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PUTTING KNOWLEDGE ON THE MAP

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CENTRE NATIONAL D'ETUDES SPATIALES

PICSCAR Initiative presentation
14/11/2024 – GSICS

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Patrice Henry

PICSCAR initiative

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.

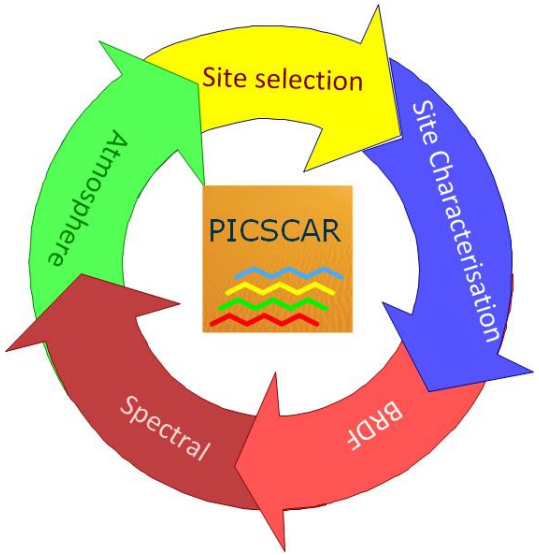
- PICSCAR Working group : CNES, SDSU, JPL, Argans, NPL, ESA, USGS

Task 1

Inventory of existing data, methods and results

PICSCAR Roadmap

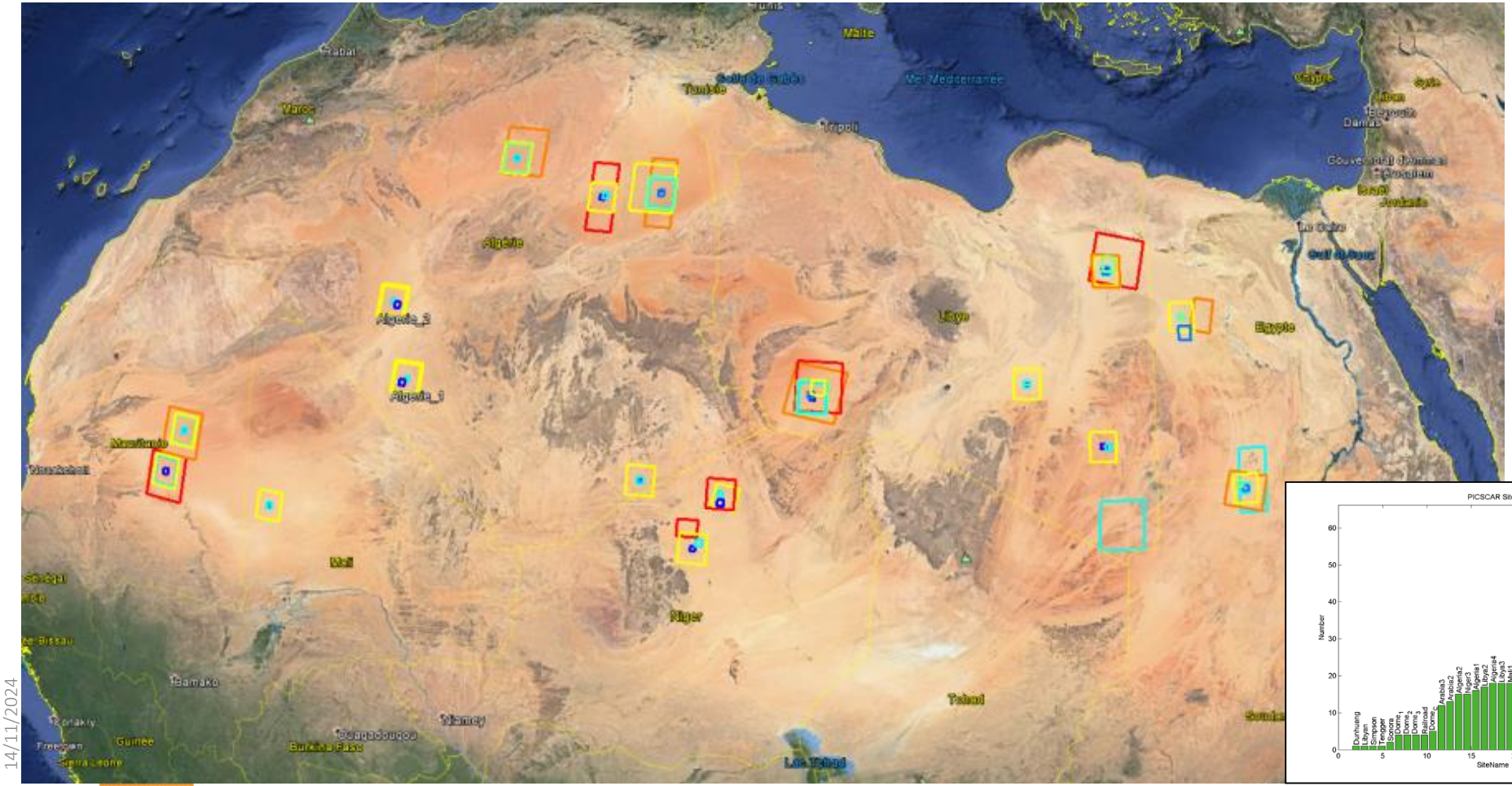
- Priority subjects to adress
  - Based on questionnaire sent to to assess user practices (in terms of site) and identify future needs
    1. BRDF behaviour
    2. Spectral characterization
    3. Atmosphere properties
    4. Temporal Stability
    5. Combining multiple sites calibration results
    6. Revisiting the sites



