



PICSCAR

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

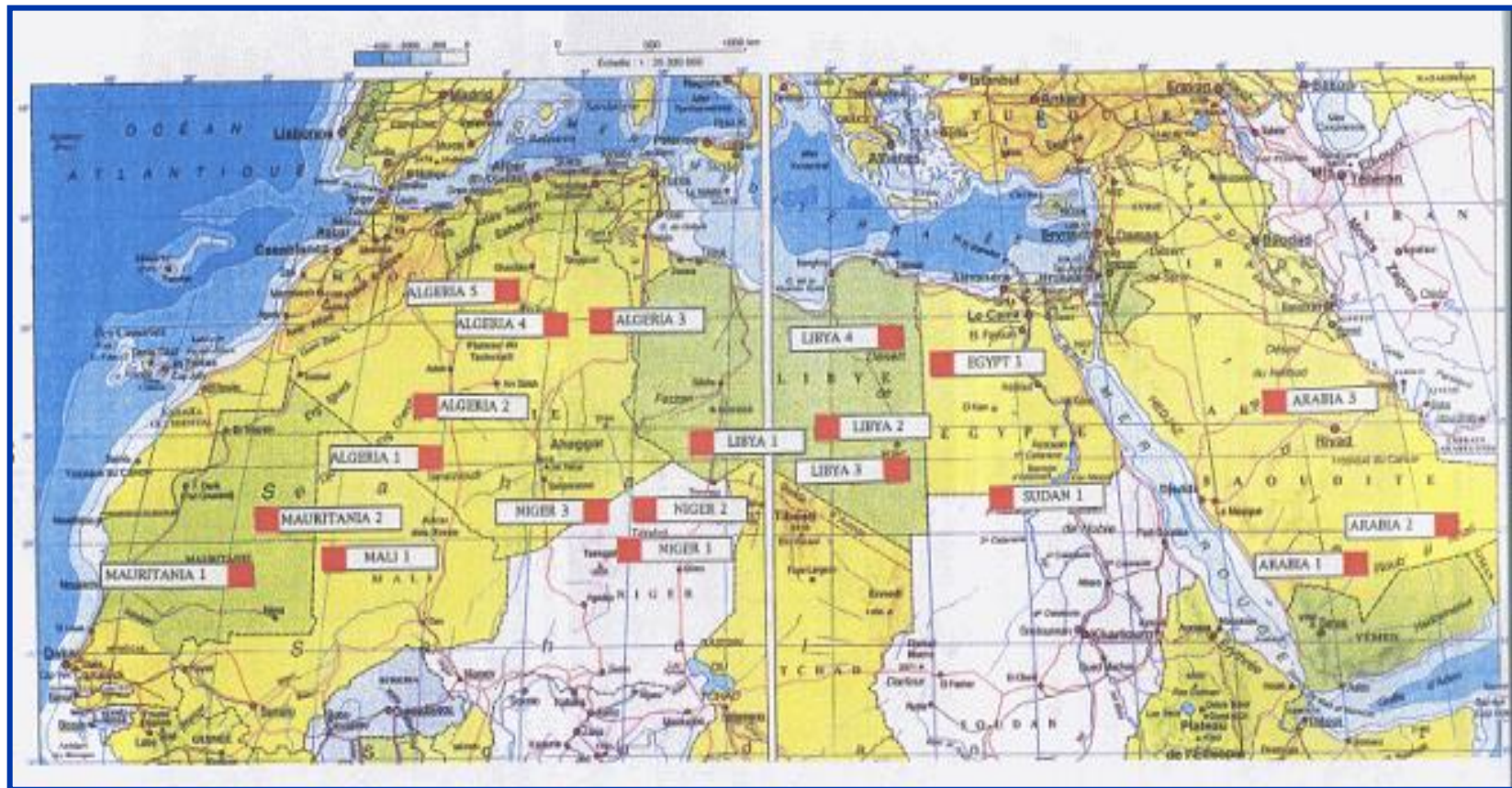
Béatrice Berthelot (Magellium)
Patrice Henry (CNES)

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



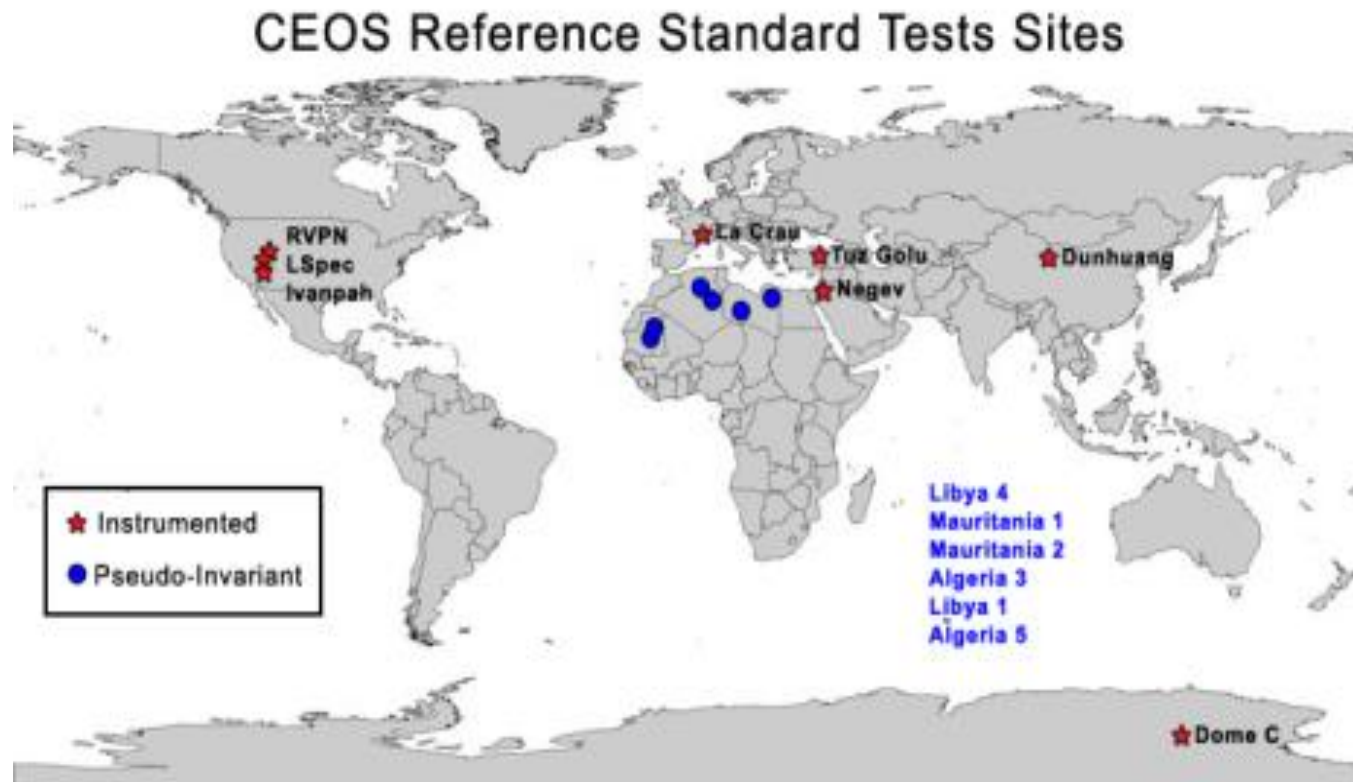
- **Pseudo Invariant Calibration Sites (PICS)** are **natural sites** used as calibration data source because of they exhibit no or low changes on spatial and spectral properties.
 - Selection performed to identify sites with high temporal stability and high spatial homogeneity
- **PICS** can be used 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 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 developed 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.**



