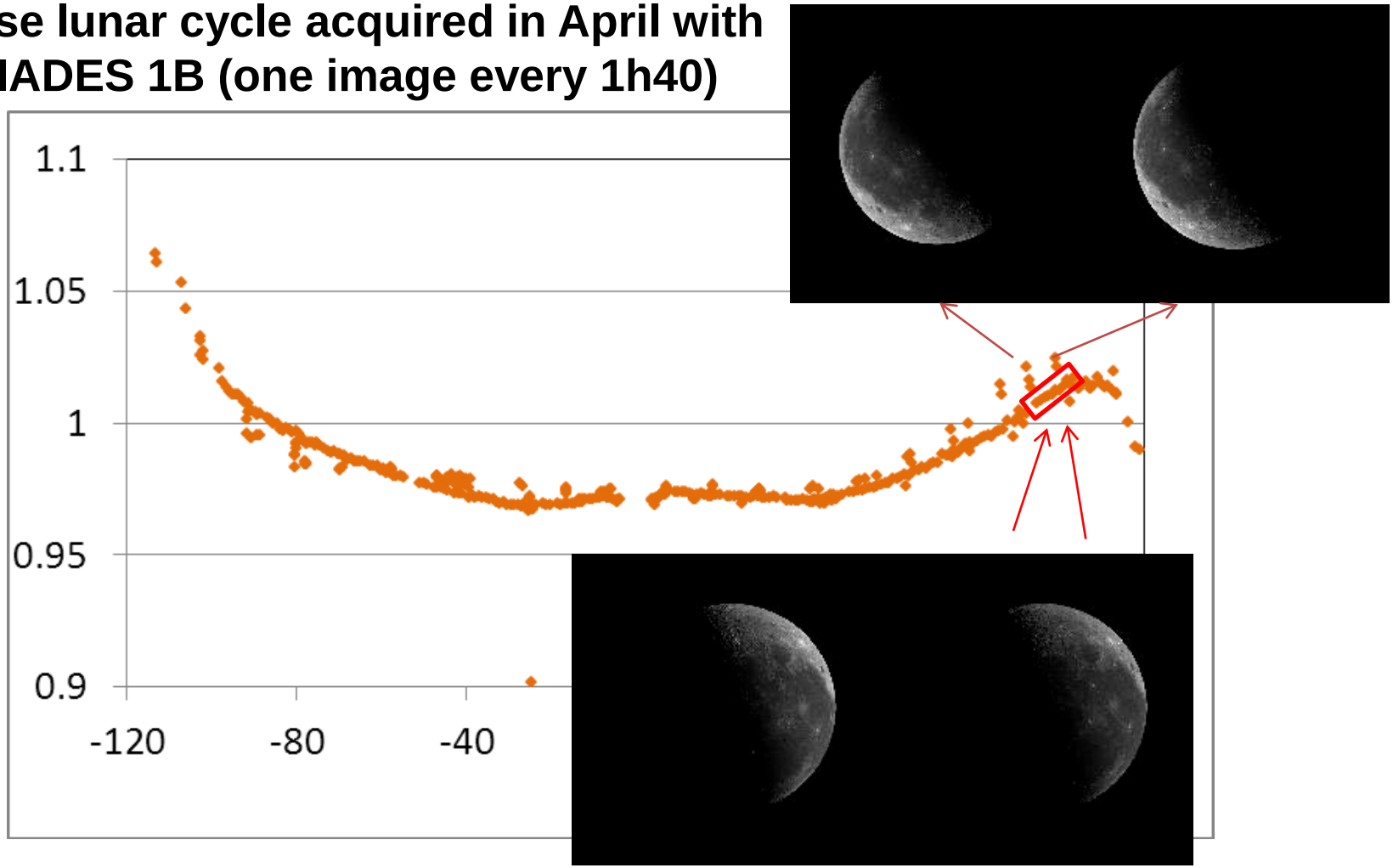


Two images per day

One moon every orbite
(1h40 between each image)

PLEIADES Lunar Calibration

Dense lunar cycle acquired in April with PLEIADES 1B (one image every 1h40)



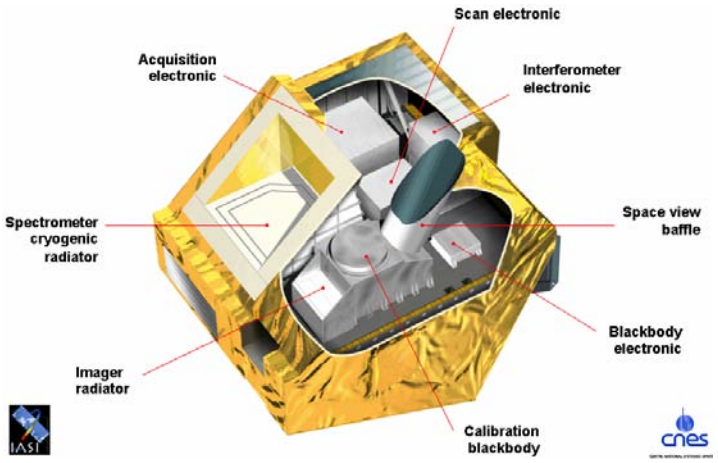
Calibration results obtained for the blue band
→ important dependency of the method to the phase !

