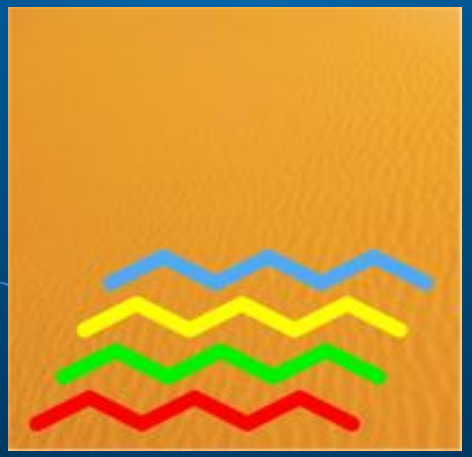


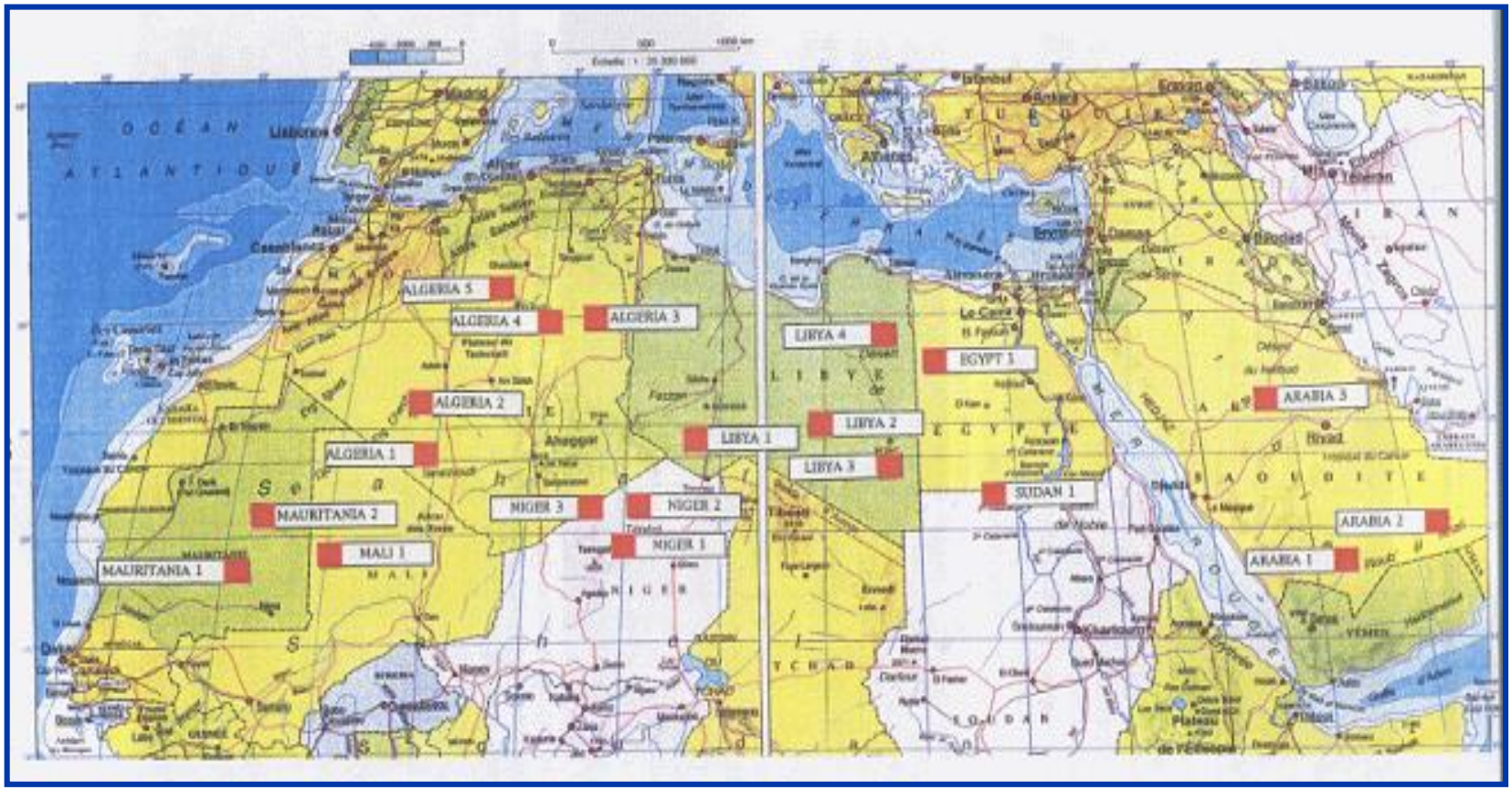
PICSCAR
The CEOS Initiative for PICS characterization
Use of PICSCAR for VH resolution sensors

Béatrice Berthelot (Magellium)
Patrice Henry (CNES)

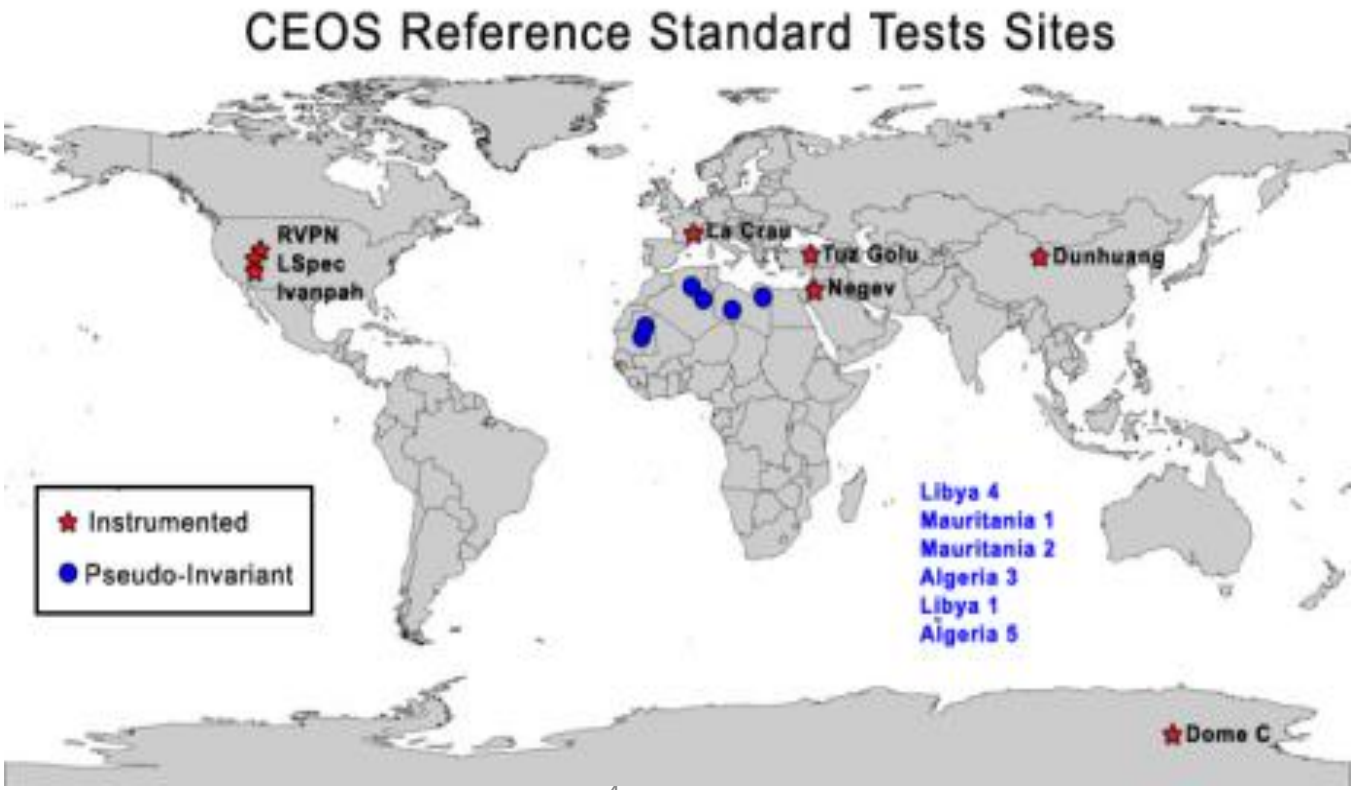
VH-RODA: Very High-resolution Radar & Optical Data Assessment workshop
and CEOS SAR 2019 workshop

- **Pseudo Invariant Calibration Sites (PICS) are natural sites used as calibration data source because of they exhibit no or low changes on spatial and spectral properties.**
  - **Selection performed to identify sites with high temporal stability and high spatial homogeneity**
- **PICS** can be used to evaluate the long-term stability of an instrument and to facilitate inter-comparison of multiple instruments.

- The sites are mainly located in the desert. CNES uses 20 for instance



- There are **six PICS** endorsed by CEOS as standard reference sites for the post-launch calibration of space-based optical imaging sensors, assumed to be radiometrically stable in time:



- **IVOS 27** recommendations (Nov 2015)
- ***To establish a task group/project to coordinate the communities work on PICS. With the main objective to improve the characterisation of the sites and enhance calibration methods based on these sites***

- **Leadership** has been taken by **Patrice Henry (CNES)** with the objective to facilitate the coordination and help prioritise research on PICS and their usage.