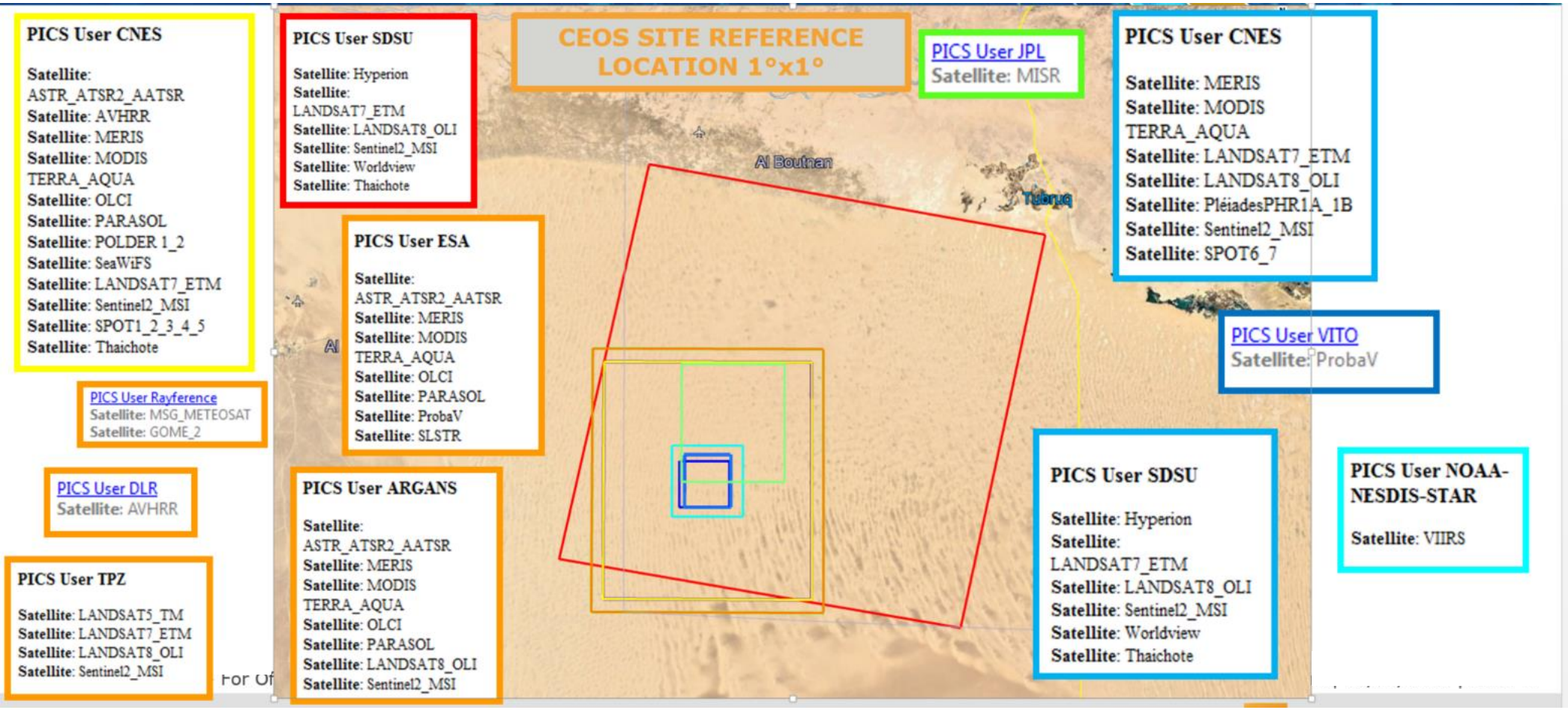
PICSCAR Outcome

- 14 agencies or companies
- 33 sensors (multi resolution)
- 30 sites of interest