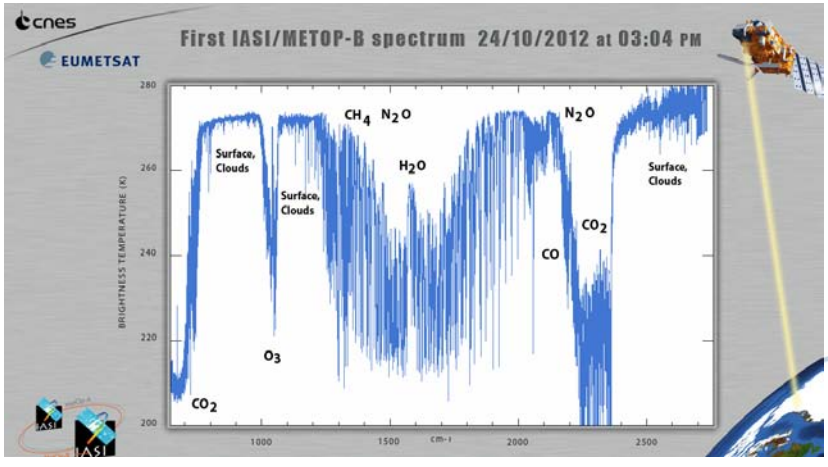
IASI-B Calibration

IASI-B Performances

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)
- 3 models: Metop-A Oct. 2006, Metop-B Sept. 2012, Metop-C end 2016?





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

- MetOp-B launch: 17th Sept 2012
- IASI first interferograms (start of L1 CalVal): 23th 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

Massive Cross-Calibration with IASI

- 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?

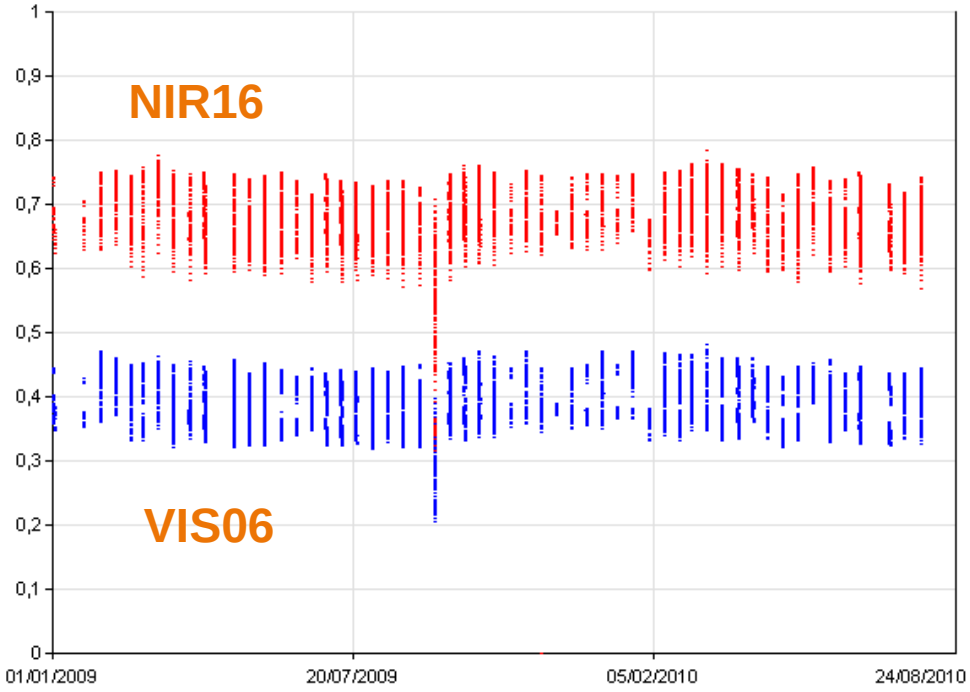
- ATBD – The IEEE TGARS Special Issue opportunity
- Bidirectional characterization of sites
  - continuation of modeling using PARASOL data archive (bidirectional sensor)
  - automatic procedure have been operated to generate BRDF models
  - deep evaluation has to be done : made for Libya-4 (see WG)
  - 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….