PICSCAR outline

- PICSCAR Working group : CNES, SDSU, JPL, Argans, NPL, ESA, USGS
- Roadmap
- Regular meetings
- Portal to support PICSCAR activities and PICS documentation
  - Capitalisation on site information
  - Tools developped for calibration purposes
  - Demonstrator of PICS usage for sensor intercalibration
- Reporting to WGCV/IVOS

Need for understanding :Questionnaire

- Establish and distribute a **questionnaire** to assess the user practices and define the future needs.
    - PICS identification, PICS characteristics, need of auxiliary data etc
    - Sent to CEOS members and affiliates
- Successful returns allow to identify priority subjects to address
    1. BRDF behaviour
    2. Spectral characterization
    3. Atmosphere properties
    4. Temporal Stability
    5. Combining multiple sites calibration results
    6. Revisiting the sites
- **This defines our roadmap.**

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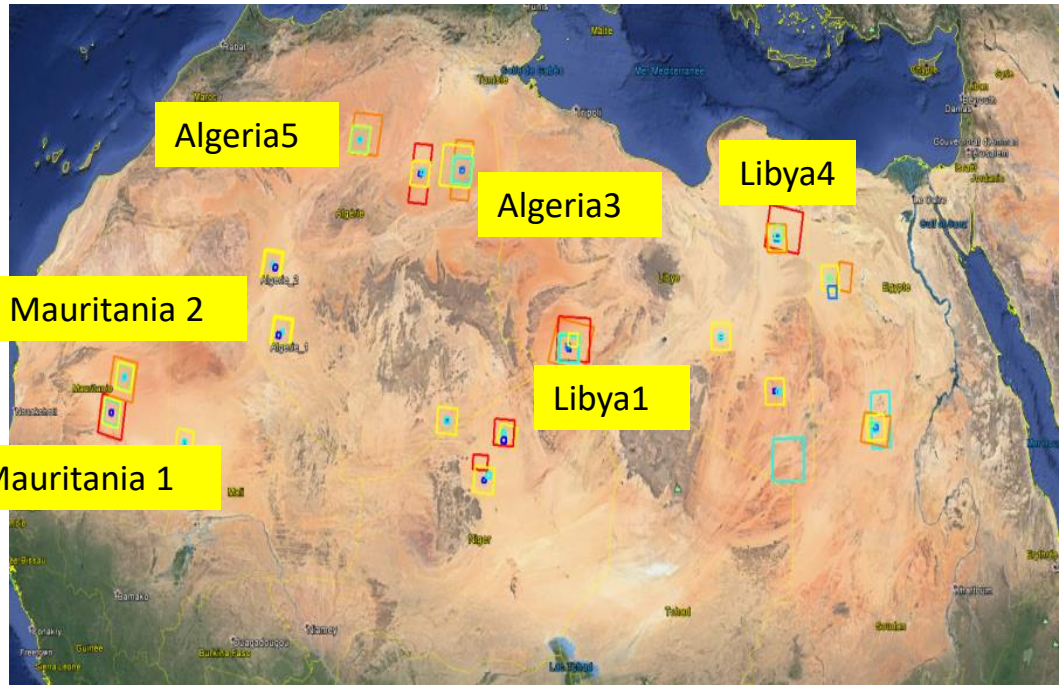
From questionnaire: Projects and activities

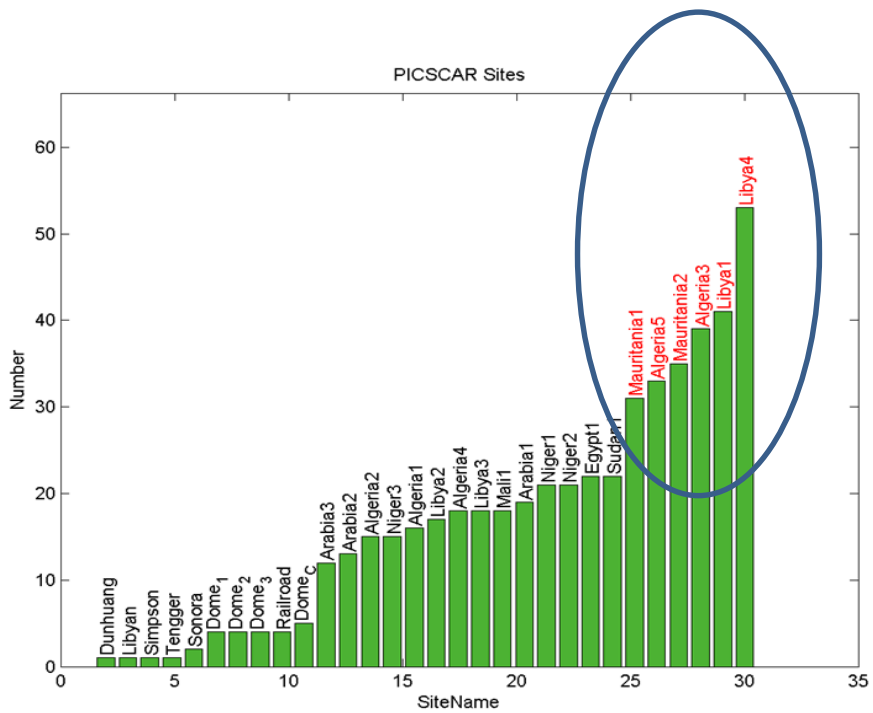
Operational Calibration Monitoring
CNES
ESA (Argans, ONERA)
SDSU
JPL
VITO
CMA
NOAA, JAXA, EOSense
Future sensors
AIST
Specific studies
Rayference
TPZ, DLR
Onera (PICSsand), CNES

From questionnaire: Site interest

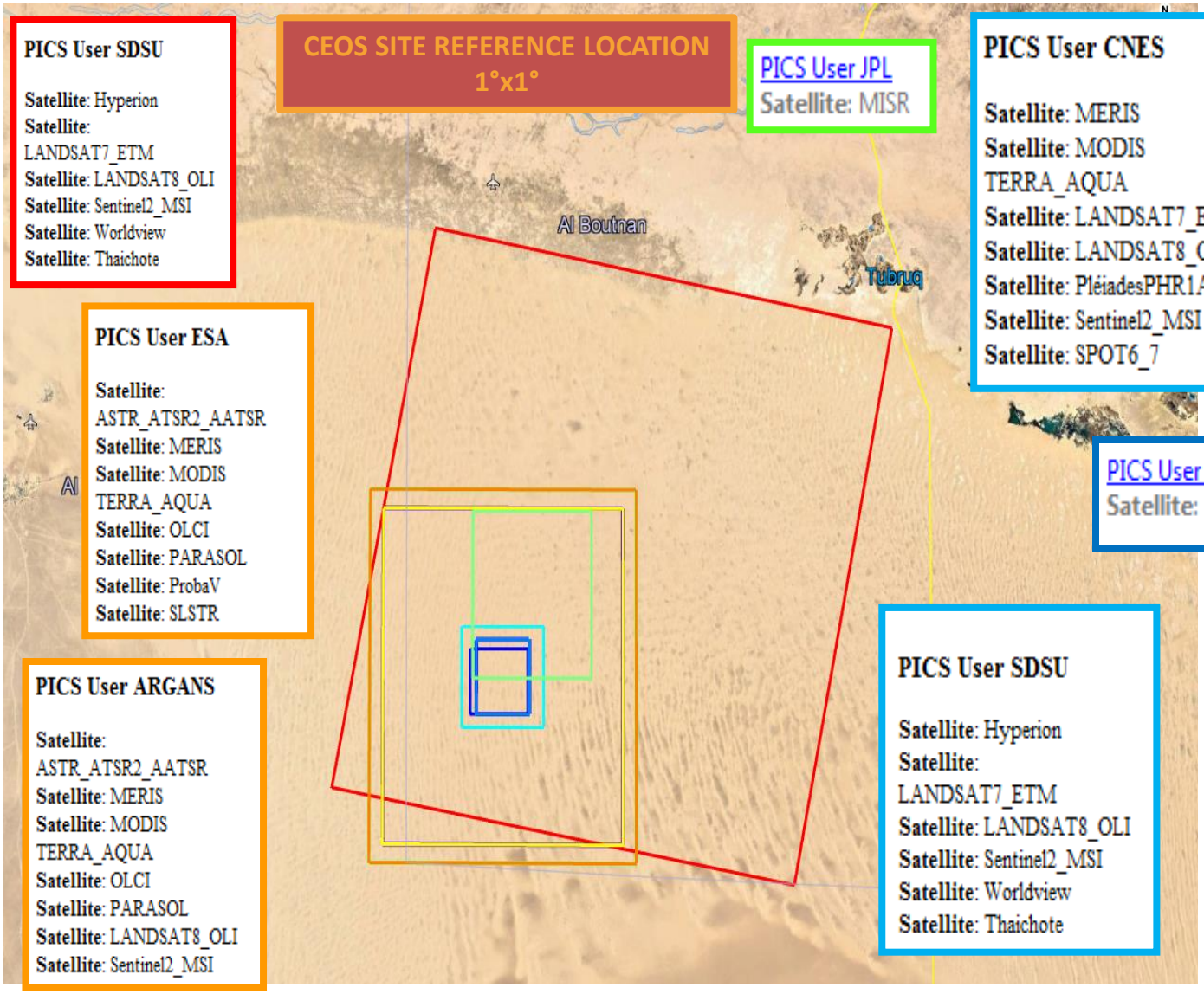
- Summary:
  - 30 sites of interests
  - 33 sensors (Multi resolution)



CEOS PICS



Libya4 seen by different groups



PICS User CNES

Satellite: ASTR_ATSR2_AATSR
Satellite: AVHRR
Satellite: MERIS
Satellite: MODIS TERRA_AQUA
Satellite: OLCI
Satellite: PARASOL
Satellite: POLDER 1_2
Satellite: SeaWiFS
Satellite: LANDSAT7_ETM
Satellite: Sentinel2_MSI
Satellite: SPOT1_2_3_4_5
Satellite: Thaichote

PICS User Rayference
Satellite: MSG_METEOSAT
Satellite: GOME_2

PICS User DLR
Satellite: AVHRR

PICS User TPZ

Satellite: LANDSAT5_TM
Satellite: LANDSAT7_ETM
Satellite: LANDSAT8_OLI
Satellite: Sentinel2_MSI

PICS User SDSU

Satellite: Hyperion
Satellite: LANDSAT7_ETM
Satellite: LANDSAT8_OLI
Satellite: Sentinel2_MSI
Satellite: Worldview
Satellite: Thaichote

PICS User ESA

Satellite: ASTR_ATSR2_AATSR
Satellite: MERIS
Satellite: MODIS TERRA_AQUA
Satellite: OLCI
Satellite: PARASOL
Satellite: ProbaV
Satellite: SLSTR