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



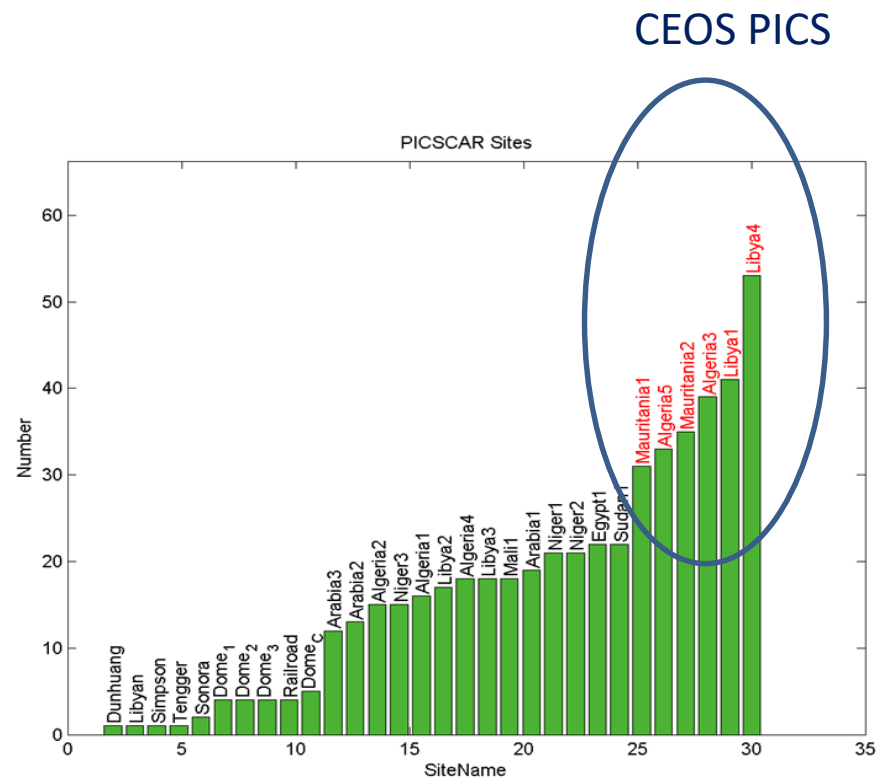
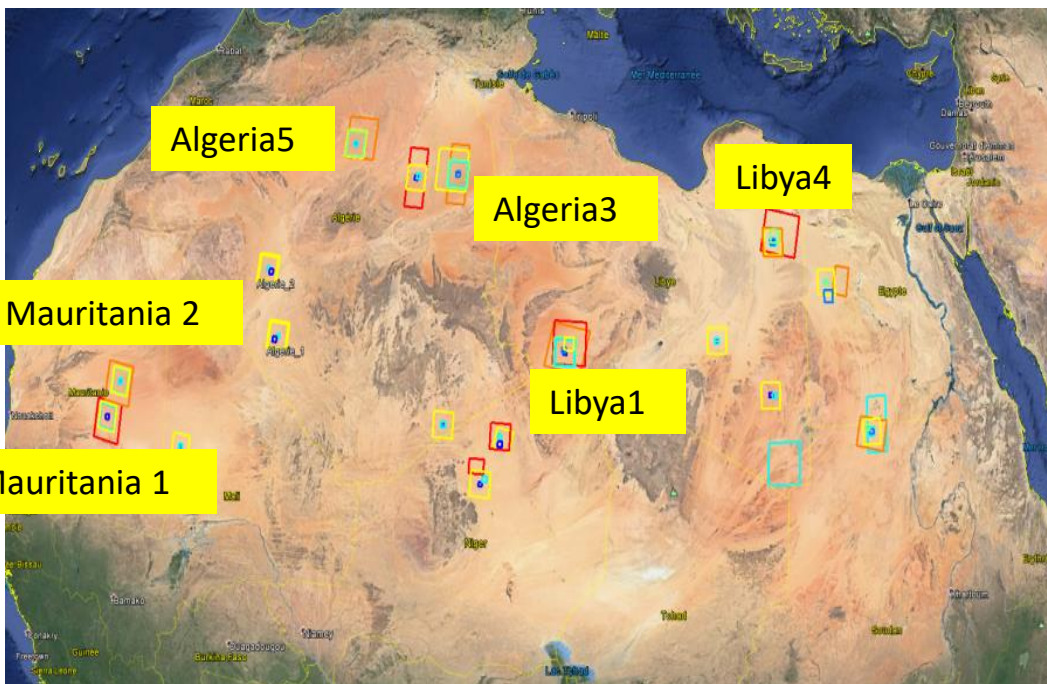
Onera (PICSSand), CNES





From questionnaire: Site interest

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



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 SDSU

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

CEOS SITE REFERENCE LOCATION
1°x1°

PICS User JPL
Satellite: MISR

PICS User CNES

- Satellite: MERIS
- Satellite: MODIS
- TERRA_AQUA
- Satellite: LANDSAT7_ETM
- Satellite: LANDSAT8_OLI
- Satellite: PleiadesPHR1A_1B
- Satellite: Sentinel2_MSI
- Satellite: SPOT6_7