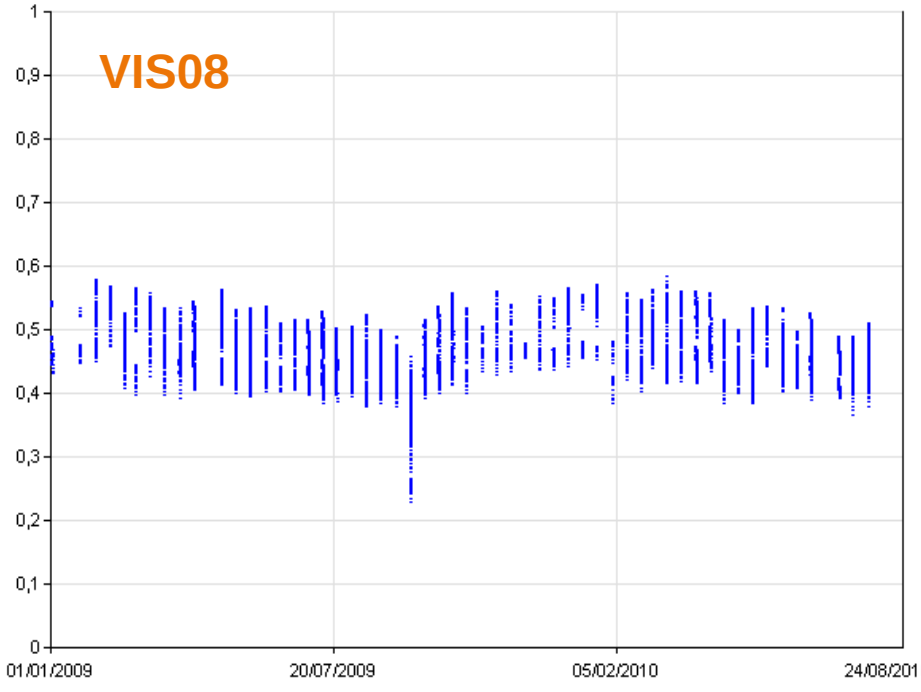
SEVIRI Time Series over Desert Sites

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)