6 CEOS PICS ranked in the top of the list



PICS identification

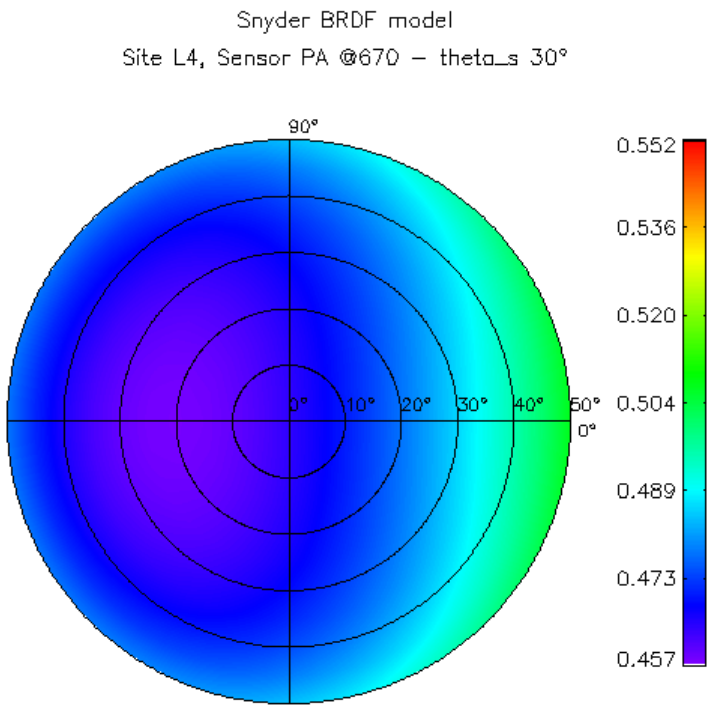


To concentrate our efforts we firstly choose to focus on **Libya 4 site**

Task 2
BRDF Modelling

PICS BRDF modelling

- Site stability can be assessed using BOA reflectances corrected from BRDF effects
- Applying a normalisation based on a Snyder BRDF model derived from recalibrated PARASOL data



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

- BRDF modelling using Snyder modelling
- Linear model
- 7 parameters
- Fitted in GREEN, RED, NIR wavelengths

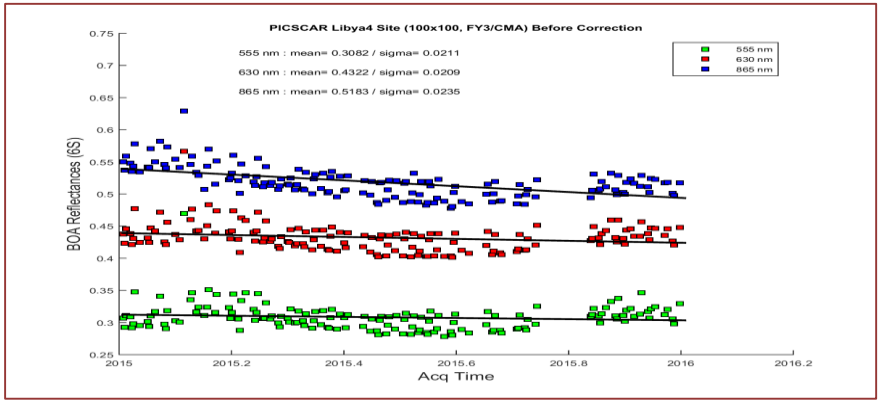
BRDF normalisation has been applied to the full dataset

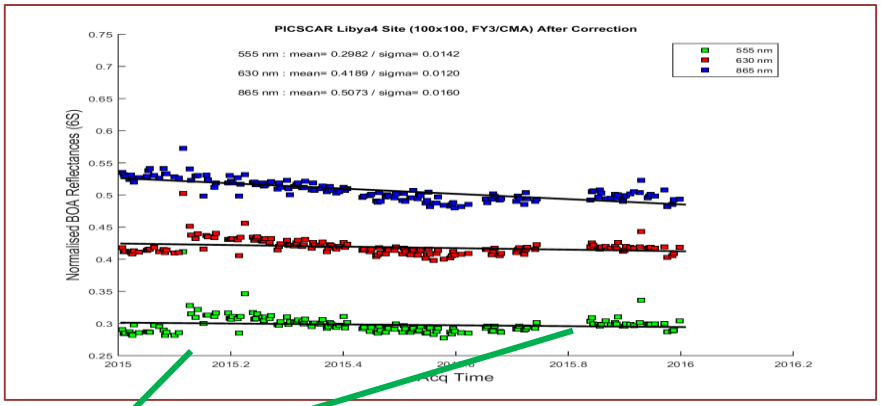
Interest and limitation of the BRDF normalisation