PICS User ESA

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

PICS User VITO
Satellite: ProbaV

PICS User Rayference
Satellite: MSG_METEOSAT
Satellite: GOME_2

PICS User DLR
Satellite: AVHRR

PICS User ARGANS

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

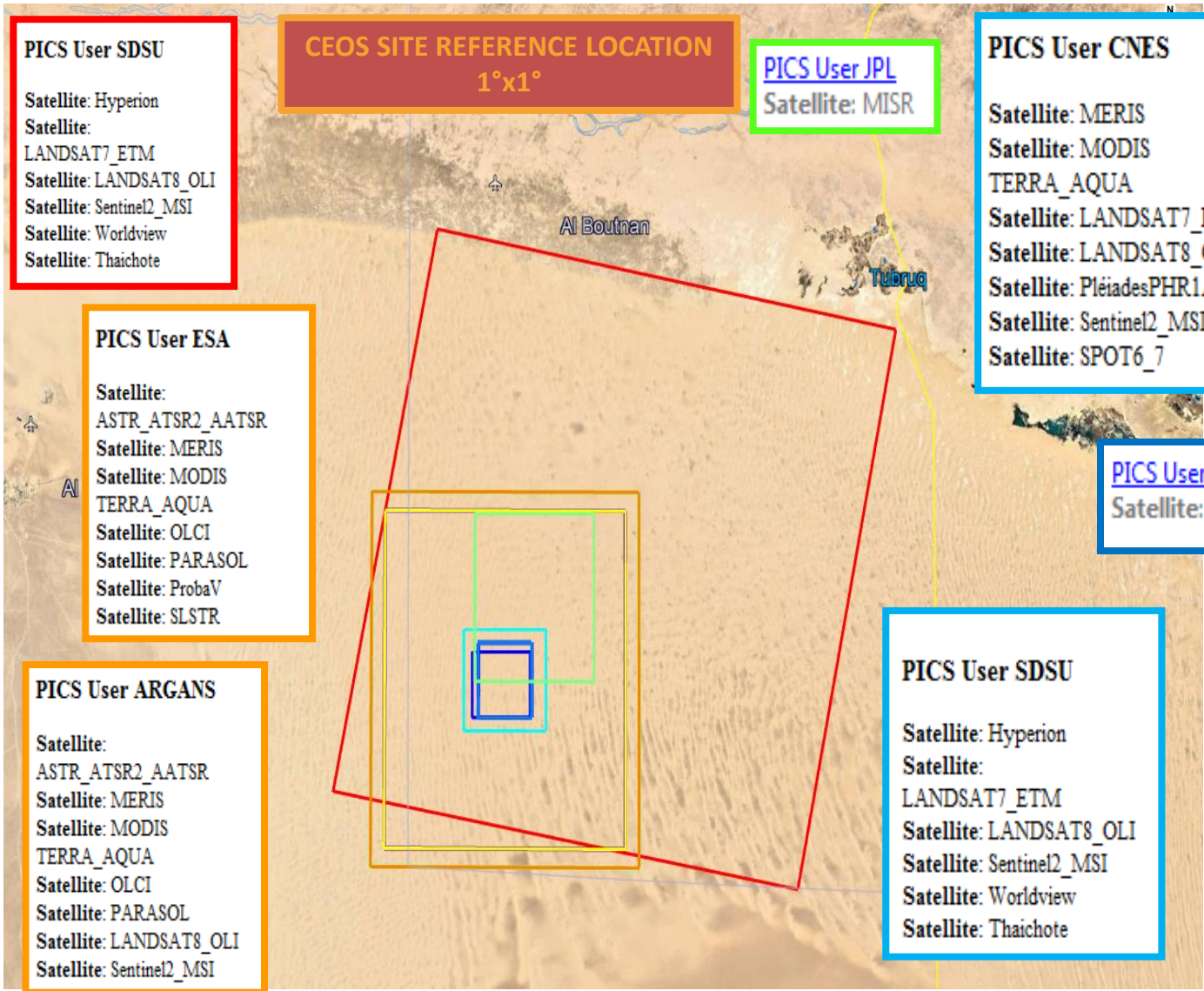
PICS User SDSU

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

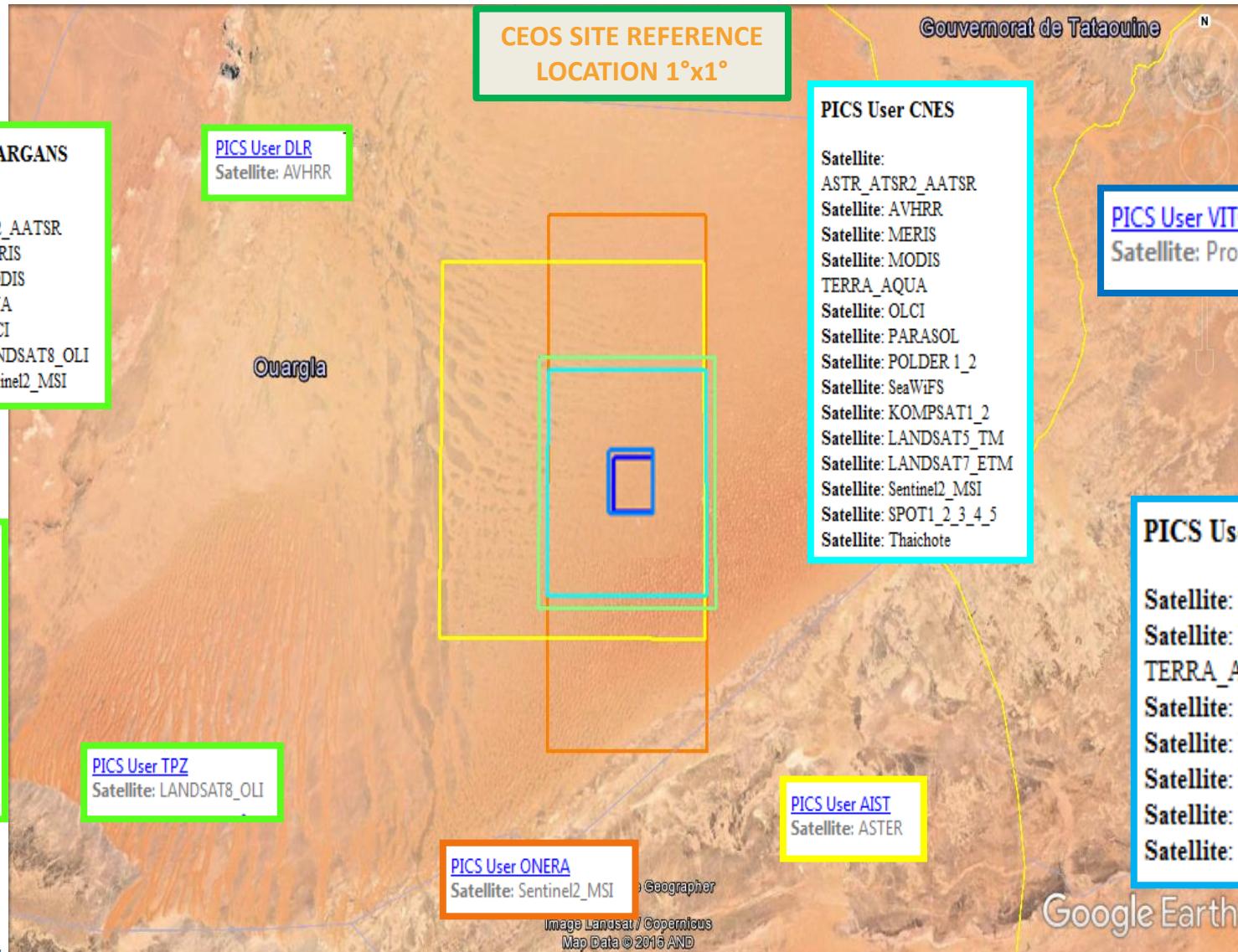
PICS User NOAA-NESDIS-STAR
Satellite: VIIRS

PICS User TPZ

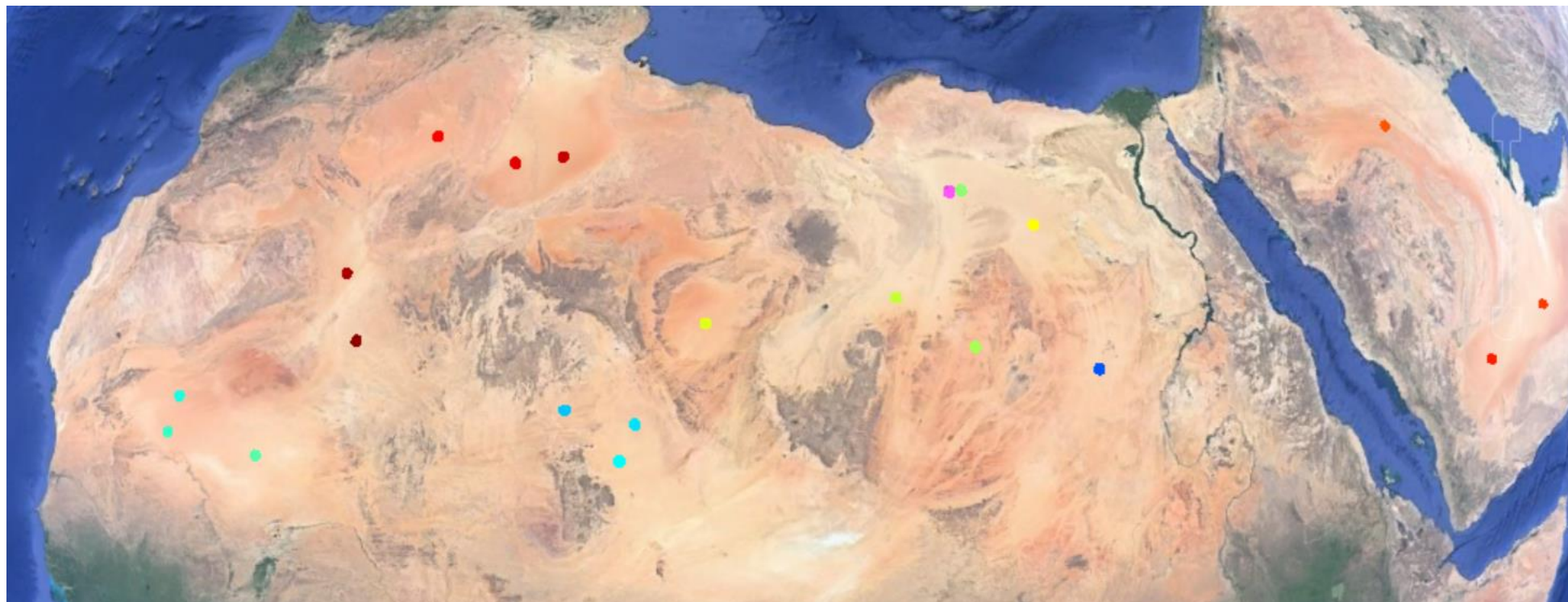
- Satellite: LANDSAT5_TM
- Satellite: LANDSAT7_ETM
- Satellite: LANDSAT8_OLI
- Satellite: Sentinel2_MSI