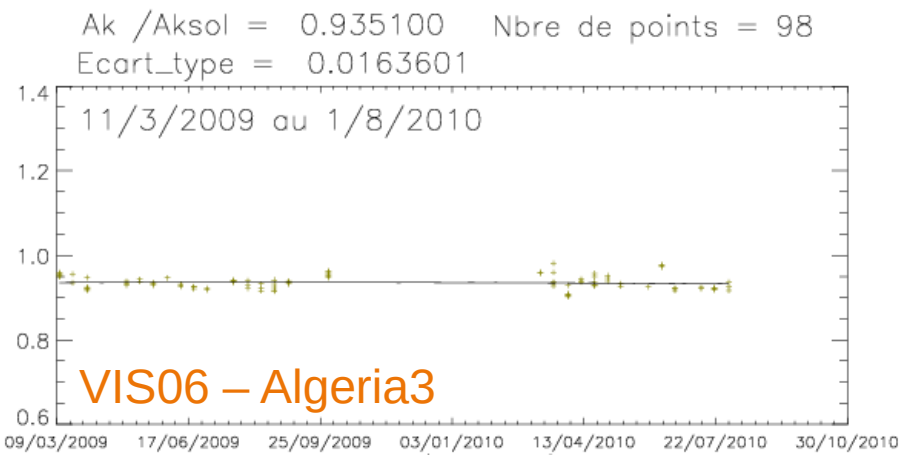
To be extended over the full archive

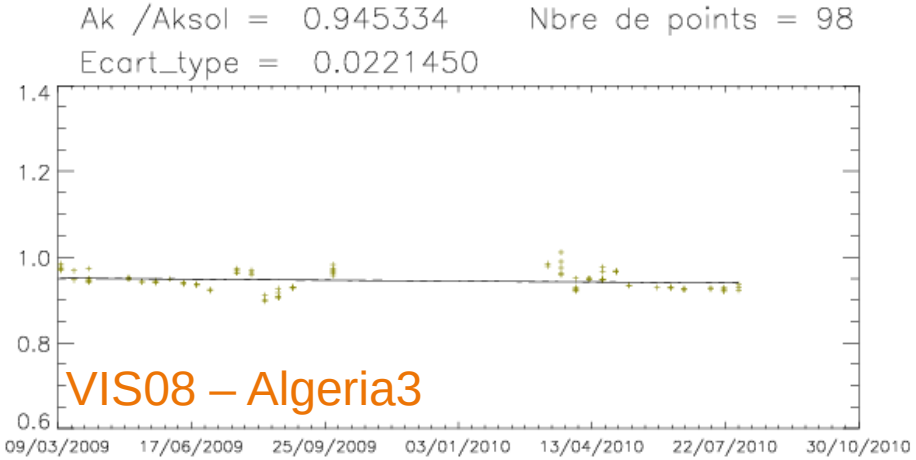


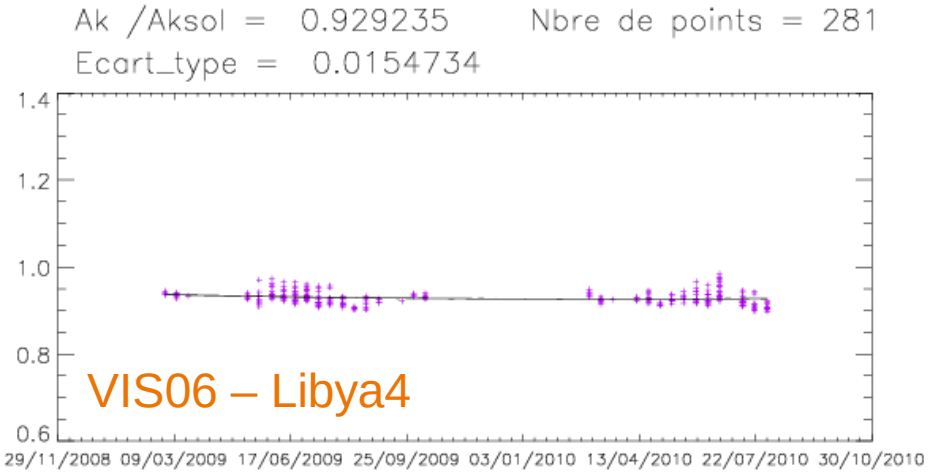


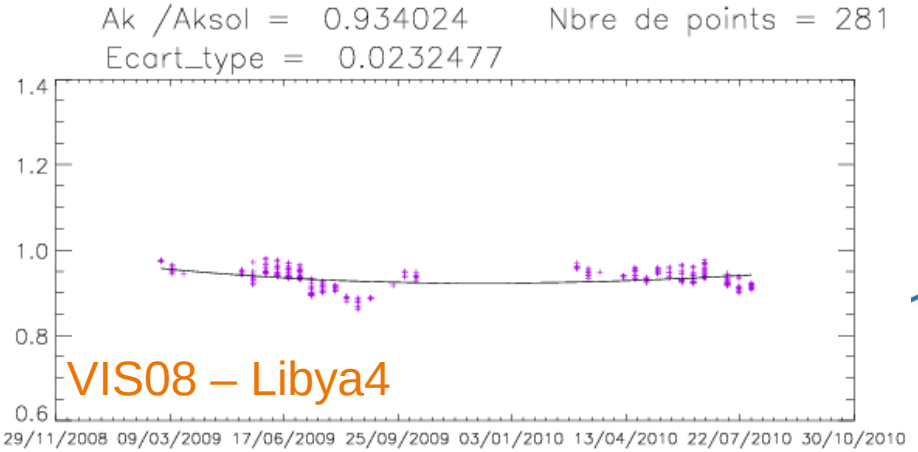
SEVIRI vs MERIS Intercalibration over Desert Sites

Preliminary results : MERIS as reference





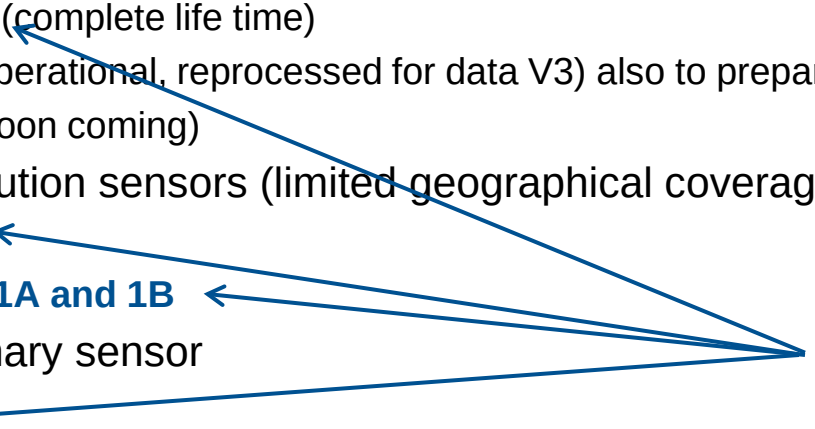




Rayleigh Scattering Calibration – What's new in CNES?