Before normalisation

After normalisation

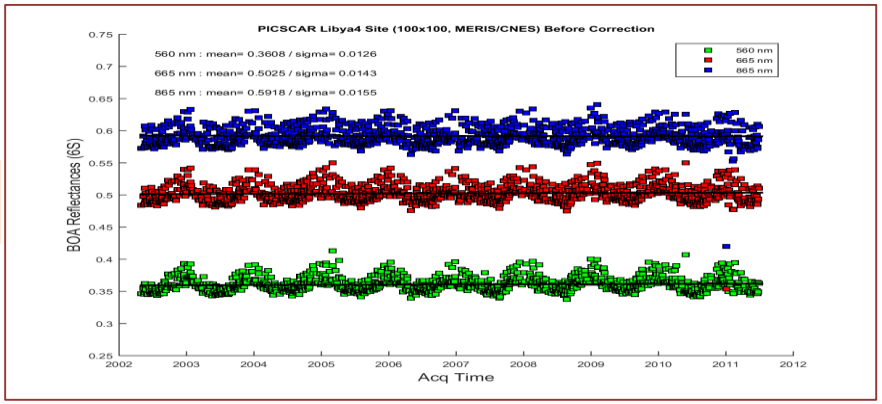
FY-3

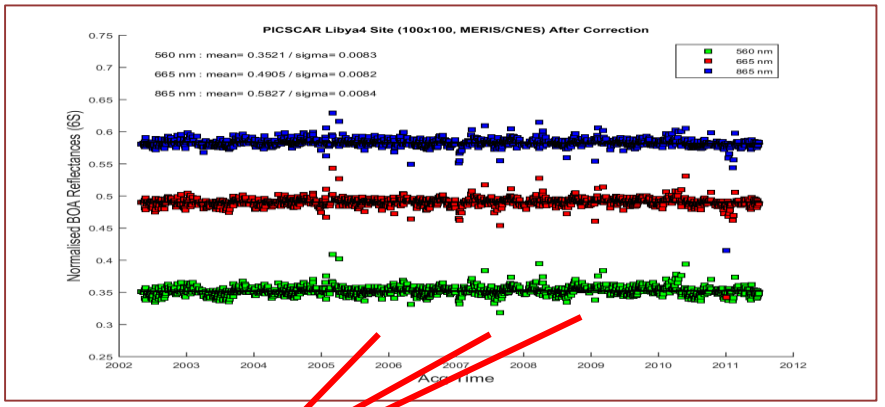




Detection of calibration changes

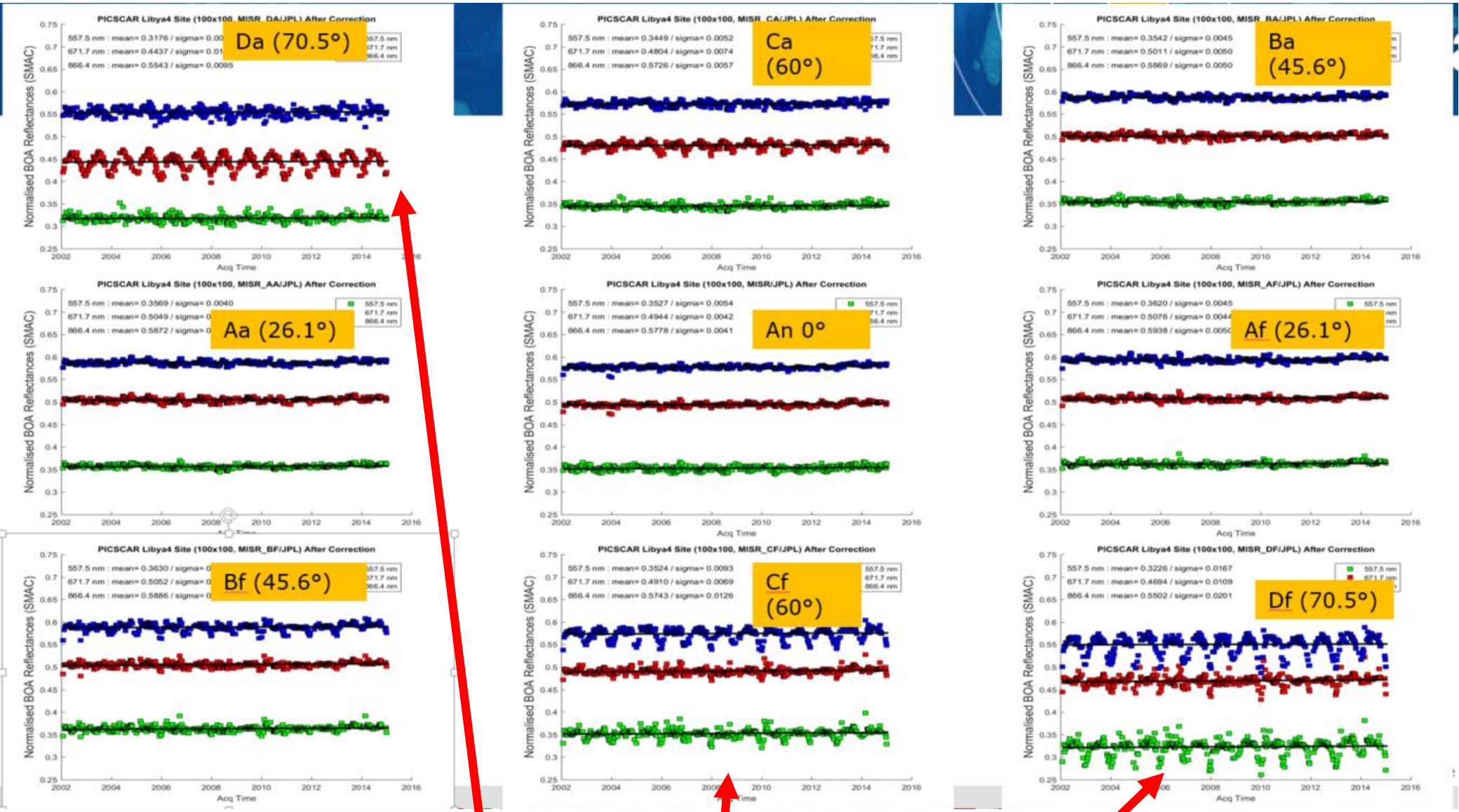
MERIS





Overcorrected reflectance in backscattering conditions

BRDF normalisation: MISR sensor

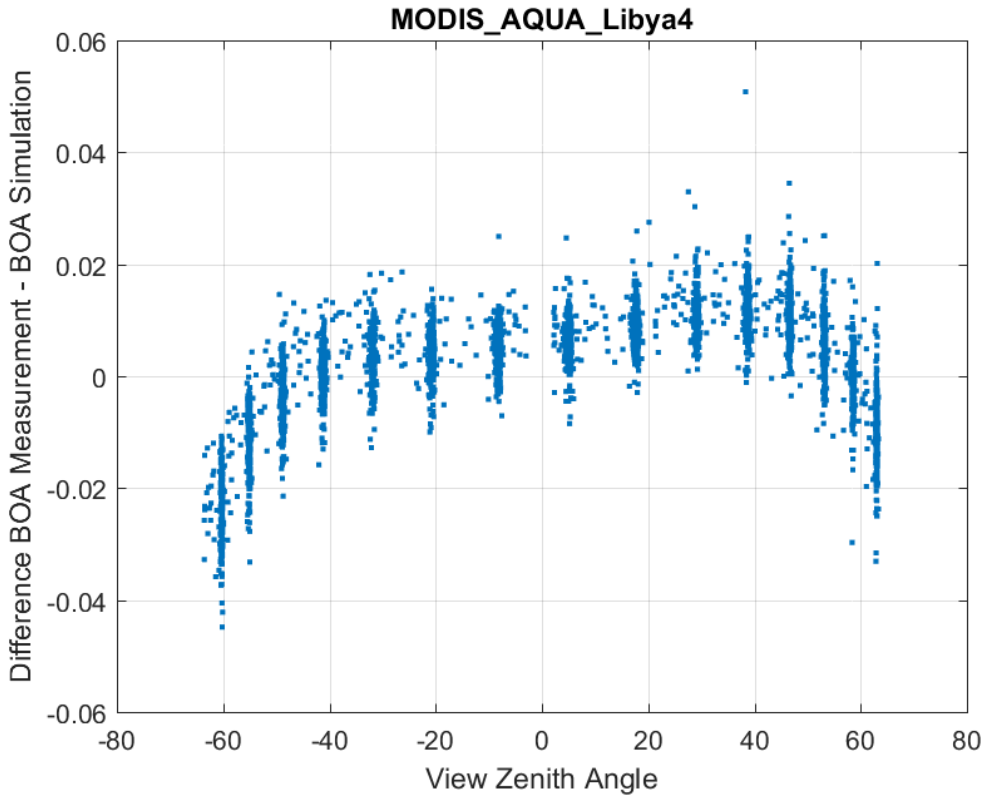


BRDF model not suitable for large viewing angles

BRDF normalisation: MODIS Aqua

- Mean residue different between east and west viewing condition (-0.0033/0.0058)

Reciprocity principle not respected



⇒ Need for an improved BRDF model

- Improvement of the cloud screening
- Taking into account different sensors