Algeria 3 seen by different groups



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



- 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



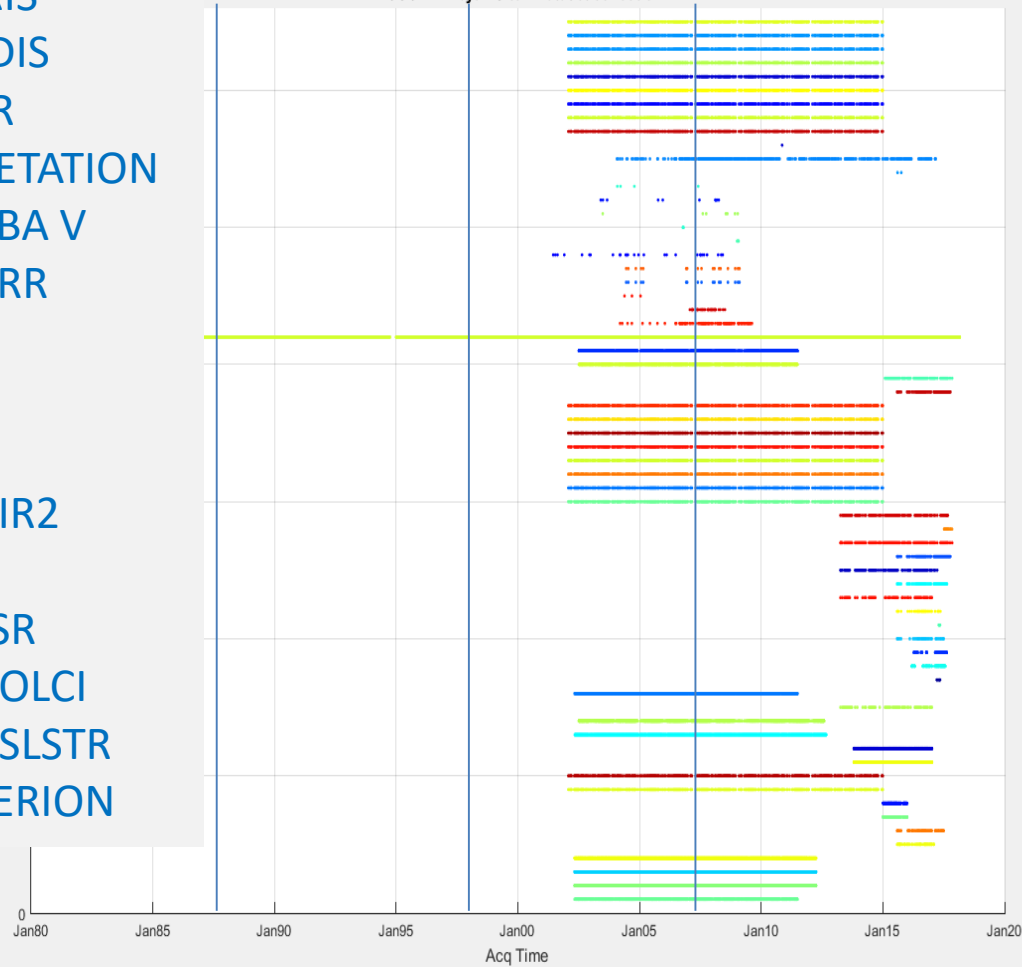
Overview of the large data collection for our assessment

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

PICSCAR Libya4 Site : Dataset collection

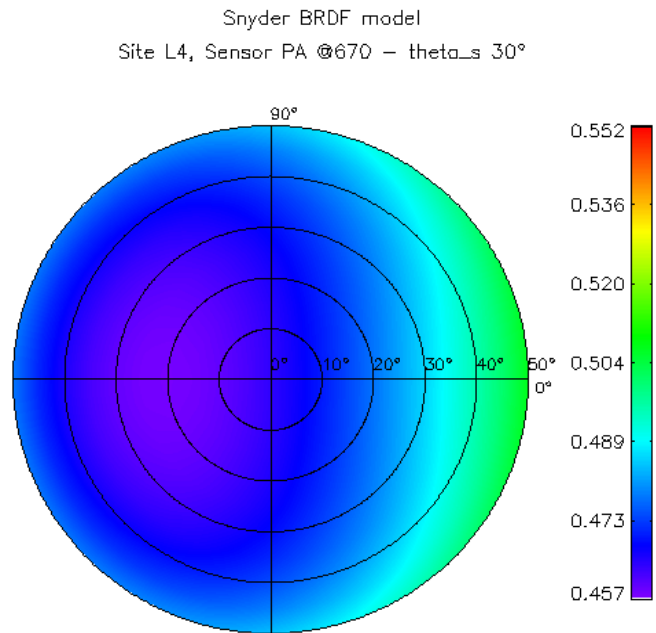


1980 1990 2000 2010 2020

- 1: CNES.MERIS,100x100 : 1059
- 2: ESA.MERIS,100x100 : 1713
- 3: ARGANS.MERIS,100x100 : 1710
- 4: ARGANS.MERIS,20x20 : 1535
- 5: ARGANS.SZAMSI,20x20 : 61
- 6: CNES.SZAMSI,20x20 : 46
- 7: CMA.FY3,20x20 : 157
- 8: CMA.FY3,100x100 : 149
- 9: JPL.MISR,100x100 : 378
- 10: JPL.MISR,20x20 : 378
- 11: VITO.PROBAV,100x100 : 825
- 12: VITO.PROBAV,20x20 : 825
- 13: CNES.VGT2,100x100 : 2338
- 14: CNES.MODIS,100x100 : 1919
- 15: CNES.L8,20x20 : 60
- 16: CNES.MERIS,20x20 : 1128
- 17: CNES.S2BMSI,20x20 : 5
- 18: CNES.S3AOLCI,100x100 : 97
- 19: CNES.S3ASLSTR,100x100 : 117
- 20: CNES.S2AMSI,100x100 : 37
- 21: CNES.S2BMSI,100x100 : 3
- 22: SDSU.S2AMSI,20x20 : 33
- 23: SDSU.L8,20x20 : 52
- 24: SDSU.S2AMSI,20x20 : 55
- 25: SDSU.L8,20x20 : 71
- 26: SDSU.S2AMSI,20x20 : 60
- 27: SDSU.L8,20x20 : 90
- 28: SDSU.S2BMSI,20x20 : 11
- 29: CNES.L8,20x20 : 82
- 30: JPL.MISR_AA,100x100 : 378
- 31: JPL.MISR_AF,100x100 : 378
- 32: JPL.MISR_BA,100x100 : 378
- 33: JPL.MISR_BF,100x100 : 378
- 34: JPL.MISR_CA,100x100 : 378
- 35: JPL.MISR_CF,100x100 : 378
- 36: JPL.MISR_DA,100x100 : 378
- 37: JPL.MISR_DF,100x100 : 378
- 38: SDSU.S2A,20x20 : 60
- 39: SDSU.L8,20x20 : 54
- 40: CNES.MERIS,100x100 : 1040
- 41: CNES.MODIS,100x100 : 1687
- 42: NASA.AVHRR,100x100 : 14090
- 43: CNES.HYPERION_Libya4,10x100 : 105
- 44: CNES.HYPERION_Algeria3,10x100 : 33
- 45: CNES.HYPERION_Algeria5,10x100 : 3
- 46: CNES.HYPERION_Mauritania1,10x100 : 17
- 47: CNES.HYPERION_Mauritania2,10x100 : 17
- 48: CNES.HYPERION_RVPN,10x100 : 28
- 49: CNES.HYPERION_DomeC,10x100 : 4
- 50: CNES.HYPERION_Dunhuang,10x100 : 3
- 51: CNES.HYPERION_Frenchman,10x100 : 7
- 52: CNES.HYPERION_vanpah,10x100 : 10
- 53: CNES.HYPERION_Sonora,10x100 : 4
- 54: PICSCAR.HYPERION,10x100 : 2
- 55: PICSCAR.HYPERION,10x100 : 428
- 56: PICSCAR.HICO,10x100 : 1
- 57: JPL.MISR,100x100 : 378
- 58: JPL.MISR_AA,100x100 : 378
- 59: JPL.MISR_AF,100x100 : 378
- 60: JPL.MISR_BA,100x100 : 378
- 61: JPL.MISR_BF,100x100 : 378
- 62: JPL.MISR_CA,100x100 : 378
- 63: JPL.MISR_CF,100x100 : 378
- 64: JPL.MISR_DA,100x100 : 378
- 65: JPL.MISR_DF,100x100 : 378