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

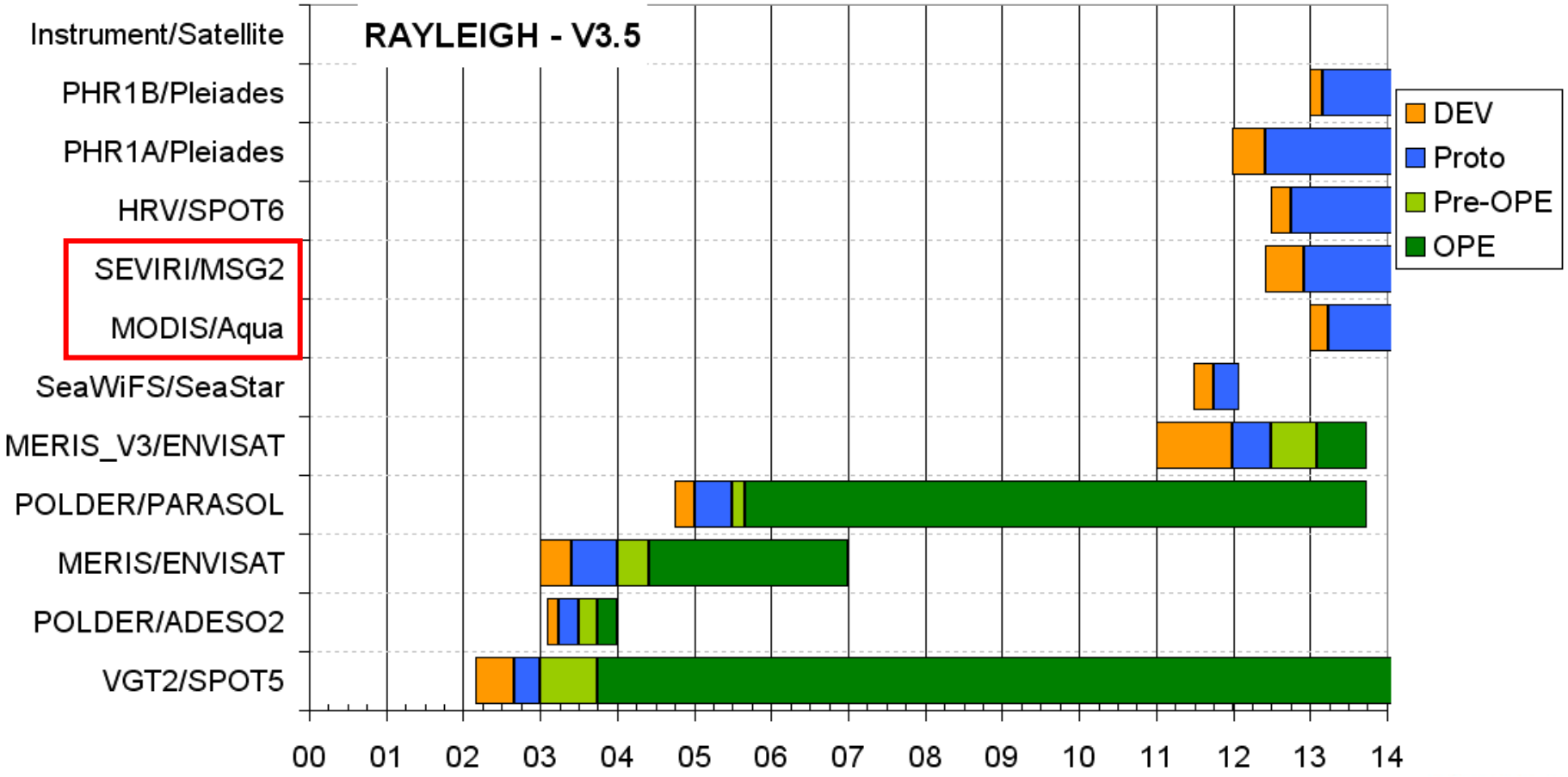
- Implementation of Version 3.5 for several sensors
  - ocean color sensor considered as radiometric reference
    - **SeaWiFS** (complete life time)
    - MERIS (operational, reprocessed for data V3) also to prepare OLCI (Sentinel-3)
    - MODIS (soon coming)
  - high-resolution sensors (limited geographical 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