PICS User ARGANS

Satellite: ASTR_ATSR2_AATSR
Satellite: MERIS
Satellite: MODIS TERRA_AQUA
Satellite: OLCI
Satellite: PARASOL
Satellite: LANDSAT8_OLI
Satellite: Sentinel2_MSI

PICS User JPL
Satellite: MISR

PICS User CNES

Satellite: MERIS
Satellite: MODIS TERRA_AQUA
Satellite: LANDSAT7_ETM
Satellite: LANDSAT8_OLI
Satellite: PléiadesPHR1A_1B
Satellite: Sentinel2_MSI
Satellite: SPOT6_7

PICS User VITO
Satellite: ProbaV

PICS User SDSU

Satellite: Hyperion
Satellite: LANDSAT7_ETM
Satellite: LANDSAT8_OLI
Satellite: Sentinel2_MSI
Satellite: Worldview
Satellite: Thaichote

PICS User NOAA-NESDIS-STAR

Satellite: VIIRS

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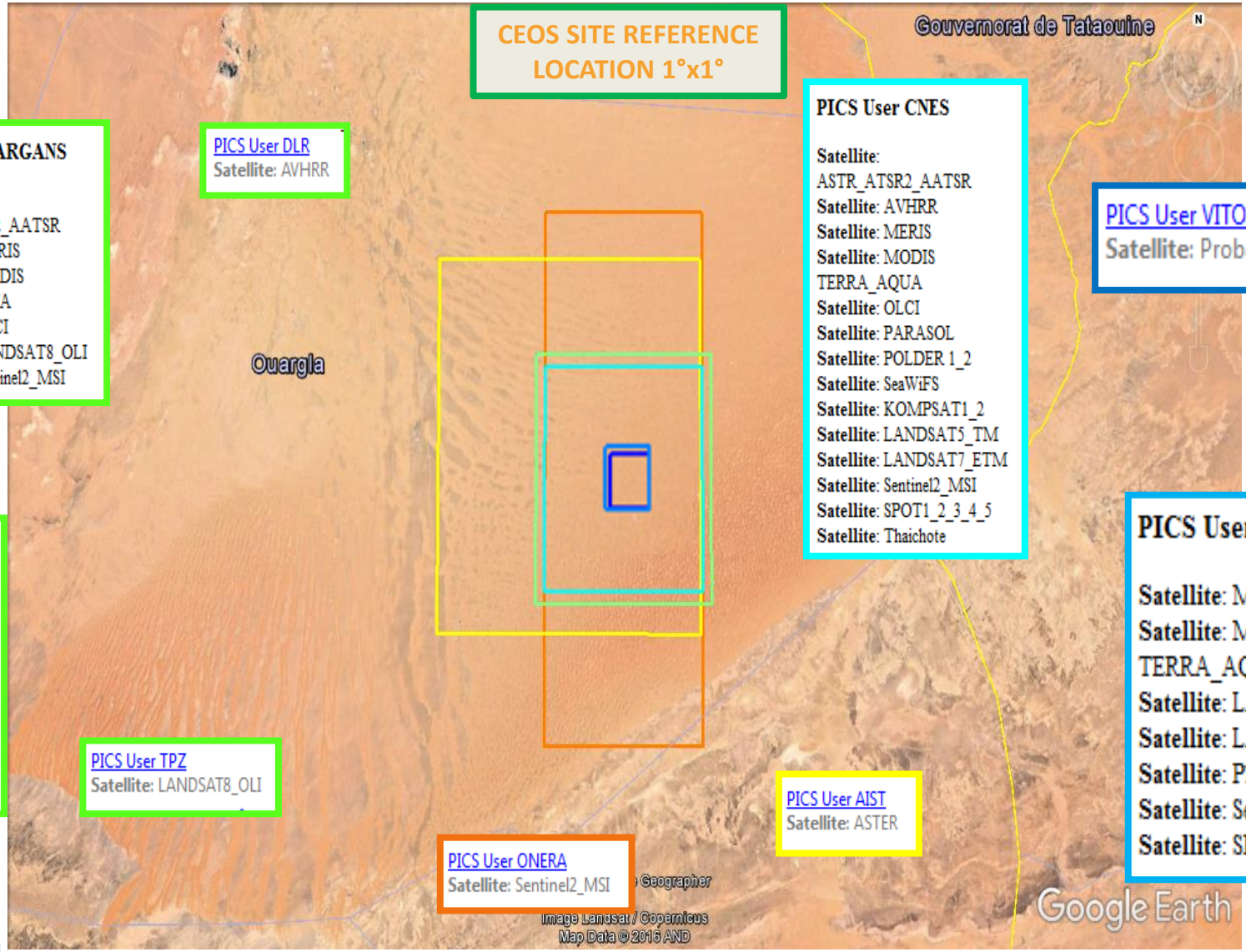
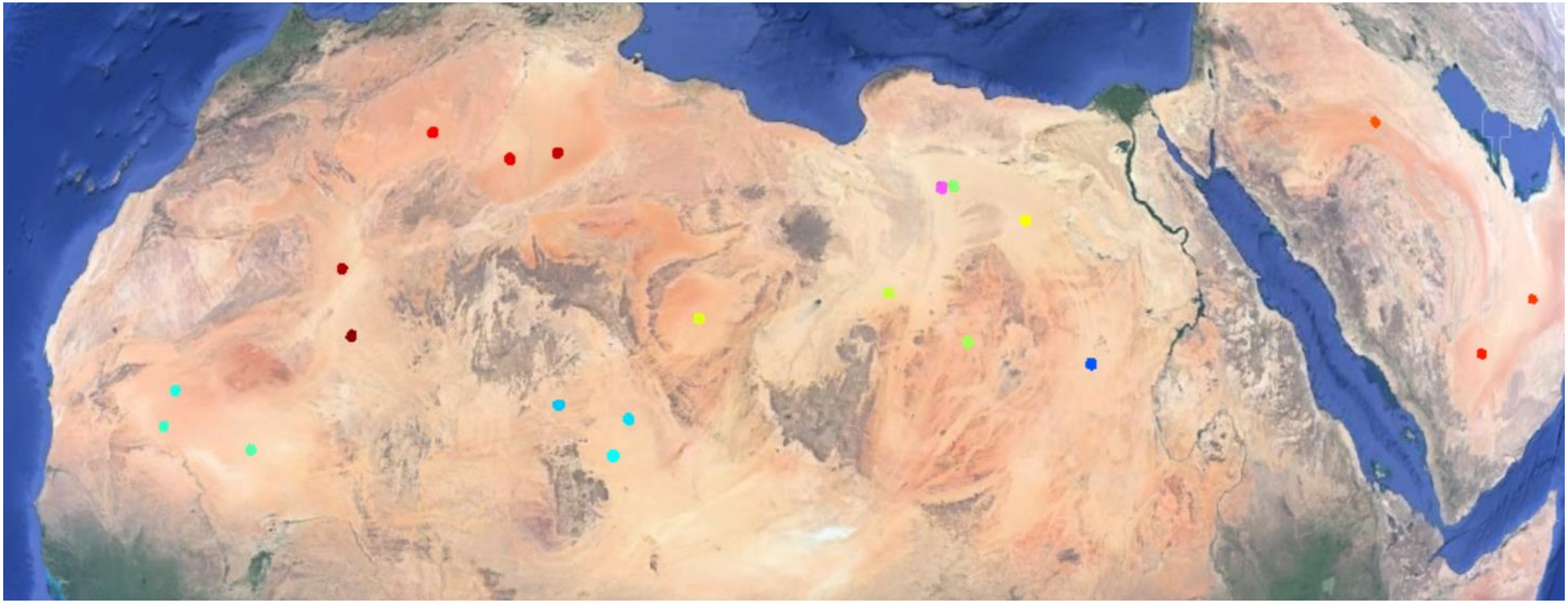
Algeria 3 seen by different groups



PICS location for Very High spatial resolution sensors

- Small sites have been defined for sensors acquiring data at high spatial resolutions



Site selection

- Many of these sites have been used in the past by various agencies, groups, researches, but to concentrate our efforts, after concertation, we choose to focus **on Libya 4 site**.
- This allowed to take into account the site heritage and the large number of datasets from multiple instruments that already existed in the EO archives and the long history of characterization performed over these sites.