- 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

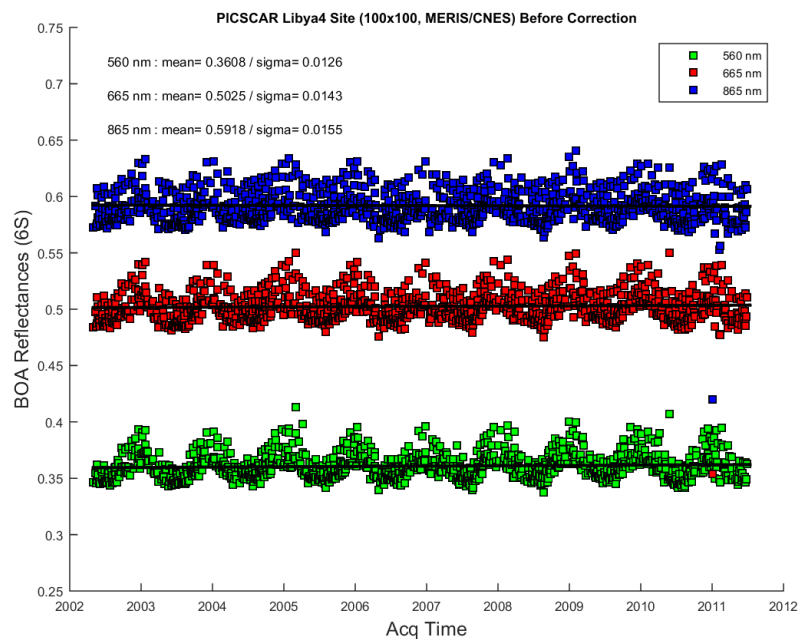
- Linear model
- 7 parameters
- Fitted in GREEN, RED, NIR wavelengths