- New inversion method

Task 3
Sensitivity of the desert intercalibration method
(on High Resolution data)

How different can intercalibration results be over the same site ?

- Intercalibration over Libya4 small site of Landsat 8/OLI versus Sentinel 2A/MSI
- 5 groups involved: SDSU, CNES, NASA, ESA MPC, and PICSCAR teams
- Over 8 years regularly published on the PICSCAR portal

Libya4 Small site
20 x 20 km^2
Centered on 28.55 °N, 23.89 °E

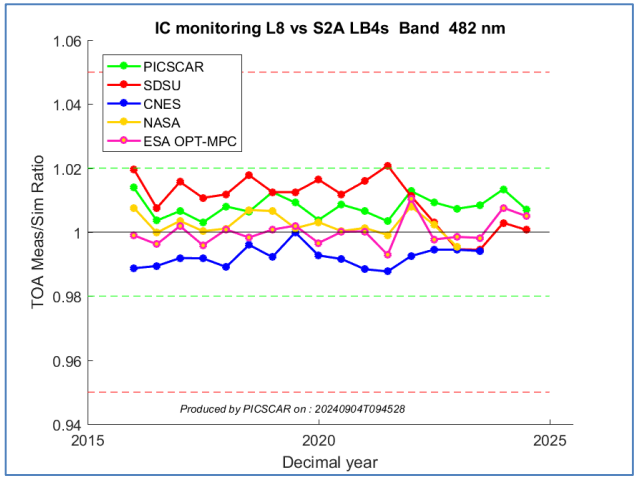
Comparison is assessed by monitoring the ratio of L8 TOA reflectances / S2A TOA reflectance based on different independant and well documented methods