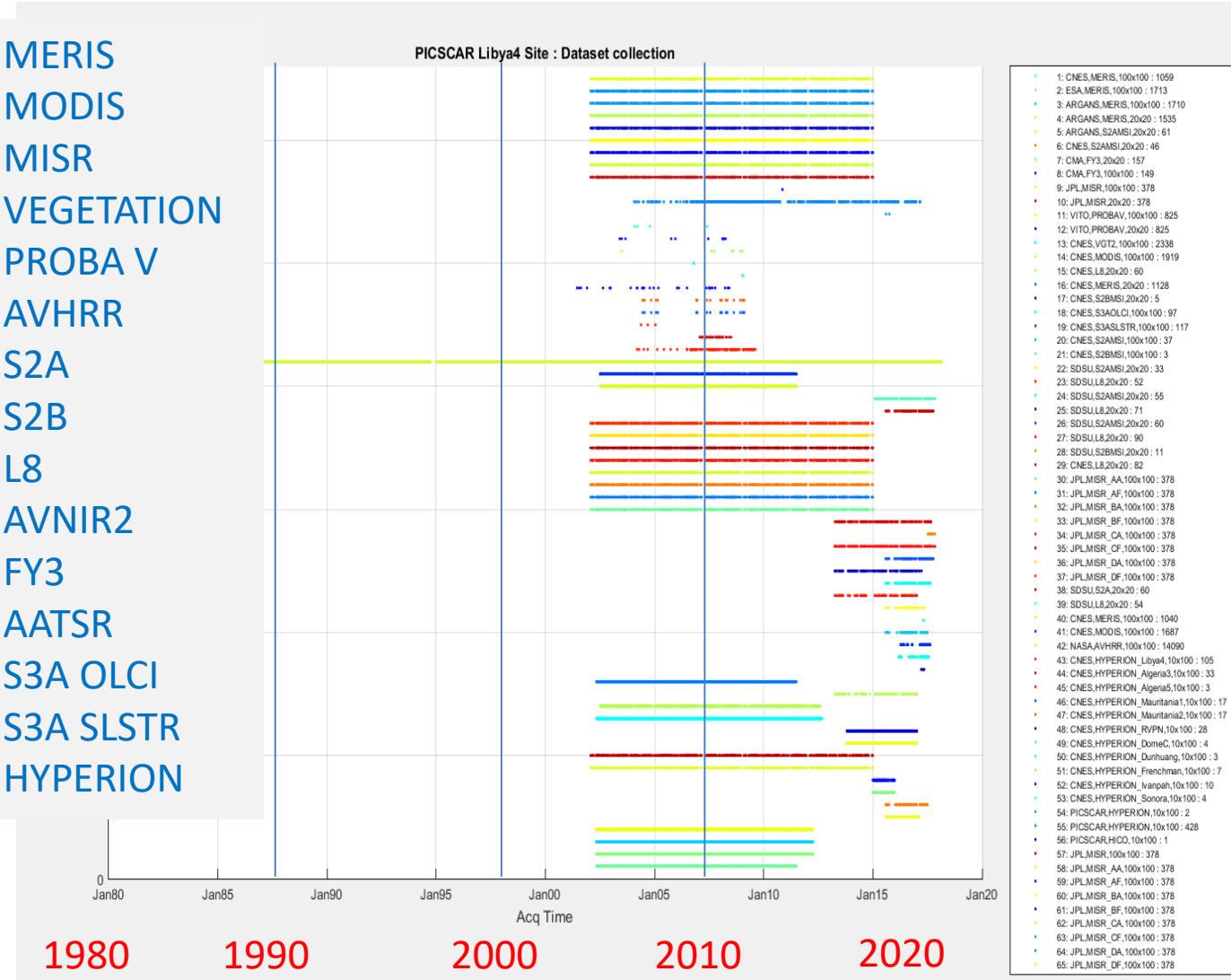
- So we collected data for this site from spatial agencies

Overview of the large data collection for our assessment

Dataset provided :

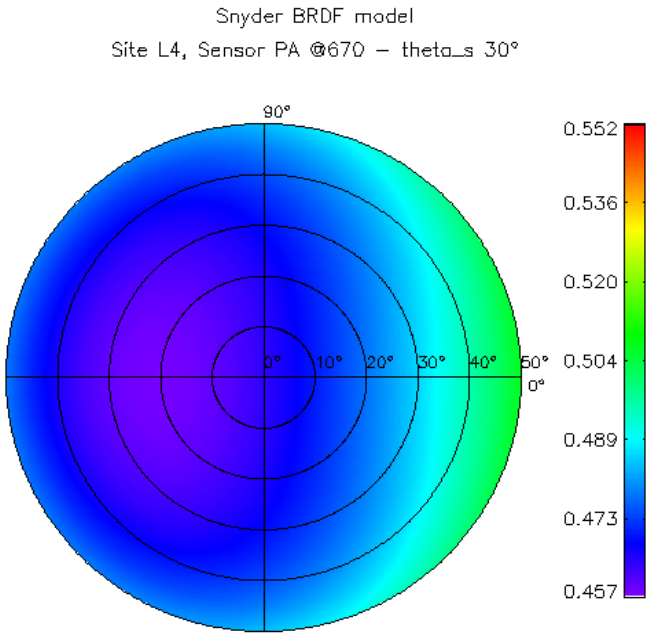
- For the same sensor by different agencies
- For the same sensor for both standard site and small site
- From high spatial resolution sensor and medium/large

MERIS
MODIS
MISR
VEGETATION
PROBA V
AVHRR
S2A
S2B
L8
AVNIR2
FY3
AATSR
S3A OLCI
S3A SLSTR
HYPERION



Assessment of the site stability

- Stability can only be assessed from BOA reflectances, corrected from BRDF effects



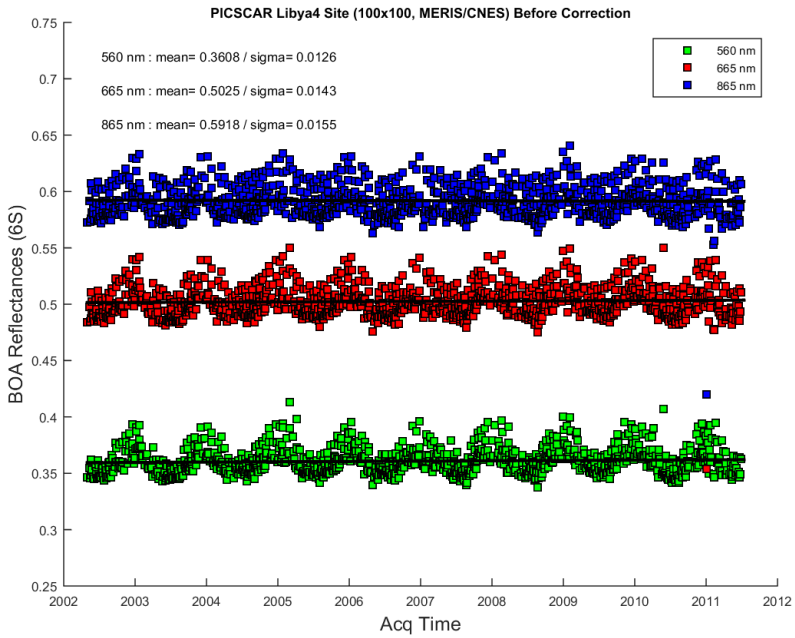
Computation of a 'large scale' BRDF model using POLDER/PARASOL recalibrated long time-series (2005-2013)
BRDF modelling using Snyder modelling

- Linear model
- 7 parameters
- Fitted in GREEN, RED, NIR wavelengths

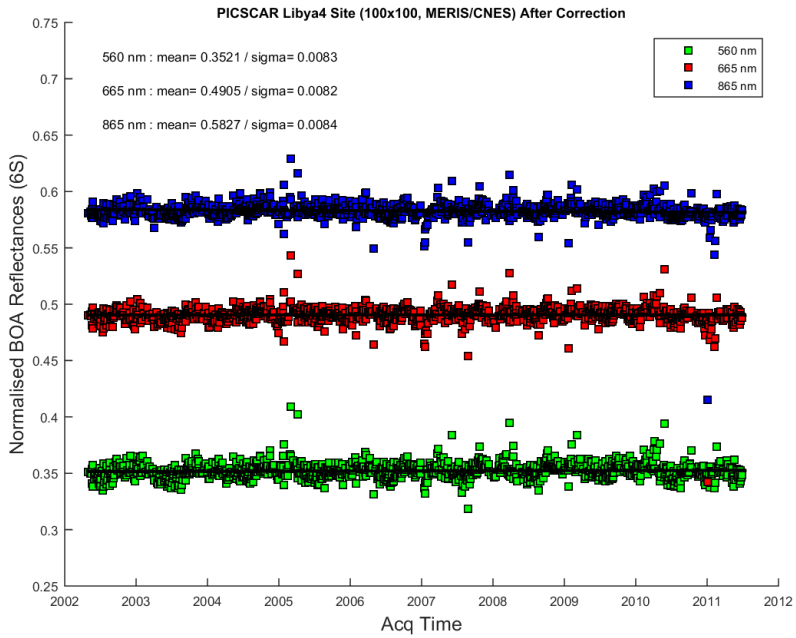
BRDF normalisation has been application to the full dataset