BRDF normalisation has been application to the full dataset

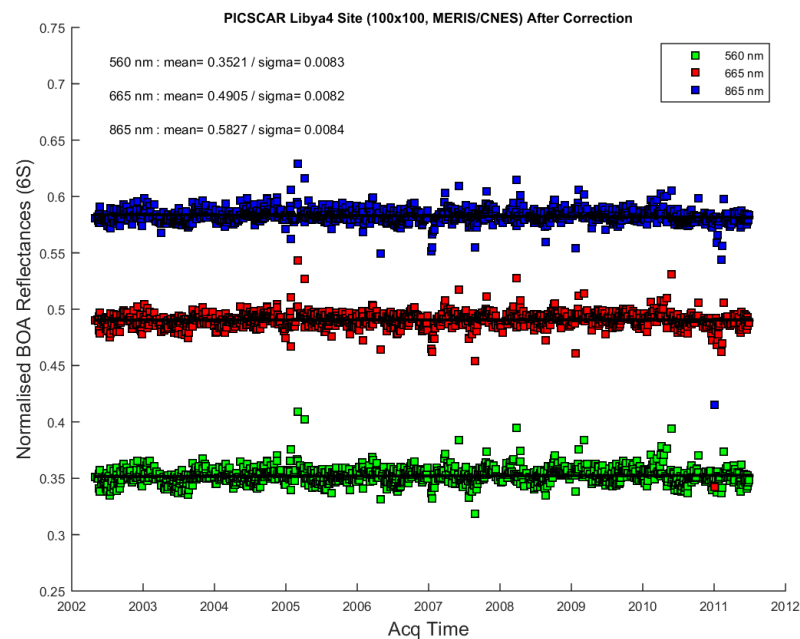


Example of Normalisation applied to 10 years of MERIS

- MERIS before normalisation



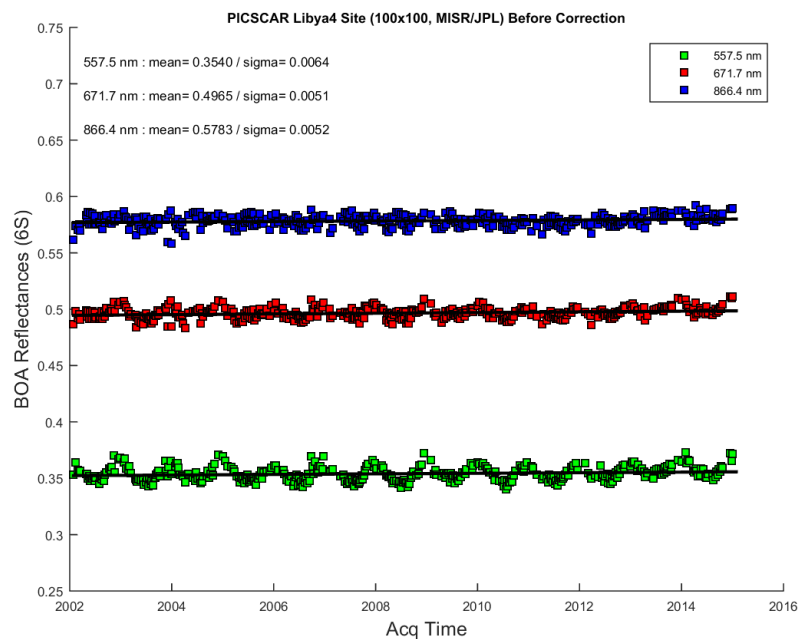
- MERIS after normalisation



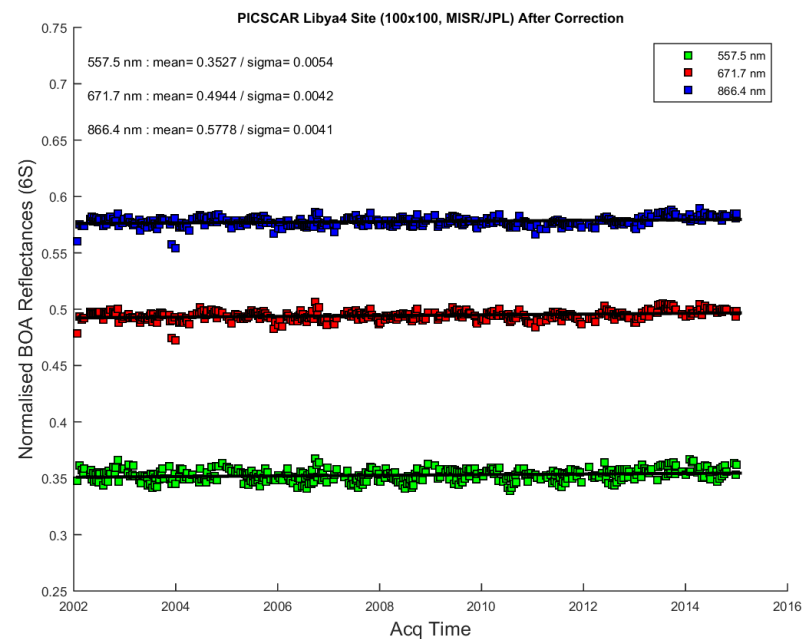


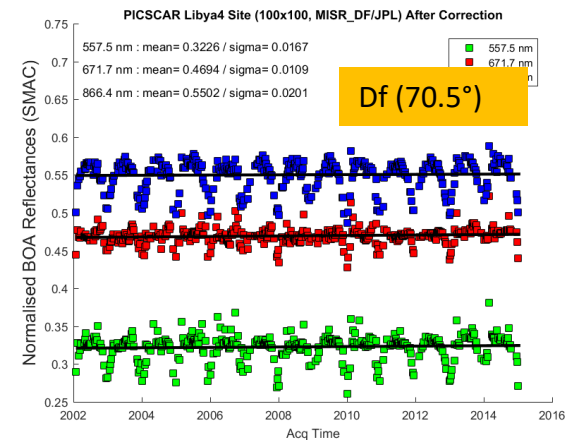
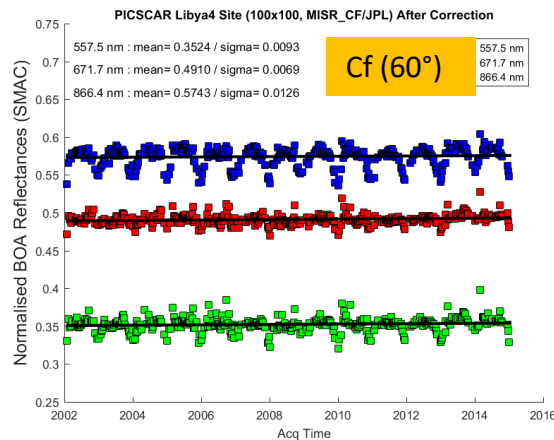
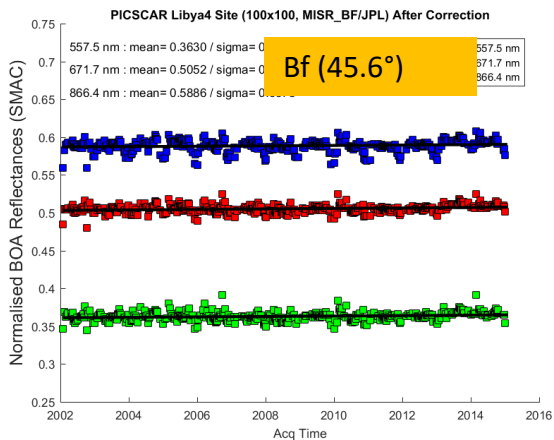
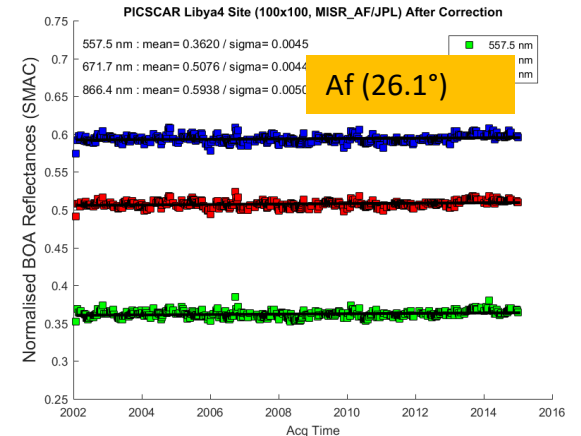
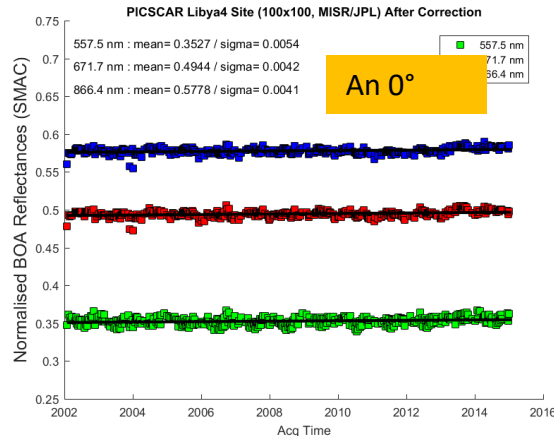
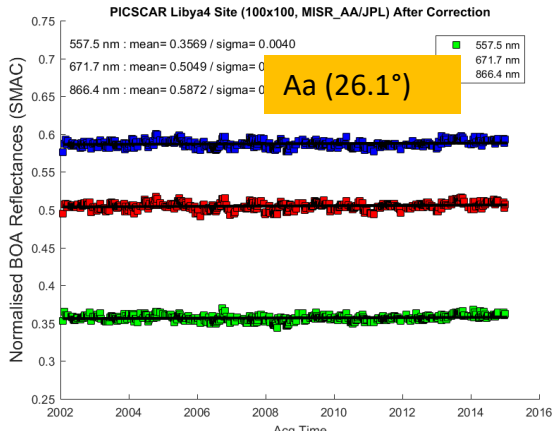
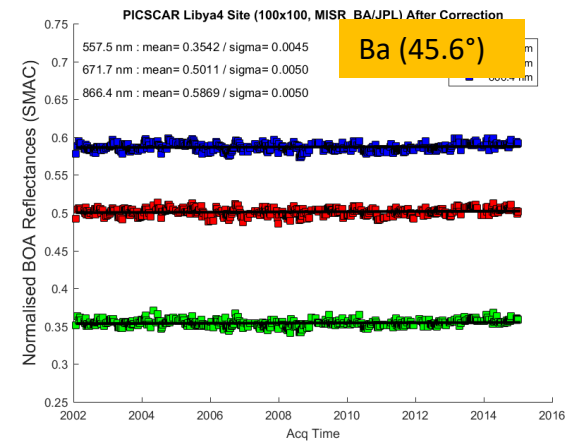
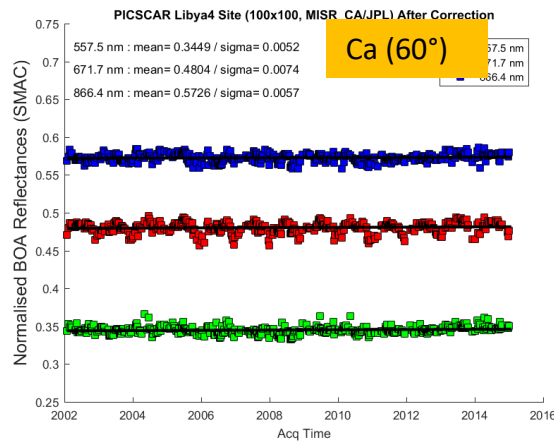
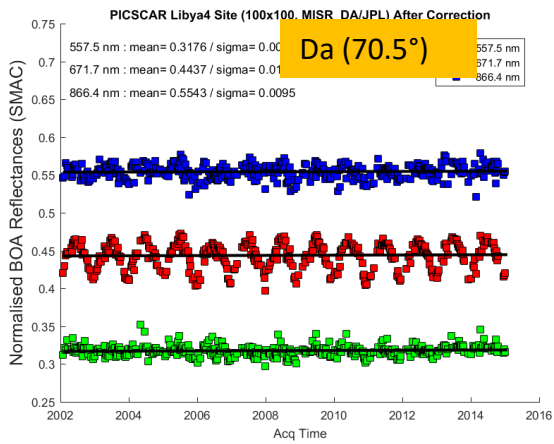
Example of Normalisation applied to 14 years of MISR