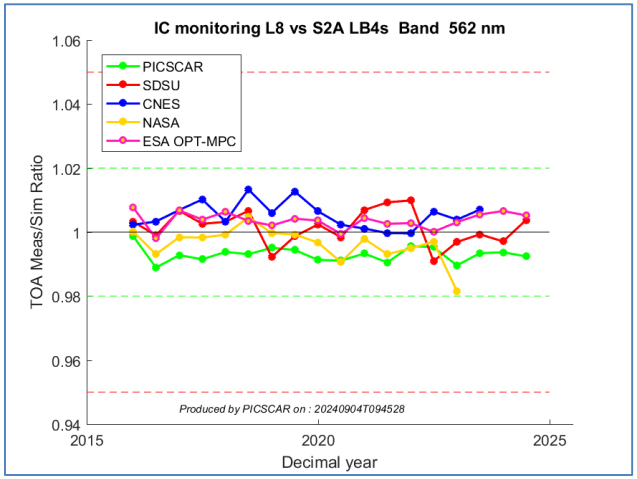
Results of the comparison

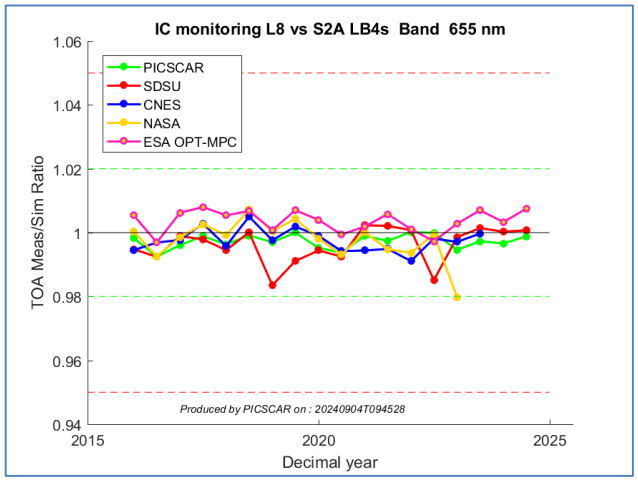
Very good coherence versus the official radiometric calibration
Slight discrepency for NIR band (-0.5%)

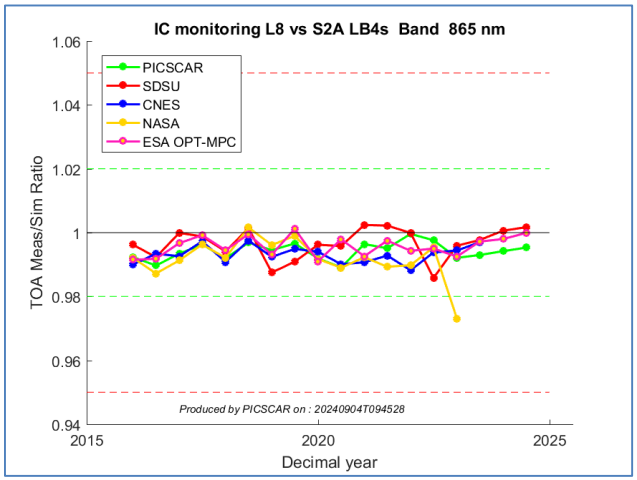
Results are consistent for Red and NIR bands
Relatively consistent for Green band, and more different for Blue band.

Temporal trending very similar for all teams (flat !)









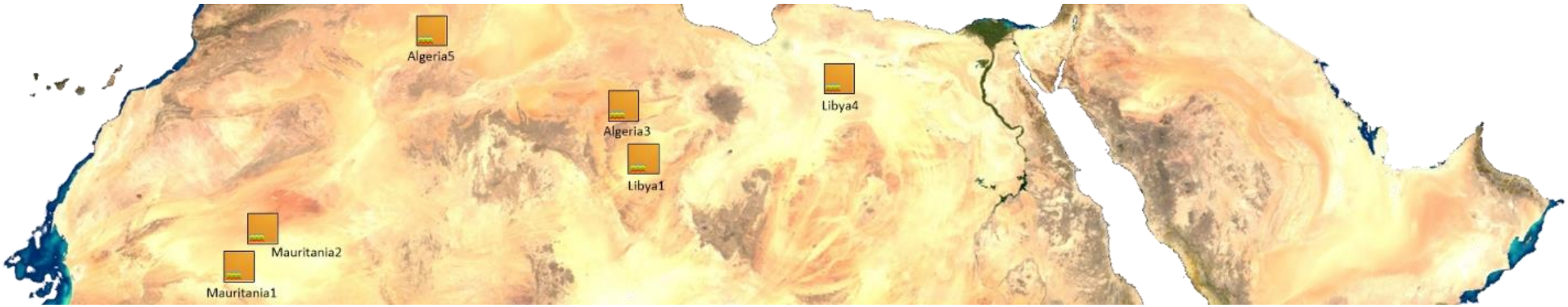
Main discrepancies due to: cloud screening and spectral interpolation