Example of Normalisation applied to 10 years of MERIS

- MERIS before normalisation

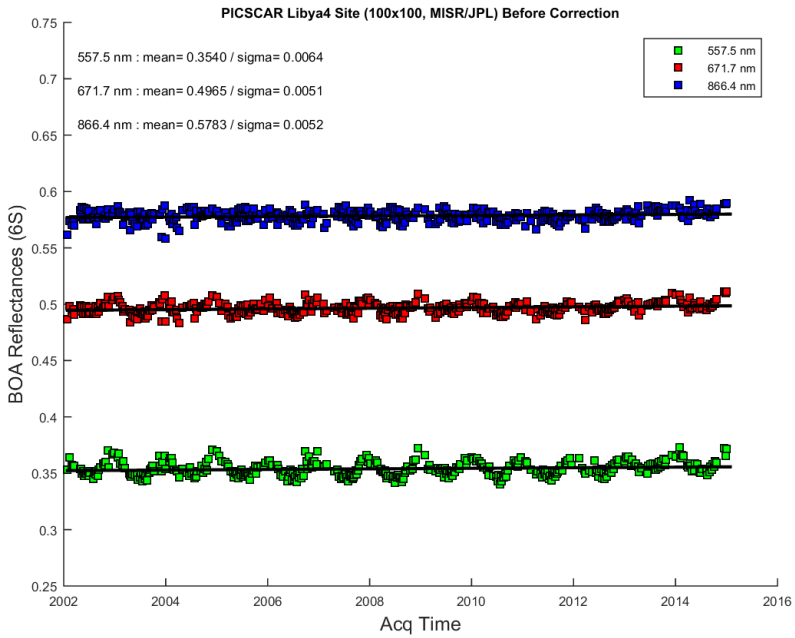


- MERIS after normalisation

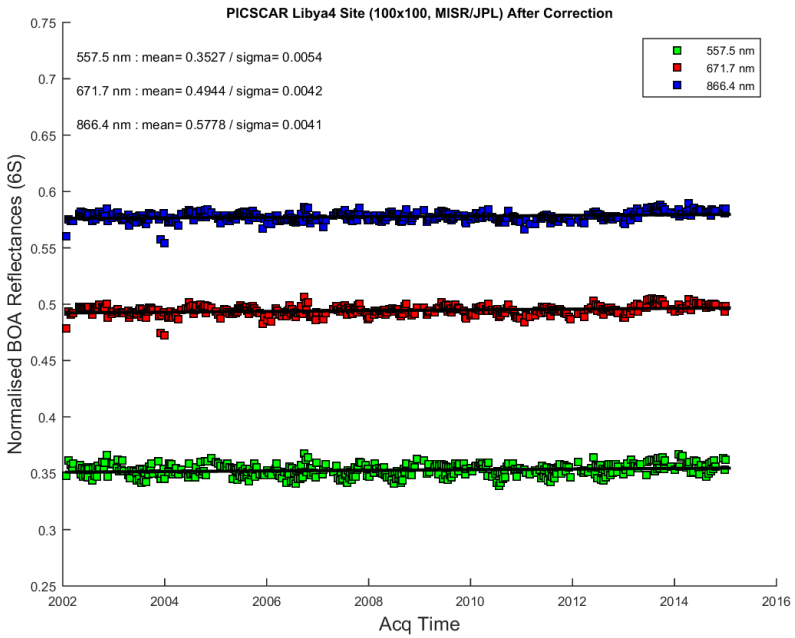


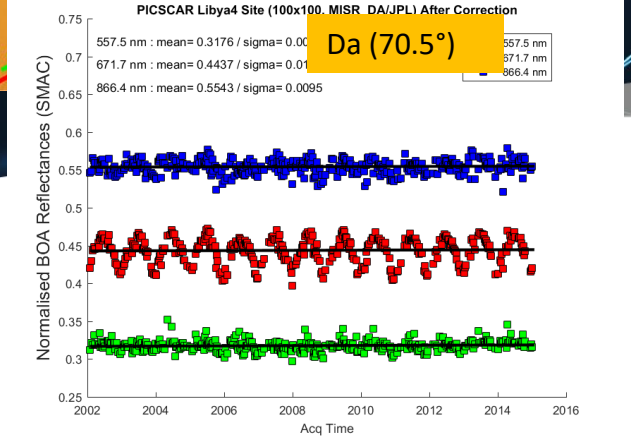
Example of Normalisation applied to 14 years of MISR