- MISR before normalisation



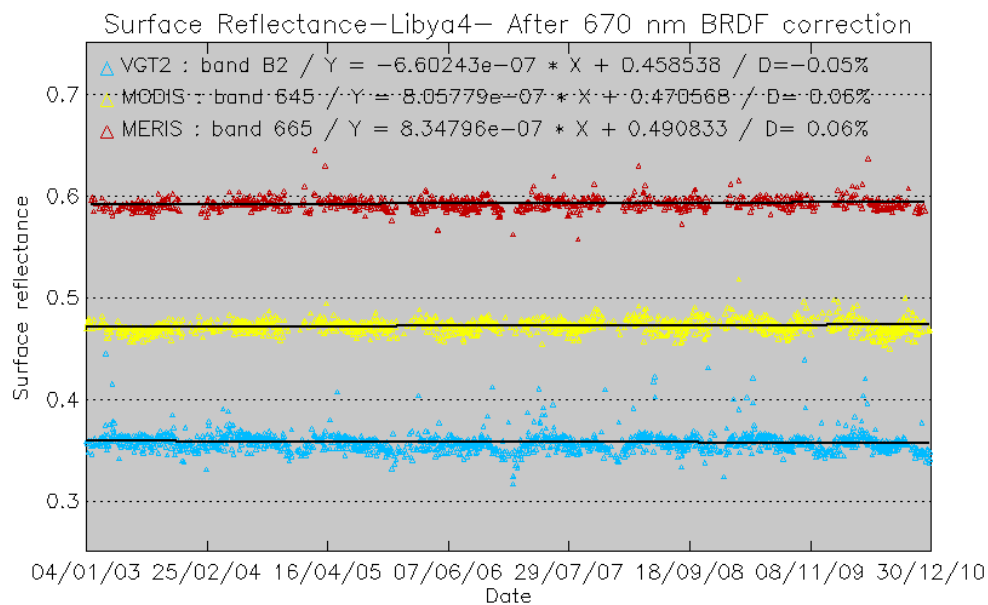
- MISR after normalisation







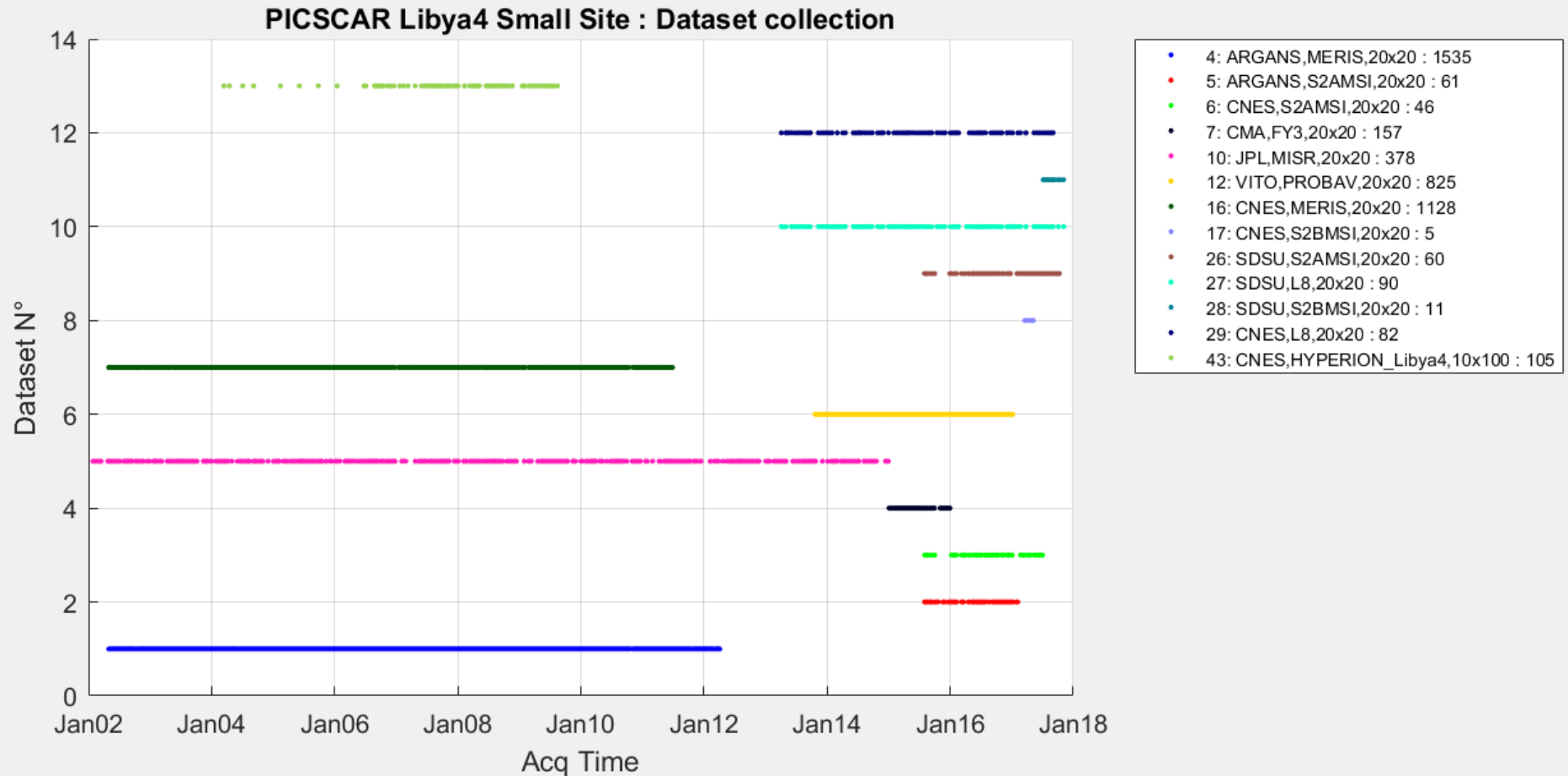
PICSCAR Outcome: Assessment of the site stability



- 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

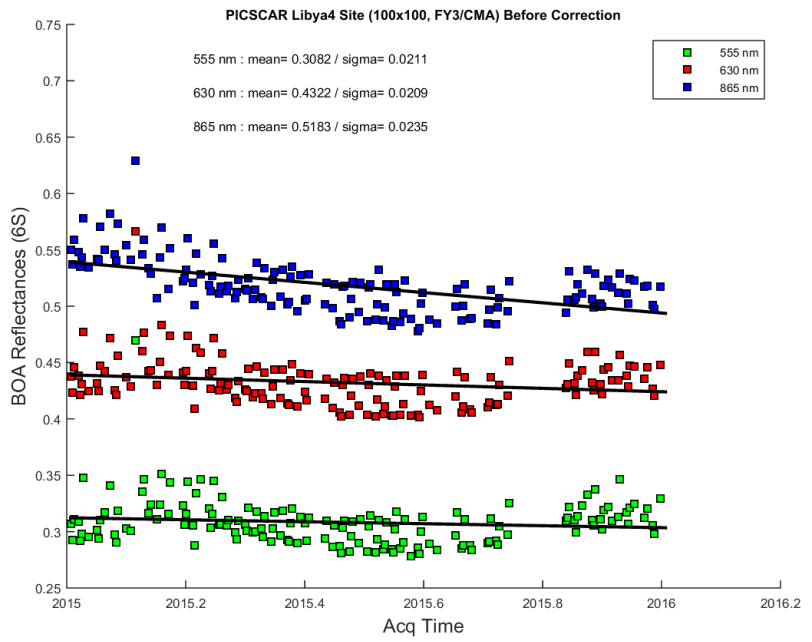


Data collection for HR Sensors

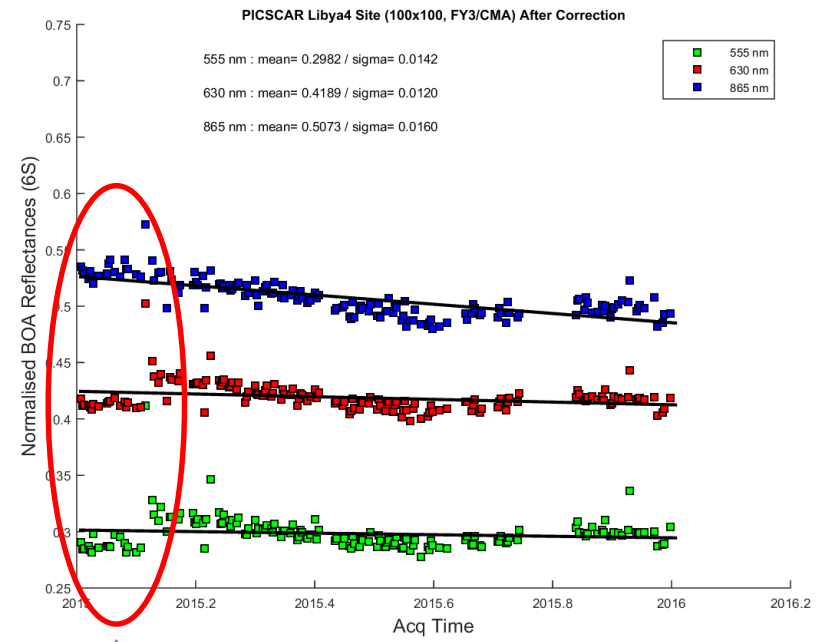


Example of Normalisation applied to 1 year of FY-3

- FY-3 before normalisation



- FY-3 after normalisation



Change in calibration



- 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, Telespazio, Jaxa and PICSCAR team

Argans MPC

TPZ

SDSU

CNES

Home Presentation **Exercise 1** Exercise 2 Exercise 3

Dataset overview S2A MSI Landsat8 OLI **Results**

Results are expressed as the ratio of band L8/S2A

IC L8/S2A	Green	Red	NIR
CNES	1.005	0.997	0.996
SDSU	0.992	0.987	0.992
JAXA/EORC	0.991	0.972	0.989
PICSCAR	0.993	0.996	0.993
TPZ	1.007	0.973	0.997
Argans MPC	1.002	1.009	0.994

Ratio of L8 measurements to simulated measurements are computed.