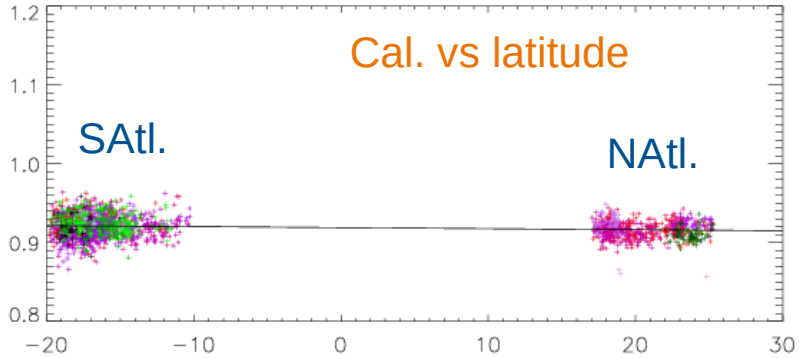
Development Plan

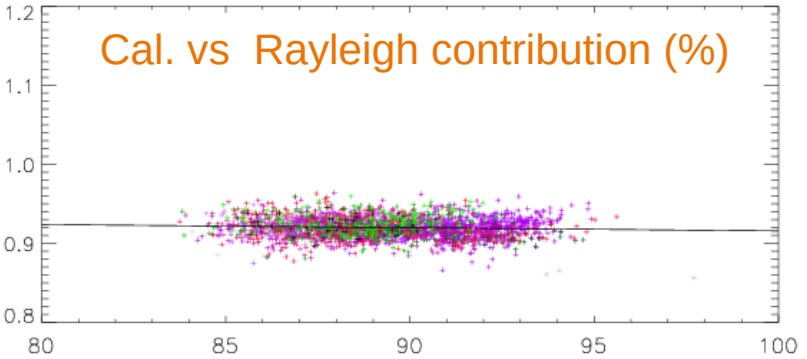
- The reference method is Rayleigh Calibration Version 3.5
  - DEV = study & ATBD first definition [resp. SI/MO]
  - PROTO = prototype on dedicated test environment on MUSCLE – Final ATBD [resp. SI/MO]
  - Pre-OPE = test on the operational MUSCLE [resp. ME/EI]
  - OPE = fully operational method / Traceability guaranteed [resp. ME/EI]

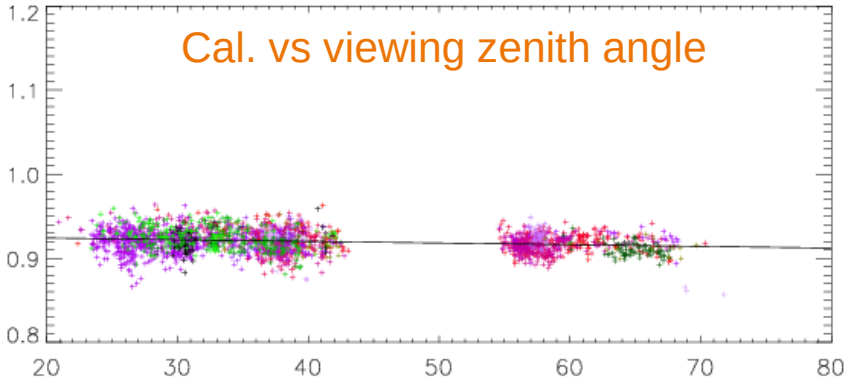


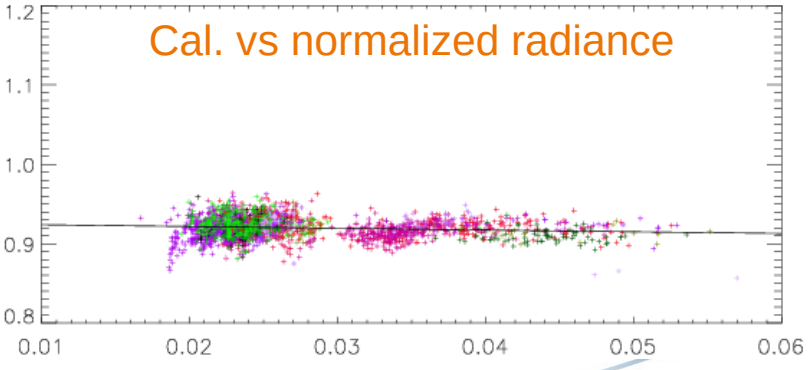
SEVIRI Calibration over Rayleigh Scattering

- Preliminary results
  - ✦ validation set – Band VIS06
    1/1/2009 to 1/8/2010
    N=2437
  - ✦ confirmation of the previous value
    <Ak>~0.92
  - ✦ clear signature with scattering angle
    error in backscattering
    to be investigated