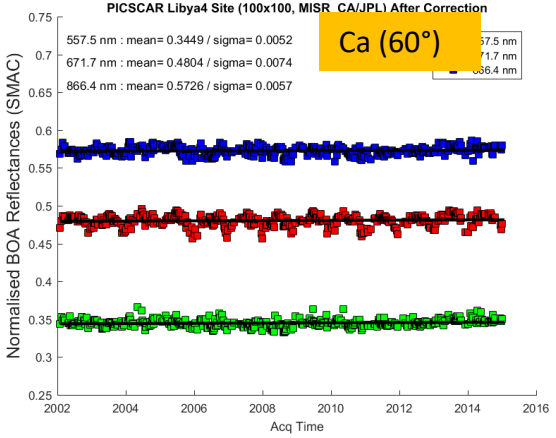
- MISR before normalisation

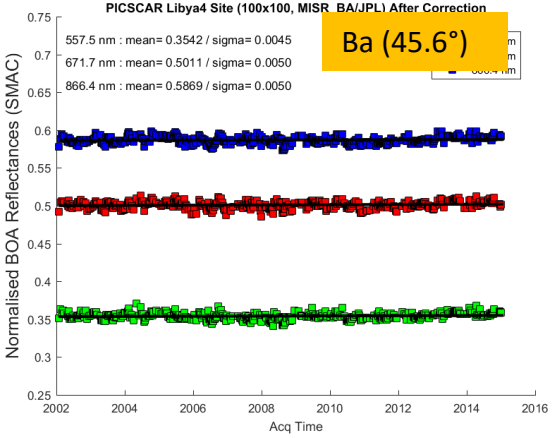


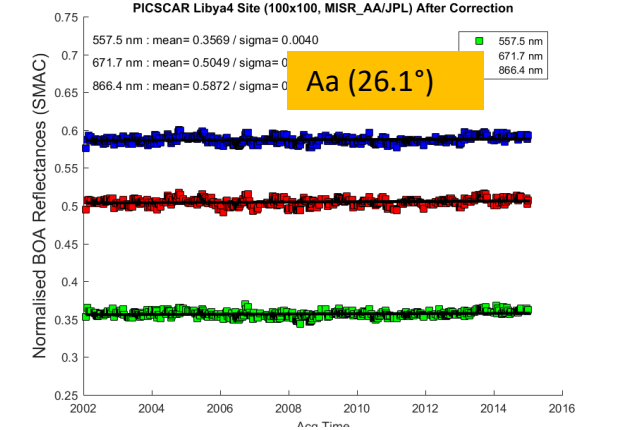
- MISR after normalisation

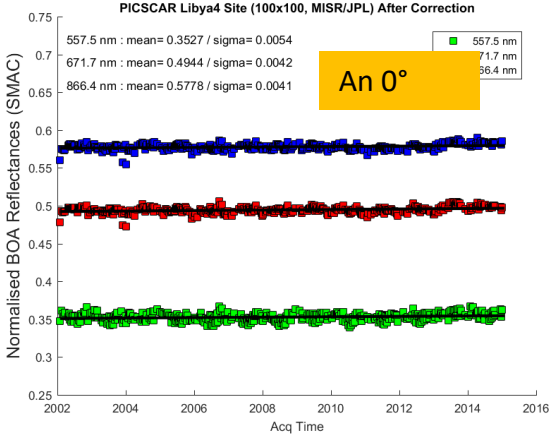


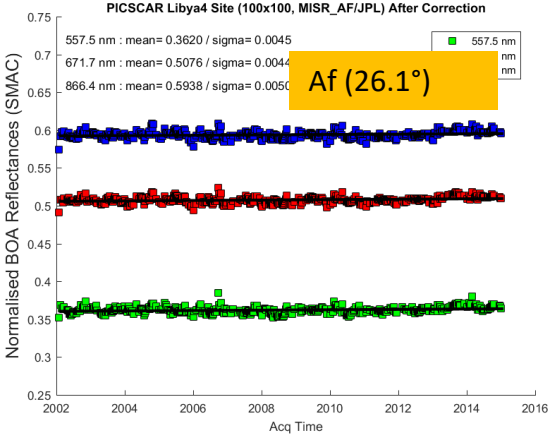


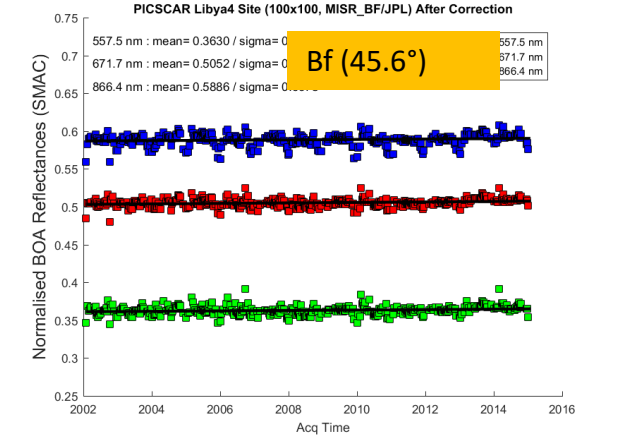


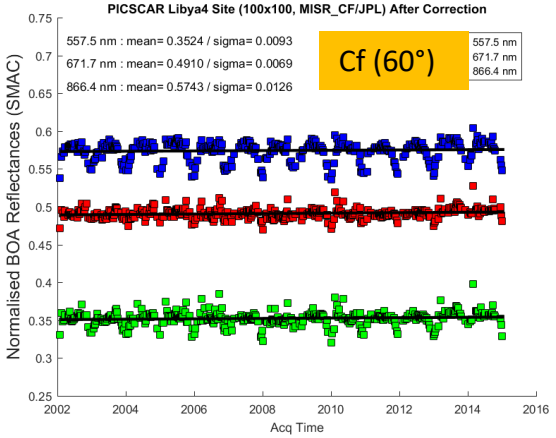


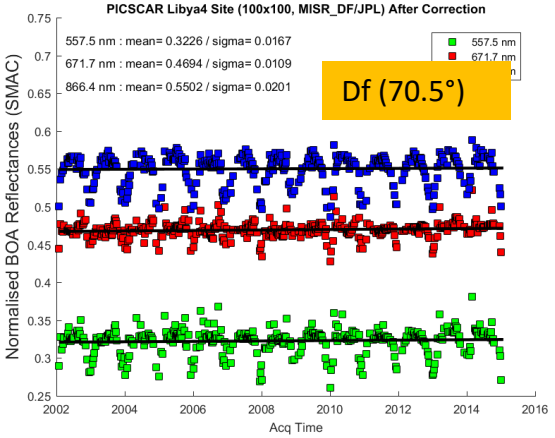












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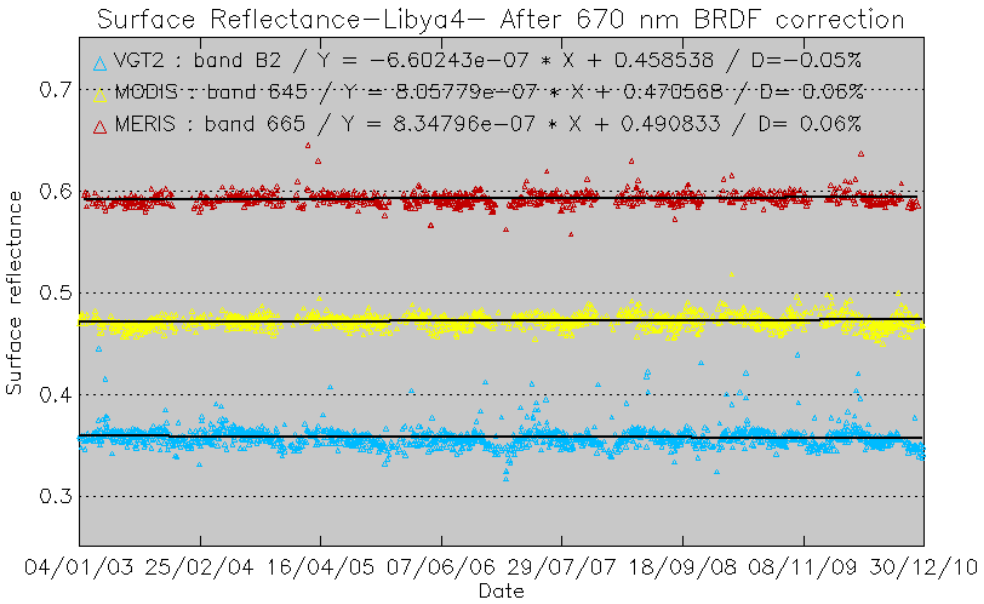
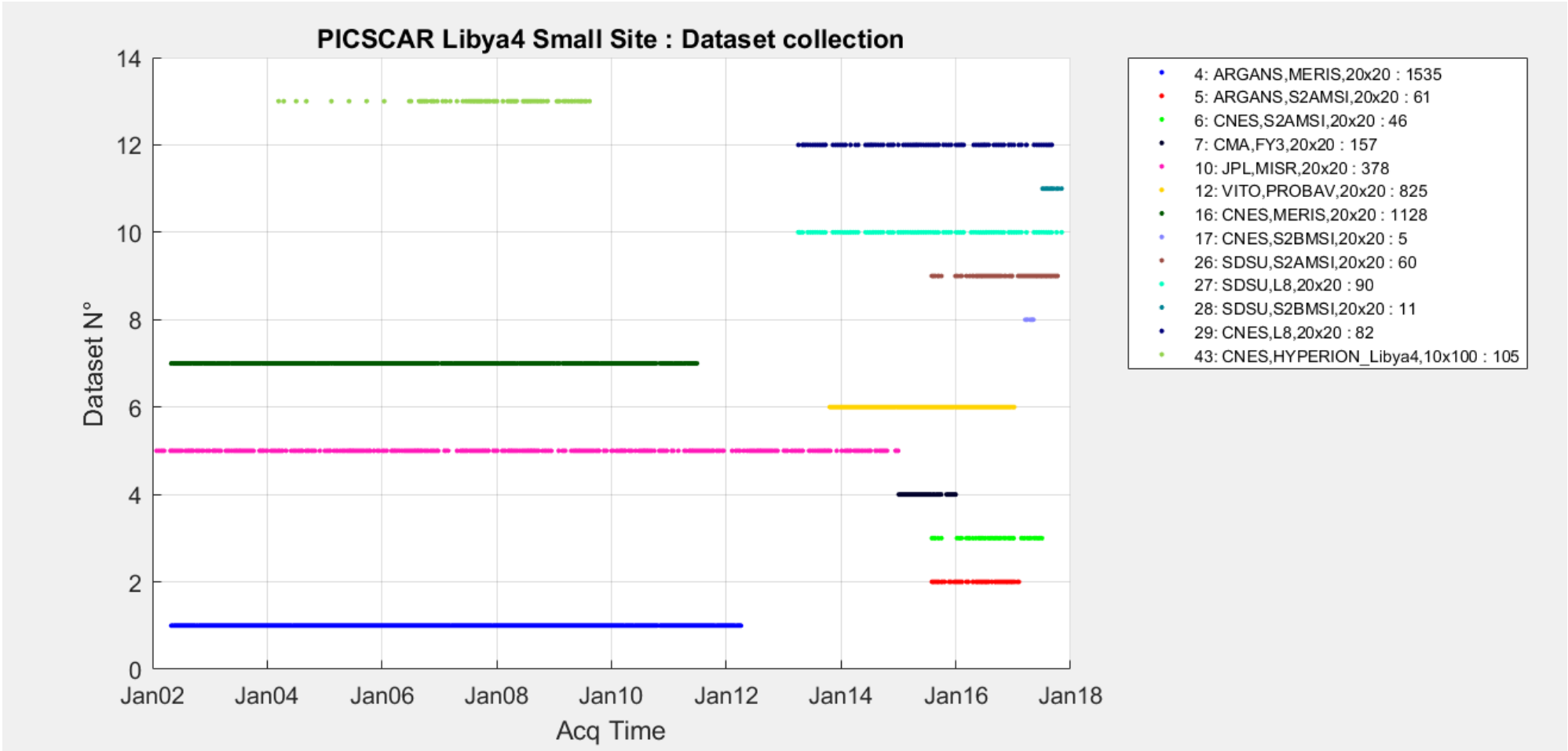
PICSCAR Outcome: Assessment of the site stability



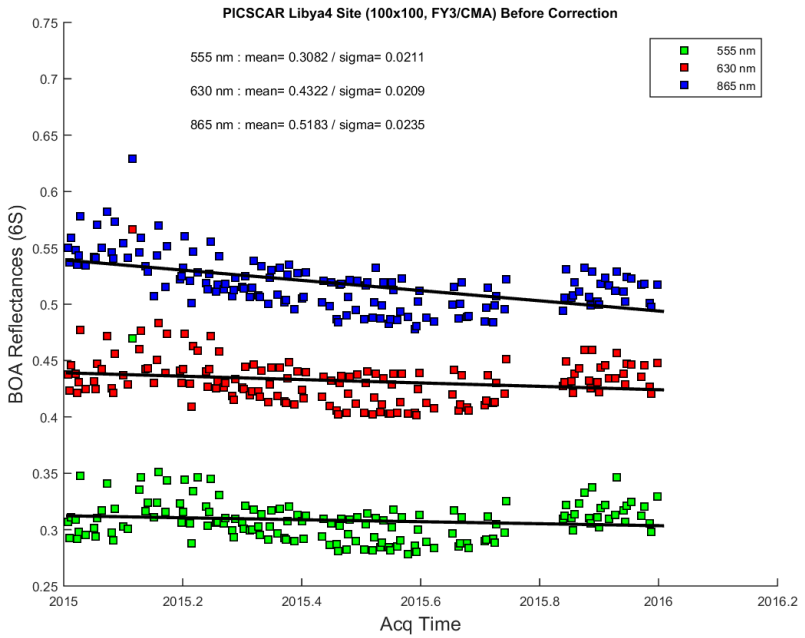
- From long time series, we observed that the stability is better than 0.3 % /year, better than 0.5 % over a 10 years period.
- Statistics are available for all datasets of the complete collection