- 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 in 2018 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

CEOS

16/01/2019

Agreement for Result publication

PICSCAR Initiative

Agreement for results publication on PICSCAR website

Agreement with

CNES
SDSU
MPC S2* (Argans)
PICSCAR

Reference	PICSCAR
Prepared by	PICSCAR team
Date	16/01/2019
Issue	1.0

picscar@magellium.fr

For further information please contact: patrice.henry@cnes.fr / leatrice.berthelot@magellium.fr

Reference: PICSCAR-PublicationOfResultsAgreement-001_v1.0



Portal dedicated to PICS



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](#)

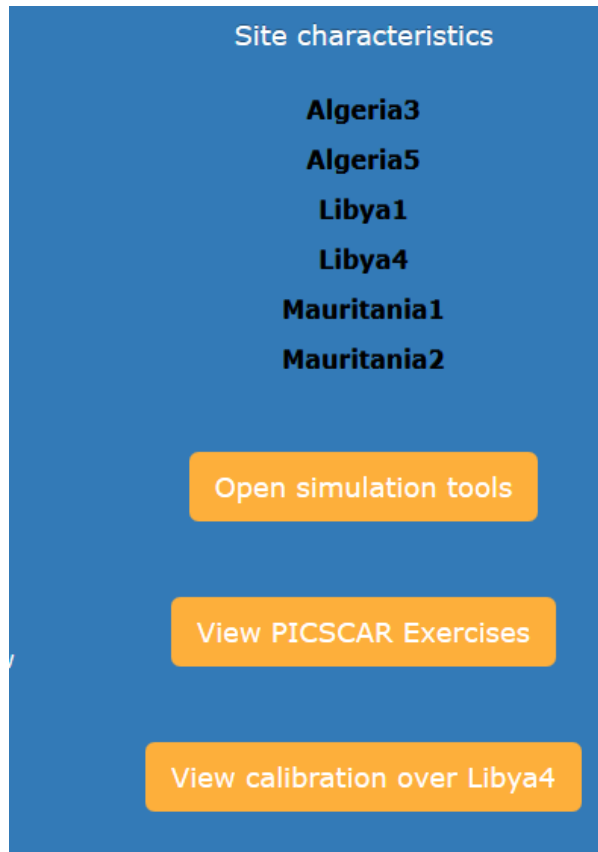
[View calibration over Libya4](#)

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

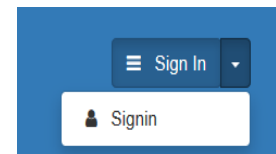
This portal contains general and detailed information about 6 PICS. It provides also a tool simulate the reflectance normalized to nadir. Please register to have access to the document.



- Information available:
 1. Site characteristics

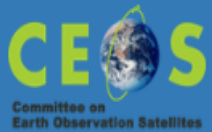
2. News

Authentication required



3. Tools

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



PICSCAR

CEOS WGCV IVOS initiative on the
characterization of PICS

Sign In

Home

Algeria3

Algeria5

Libya1

Libya4

Mauritania1

Mauritania2

Latitude/Longitude	Mean altitude	Geologic Properties	Climatology	Mean radiometry	Homogeneity	Stability
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

PICSCAR Tools

Normalisation of BOA reflectances temporal series

INPUT : BOA reflectances

OUTPUT : Normalised BOA reflectances

Simple format (csv)

The screenshot shows the 'Simulation Tools' interface. It includes a 'Drop files' area, an 'Upload queue' with a progress bar, and a 'Simulation criteria' section. The criteria section has a table for selecting files to process and dropdown menus for 'Site' (Libya) and 'Band' (Red). A 'Simulate' button is at the bottom right.

Name	Select	Actions
PICSCAR_BOA_ENVISAT_MERIS_V3_Libya_4_x_GREEN.csv	<input checked="" type="checkbox"/>	

Select the criteria:
Site: Libya
Band: Red

The screenshot shows the 'Simulation Tools' interface with simulation results. It includes a table of 'Public data available' and 'Simulation result files'. Below the tables are buttons for 'Display normalized surface reflectance', 'Upload Zip Results', and 'Simulation description'. At the bottom is a time-series plot showing normalized surface reflectance from 2002 to 2011.

Name	Select
PICSCAR_ONES_ENVISAT_MERIS_V3_Libya4x_GREEN_output.csv	<input checked="" type="checkbox"/>
PICSCAR_ONES_ENVISAT_MERIS_V3_Libya4x_NIR_output.csv	<input checked="" type="checkbox"/>
PICSCAR_ONES_ENVISAT_MERIS_V3_Libya4x_RED_output.csv	<input checked="" type="checkbox"/>

Name	Select	Actions
PICSCAR_BOA_ENVISAT_MERIS_V3_Libya_4_x_GREEN.csv	<input type="checkbox"/>	

Buttons: Display normalized surface reflectance, Upload Zip Results, Simulation description

Plot: Vs Time (Vs IZA, Vs VZA, Vs (BA-W))



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 exercise. Results of different teams are provided.

Teams to compare: PICSCAR CNES SDSU MPC2A 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

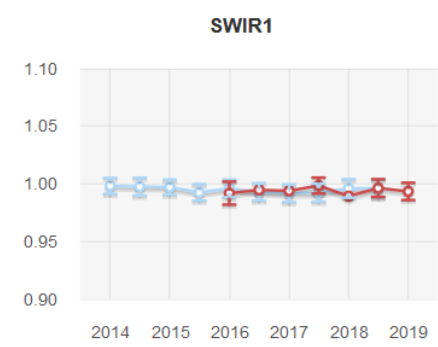
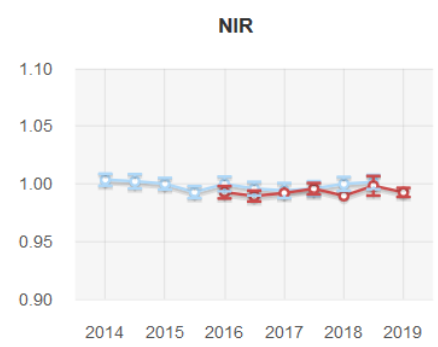
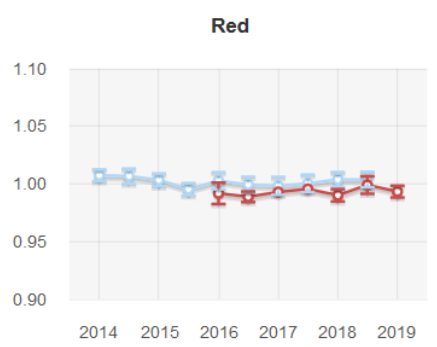
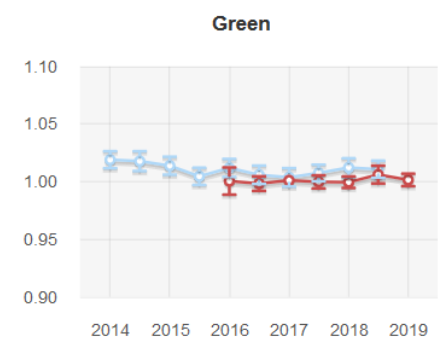
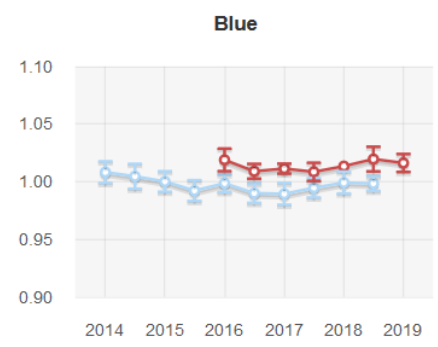
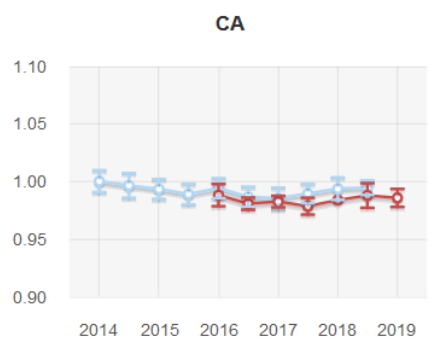
Intercomparison of S2A/MSI and L8/OLI

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Teams to compare: PICSCAR CHE\$ SD\$U MPC S2A 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

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 exercise. Results of different teams are provided.

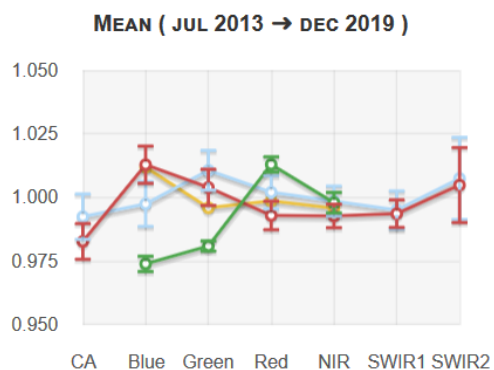
Teams to compare: PICSCAR CNES SDSU MPC2A All None

Comparison by band

Means over all dates

Comparison by date

Tables with all values



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)	()

- **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
 - Address other points of the roadmap

- 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>