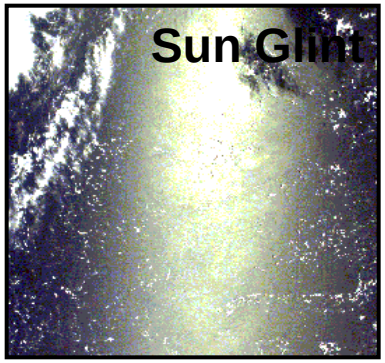






PARASOL end-of-life reCalibration

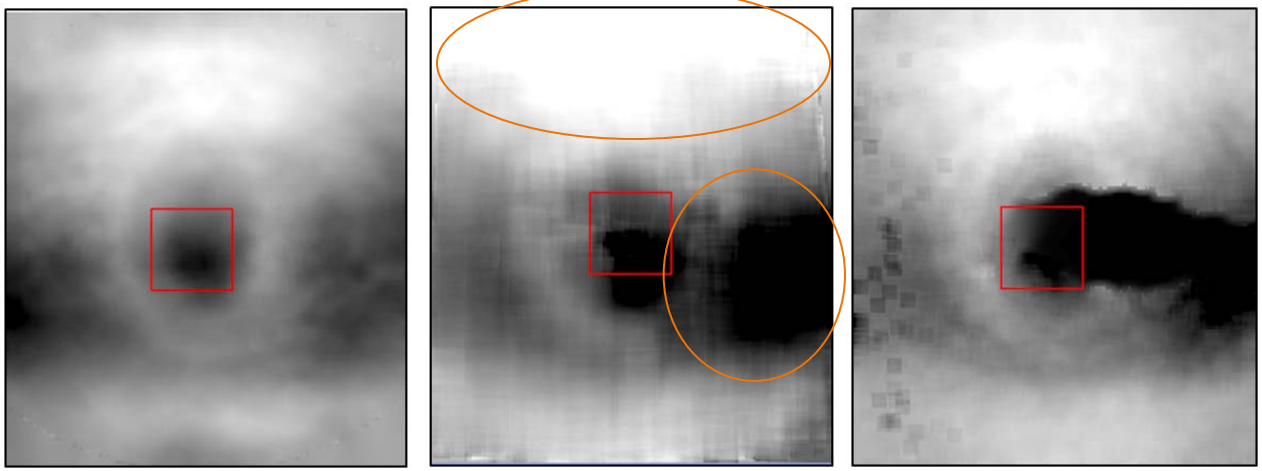
- **Multi-method Synergic Approach to derive corrections of**
  - ✦**1/ Variation of calibration inside the field-of-view**
  - ✦**2/ Temporal evolution of the mean calibration**
  - ✦**3/ Absolute calibration for the entire archive**
- **Combination of operational calibration method:**



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



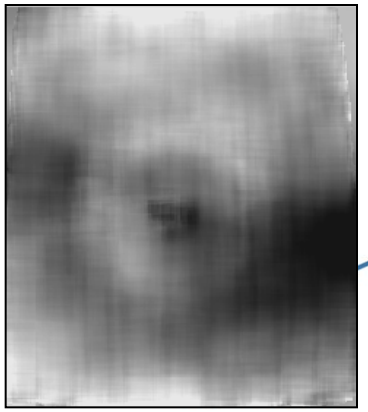
Band
490nm

Interband over DCC (ref=765)

Intercalibration over desert (ref=POL1)