⇒ Stress the need for using several sites to provide intercalibration results

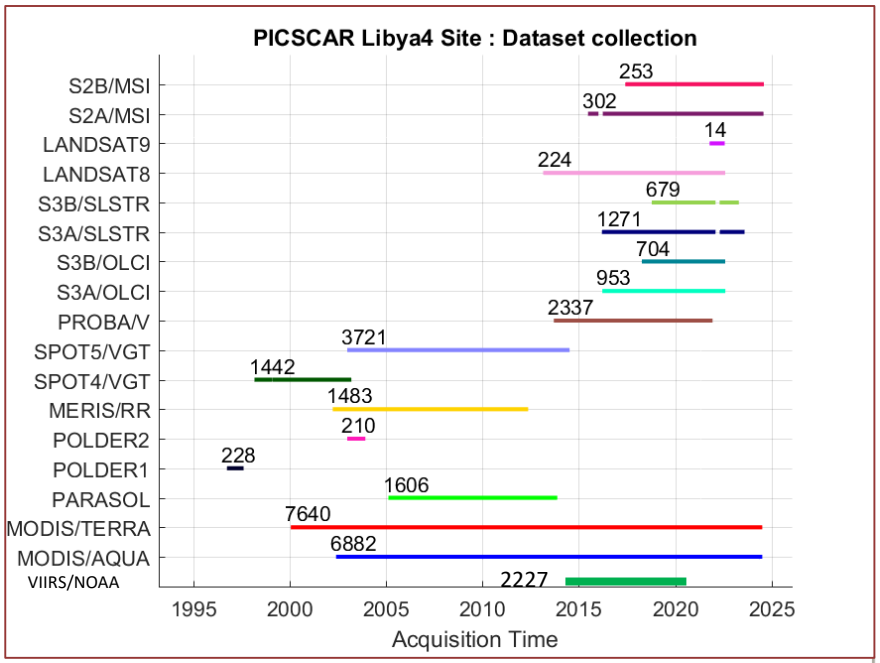
Task 4
Building a PICS Data Base

Building a PICS Data Base

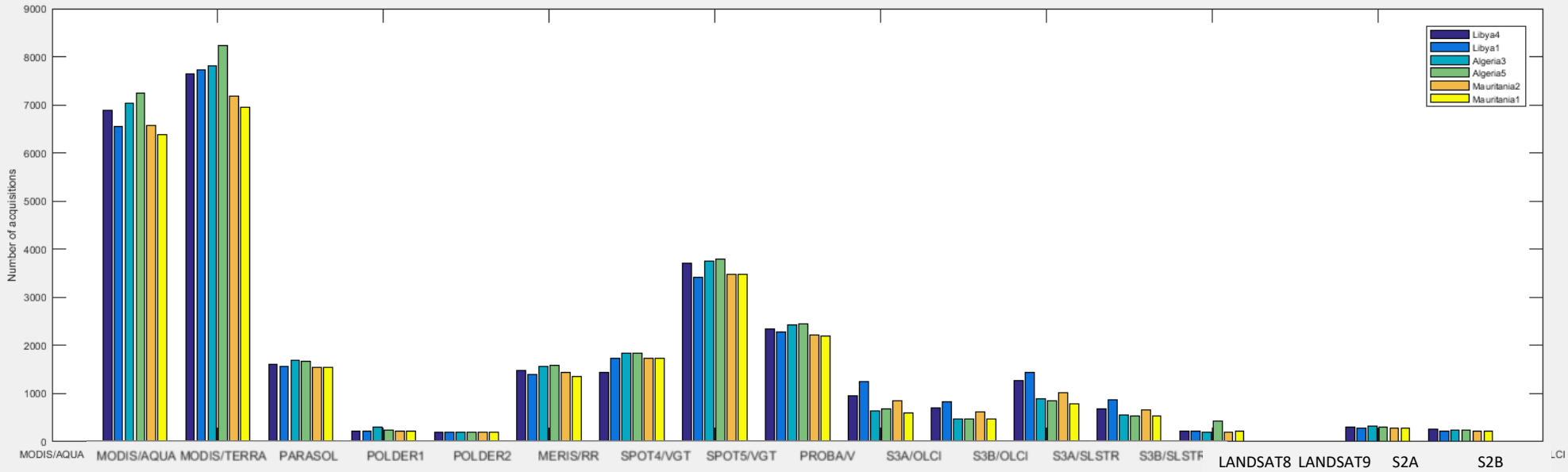
- The study has been extended to 6 PICS from data acquired from launch up to June 2024



- Database has been updated from last collections of sensors over the 6 CEOS selected PICS
- Complete site extraction and storage
- Soon available from PICSCAR portal