Data collection for HR Sensors

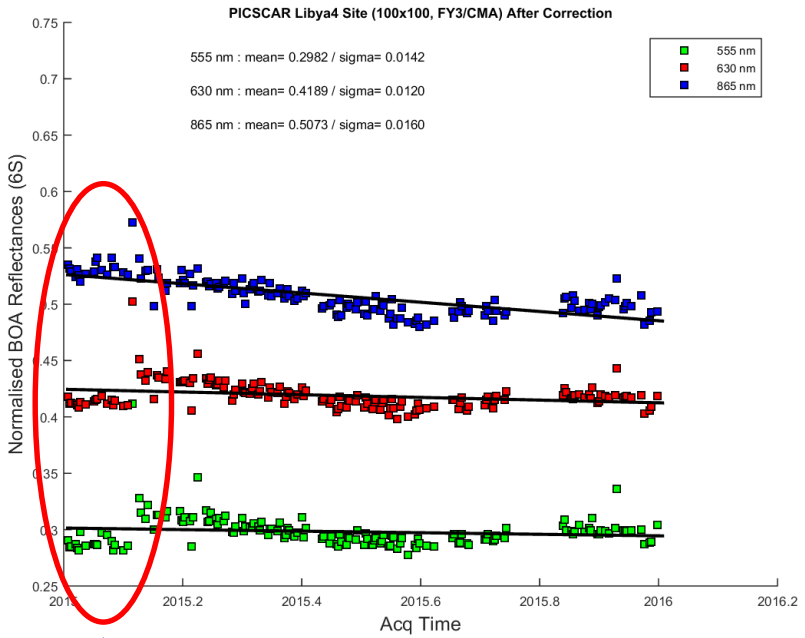


Example of Normalisation applied to 1 year of FY-3

- FY-3 before normalisation



- FY-3 after normalisation

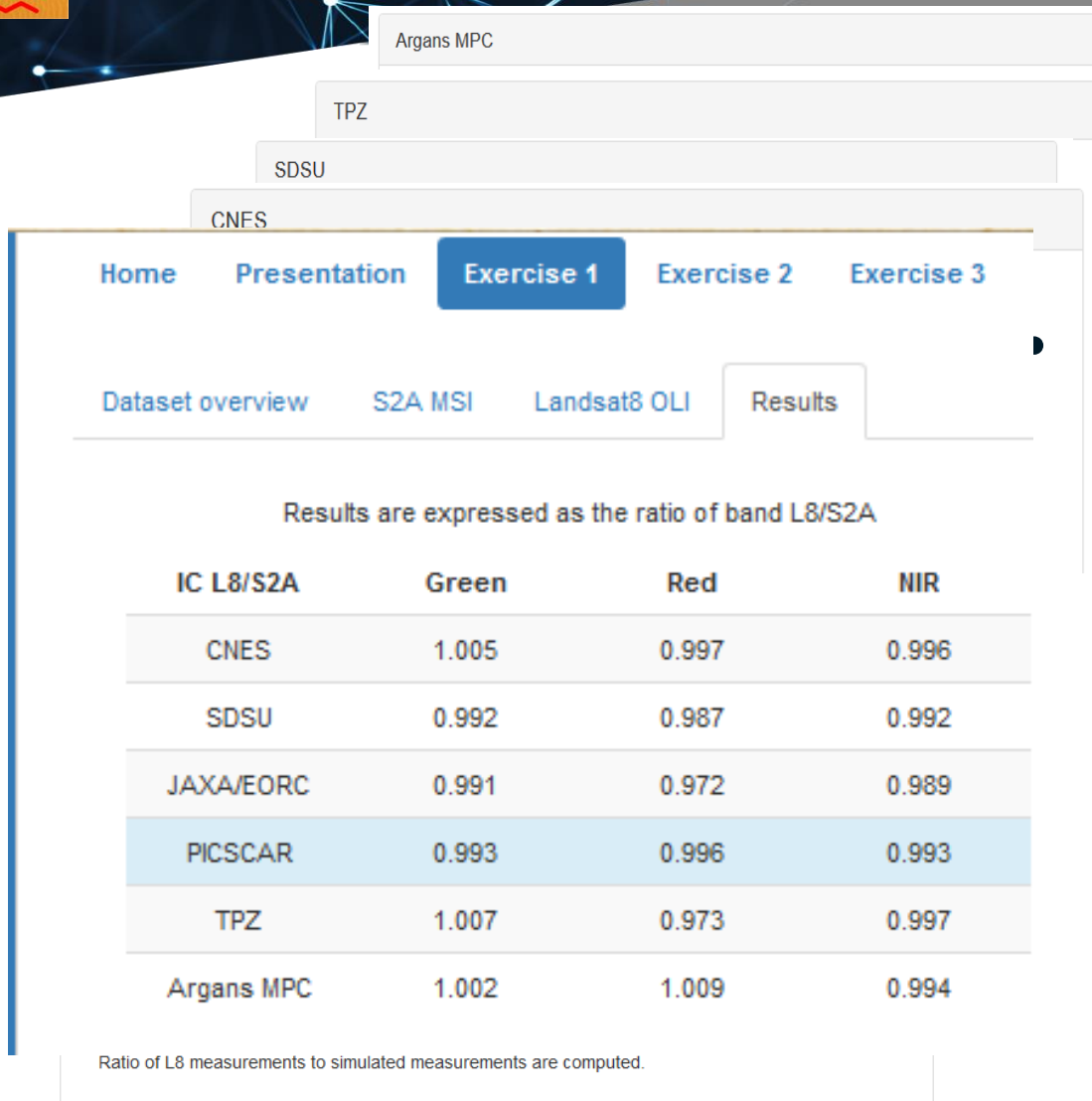


Change in calibration

Activities performed with HR dataset

- Focus on S2A/L8 dataset provided by CNES, SDSU, Argans
  - Impact of data extraction and cloud misdetection
  - Perform an Intercalibration exercise between L8 and S2A using S2A as reference sensor
  - It involves SDSU, CNES, Argans, Telespazzio, Jaxa and PICSCAR team

IC exercise summary



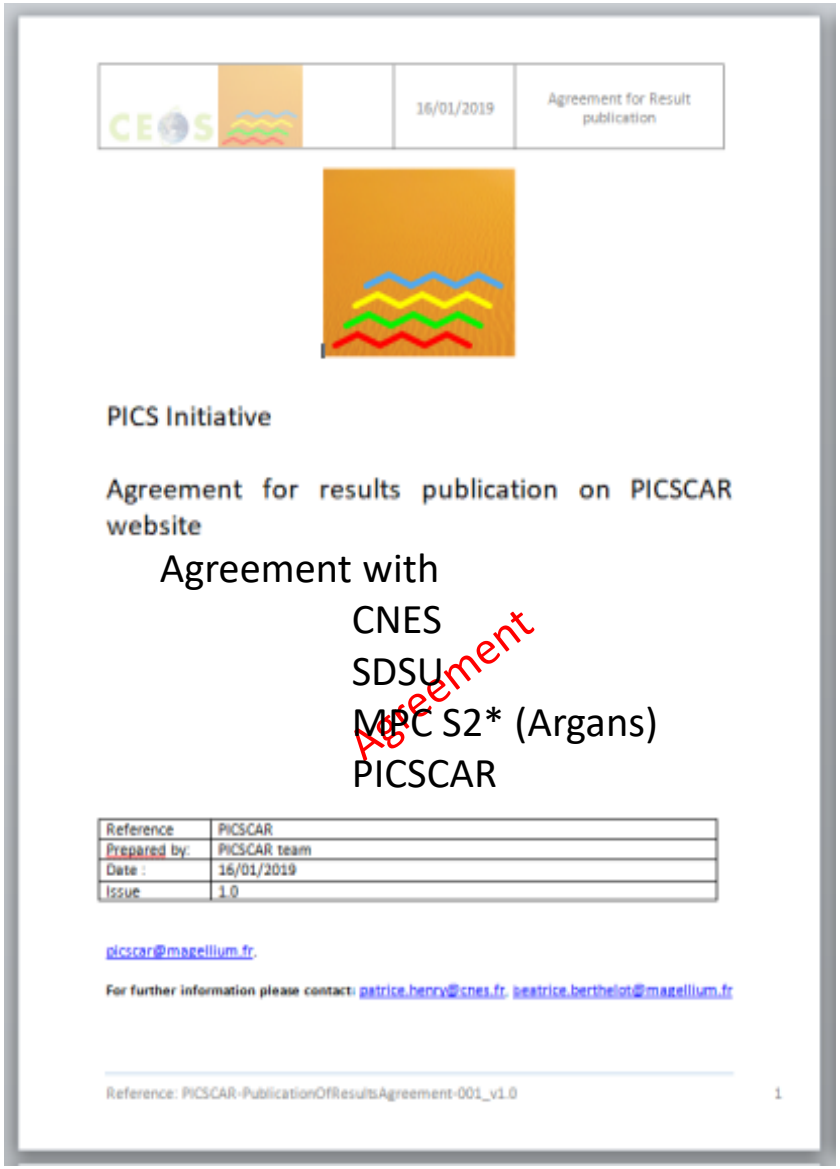
- We have a **web site** which details the methodology used to achieve these results, allowing to assess the differences between the methods.

Set up of IC result repository

- The PICSCAR intercomparison exercise of S2A/MSI and L8/OLI data performed in2018 showed that there is an interest in comparing regularly the results obtained between the different teams involved in this activity.

- Based on this initial activity, it was decided i) to extend the action and share the intercalibration results obtained operationally by the different teams using their own data extraction and data processing and ii) make these results available to users through the PICSCAR web site.

– **Objectives** : Publication of the results every 6 months



Portal dedicated to PICS

CEOS PICSCAR

CEOS WGCV IVOS initiative on the characterization of PICS

Admin | Admin panel | Log out

Site characteristics

Algeria3
Algeria5
Libya1
Libya4
Mauritania1
Mauritania2

Open simulation tools

View PICSCAR Exercises

View calibration over Libya4

Pseudo invariant calibration sites have been widely and successfully used on-orbit radiometric trending of optical satellite systems for more than 20 years. At the IVOS 27 meeting in November 2015, a new initiative was established to facilitate coordination and help prioritize research on PICS and their usage for the benefit of the EO community as a whole.

A roadmap has been set up at IVOS 28 in March 2017 where the subjects have been identified and priorities given to:

- PICS's BRDF characterization
- Spectral characterization
- Atmosphere properties
- Temporal stability
- Combining multiple sites calibration results
- Revisiting the sites

This portal contains general and detailed information about 6 PICS. It provides also a tool simulate the reflectance normalized to nadir. Please register to have access to the document.

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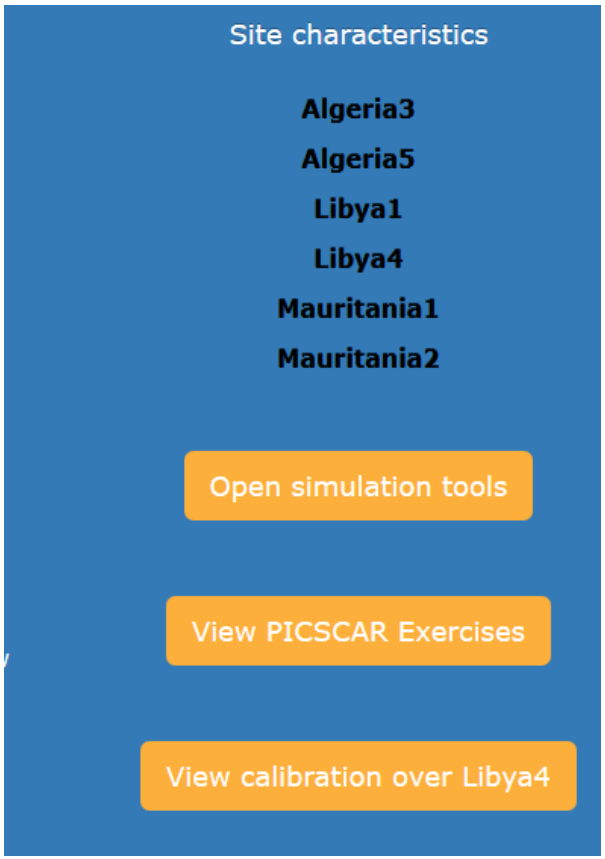
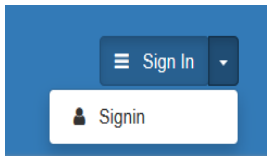
Portal content



- Information available:

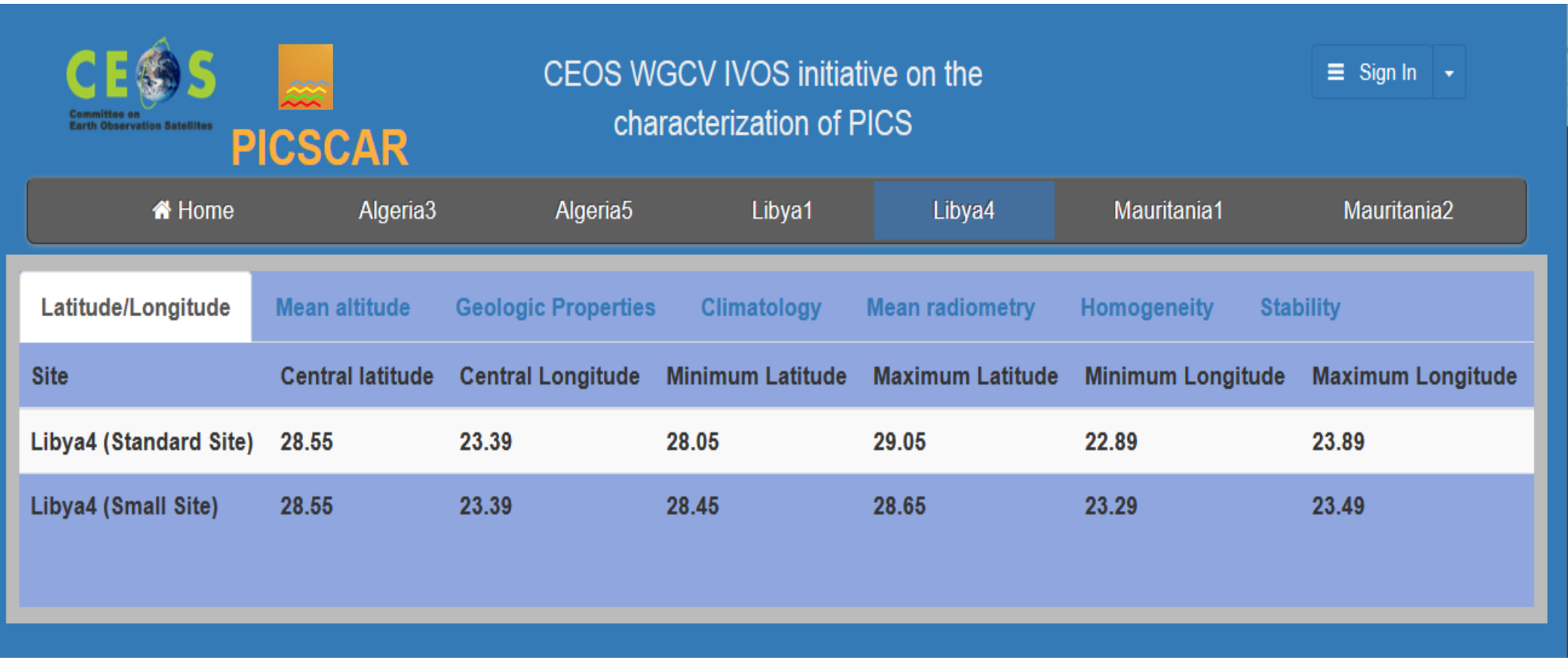
1. Site characteristics
2. News

Authentification required



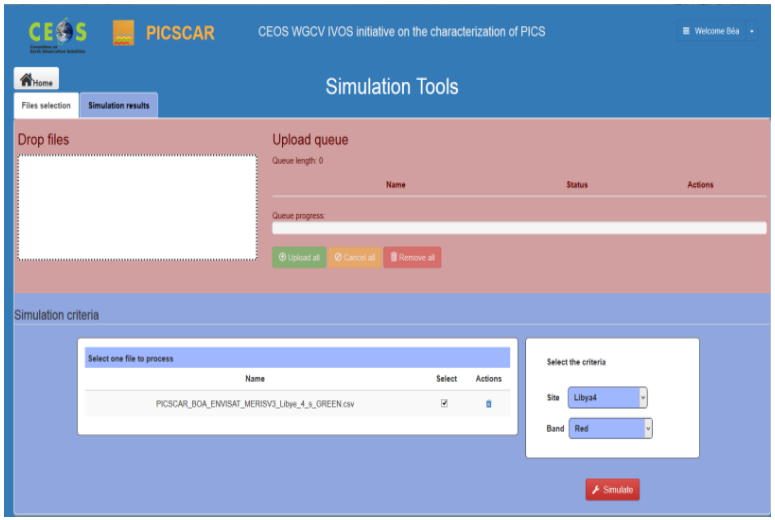
3. Tools
4. Results of Intercalibration of L8/OLI with S2A/MSI

Site characteristics



Site	Central latitude	Central Longitude	Minimum Latitude	Maximum Latitude	Minimum Longitude	Maximum Longitude
Libya4 (Standard Site)	28.55	23.39	28.05	29.05	22.89	23.89
Libya4 (Small Site)	28.55	23.39	28.45	28.65	23.29	23.49

Simulation tools



Normalisation of BOA reflectances temporal series

INPUT : BOA reflectances
OUTPUT : Normalised BOA reflectances

Simple format (csv)

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Home

Calibration over Libya4

Intercomparison of S2A/MSI and L8/OLI

The monitoring of the ratio of equivalent bands of S2A/MSI and L8/OLI sensors is provided for the team involved in the E1 exercice. Results of different teams are provided.

Teams to compare: ☑ PICSCAR ☑ CNES ☑ SDSU ☑ MPCS2A All None

Comparison by band | **Means over all dates** | **Comparison by date** | **Tables with all values**

- ☐ CA
- ☐ Blue
- ☐ Green
- ☐ Red
- ☐ NIR
- ☐ SWIR1
- ☐ SWIR2

All None

Calibration over Libya4

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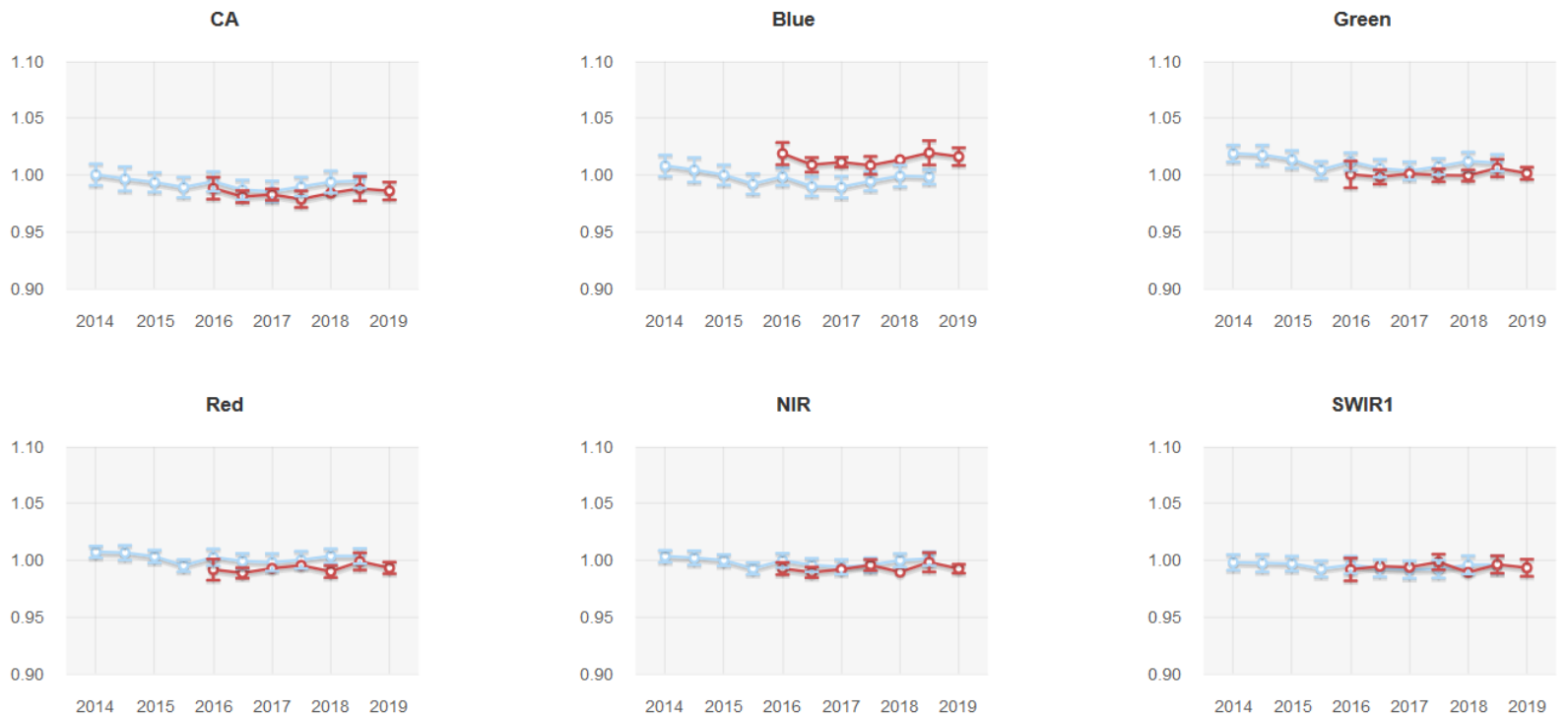
- [x] CA
- [x] Blue
- [x] Green
- [x] Red
- [x] NIR
- [x] SWIR1
- [ ] SWIR2

All None



Calibration over Libya4

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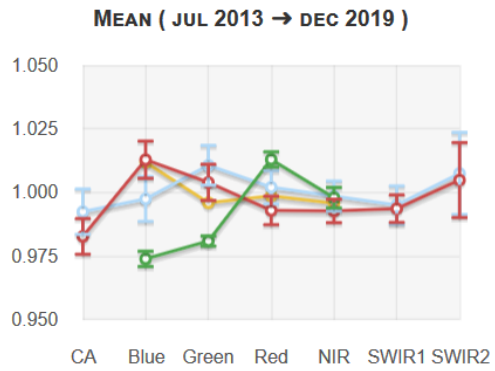

Band name	PICSCAR	CNES	SDSU	MPCS2A
CA	( )	0.9925 (0.0089)	0.9828 (0.007)	( )
Blue	1.0119 (0)	0.9975 (0.0088)	1.0129 (0.0073)	0.974 (0.003)
Green	0.996 (0)	1.0107 (0.0078)	1.004 (0.0071)	0.981 (0.002)
Red	0.9987 (0)	1.0021 (0.0065)	0.993 (0.0056)	1.013 (0.003)
NIR	0.9958 (0)	0.9986 (0.0059)	0.9928 (0.0046)	0.998 (0.004)
SWIR1	( )	0.9951 (0.0075)	0.9937 (0.0054)	( )
SWIR2	( )	1.0075 (0.0161)	1.0049 (0.0147)	( )

Conclusion

- Activity performed
  - Exercise 1 results published
  - Set up of the L8/S2A intercalibration monitoring, operational now
  - Assess the LB4 spectral variability based on HYPERION

- Activities on progress
  - Finalise the IC exercises for low resolutions sensors, and BRDF correction
  - Extend our results to other sites
  - Adress other points of the roadmap

Conclusion

- Implement tool dedicated to sensor stability assessment
  - IC with a reference sensor S2 or L8
    - Reflectance simulation tool being completed with AC/forward module and comparisons with reference reflectance.

- Continue to populate our web site to additional information on other sites

- WGCV/IVOS and PICSCAR are welcomed to provide assessment of datasets.

- Thank you for your attention

- Please visit PICSCAR web site
- https://picscar.magellium.com

- Soon
- https://picscarCEOS.org