Absolute calibration over Rayleigh

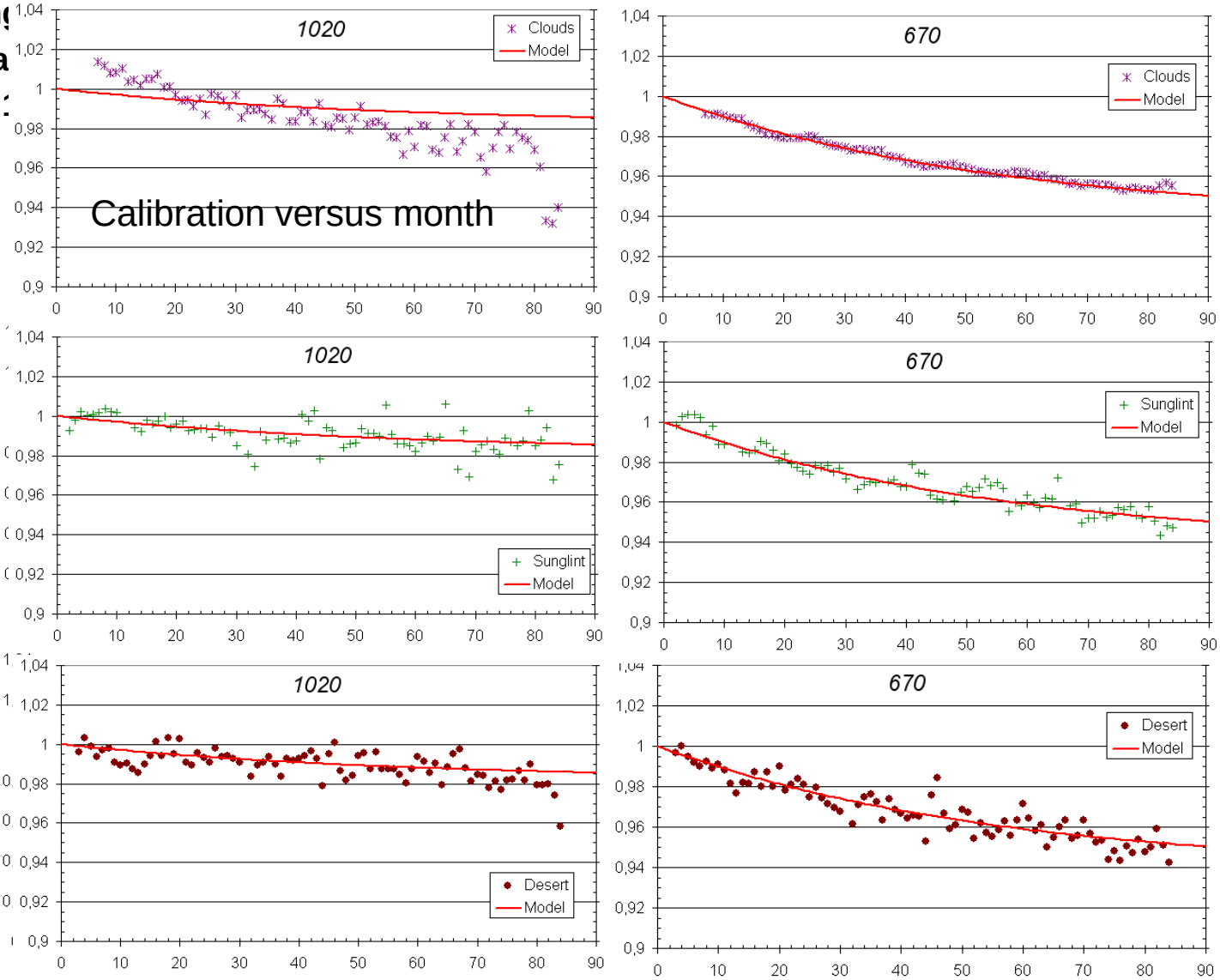
The black hole from band 765nm



Black hole – confirmed by Rayleigh → Instrument-765
Bright banner – not confirmed → method artefact

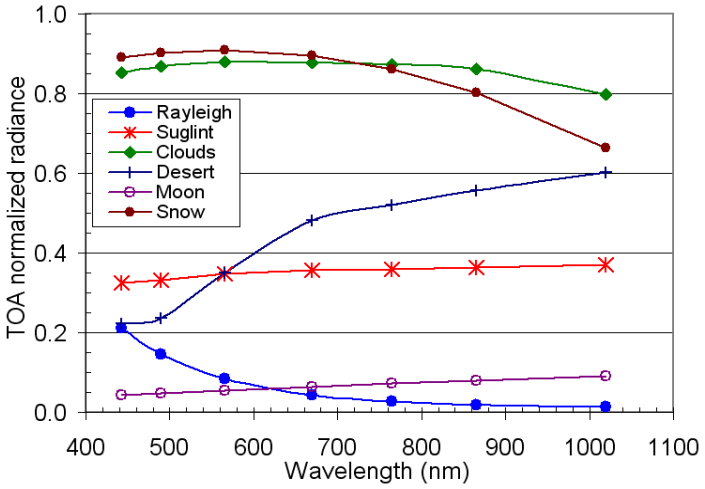
PARASOL Temporal Monitoring of the Calibration

- **Comparison of calibration methods for the temporal monitoring**
  - **670nm band aging**
  - **Validated over Ra**
  - **Not the same for :**



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**

Calibration	Deserts	Rayleigh	Sunglint	Clouds	Antarctica	Moon	La Crau
Absolute		VIS					VIS-NIR (HR)
Interband	possible		VIS-NIR-SWIR	VIS-NIR	possible	possible	
Monitoring	VIS-NIR-SWIR	possible	possible	VIS-NIR	VIS-NIR	VIS-NIR-SWIR	
Inter-Calibration	VIS-NIR-SWIR				possible	possible	
In the field of view	possible	possible		possible			

A last word… SPOT4 Take 5

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

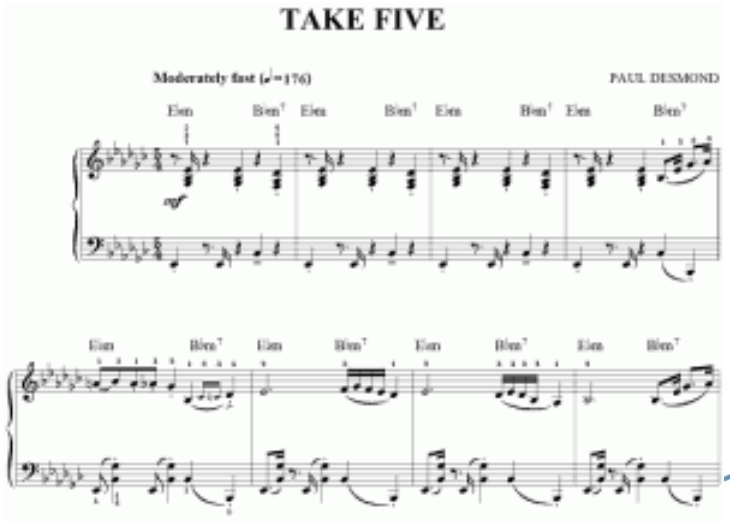
This experiment is named ‘Take 5’.

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 to be 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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