Data distribution per sensor and per site



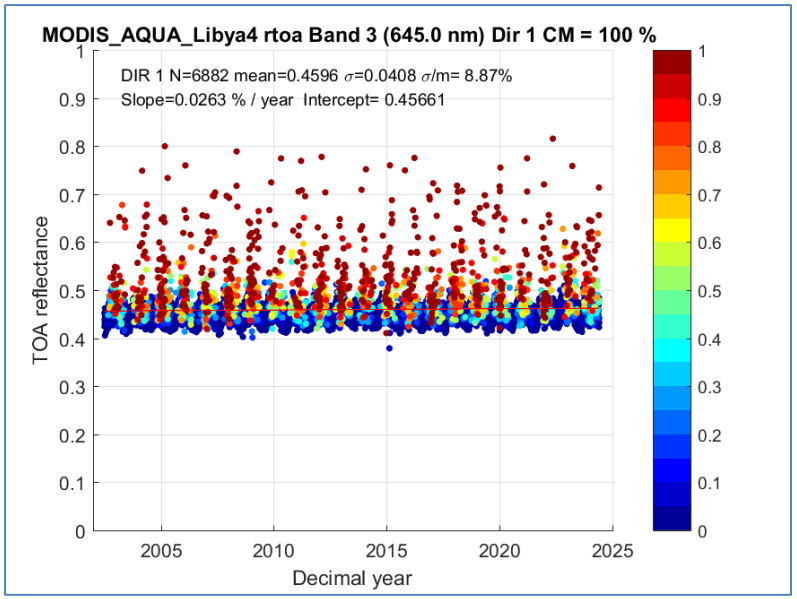
Nearly 200000 site extracted images stored in the data base

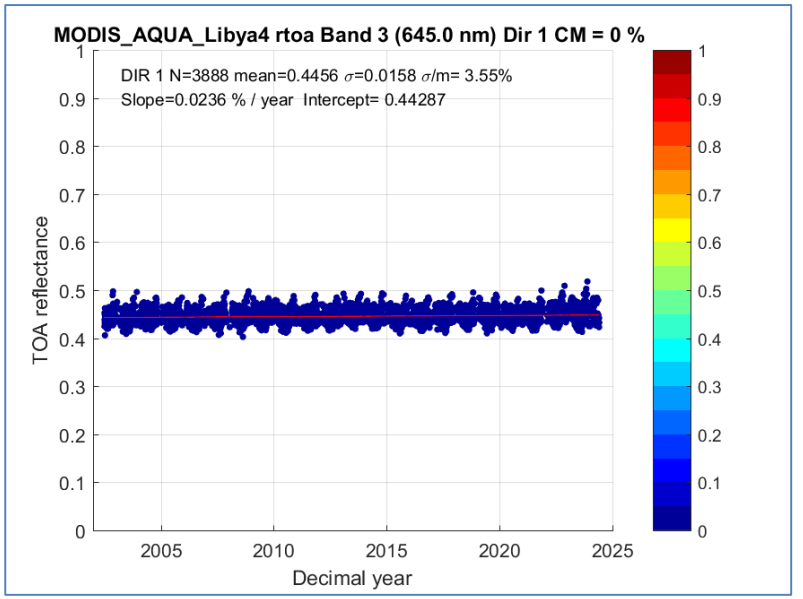
Task 5
Cloud coverage of the sites

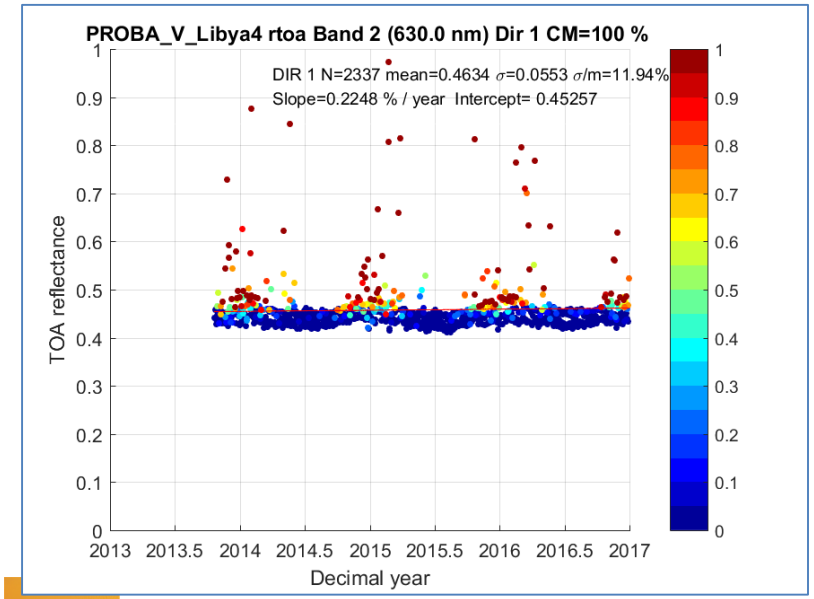
Cloud coverage assessment

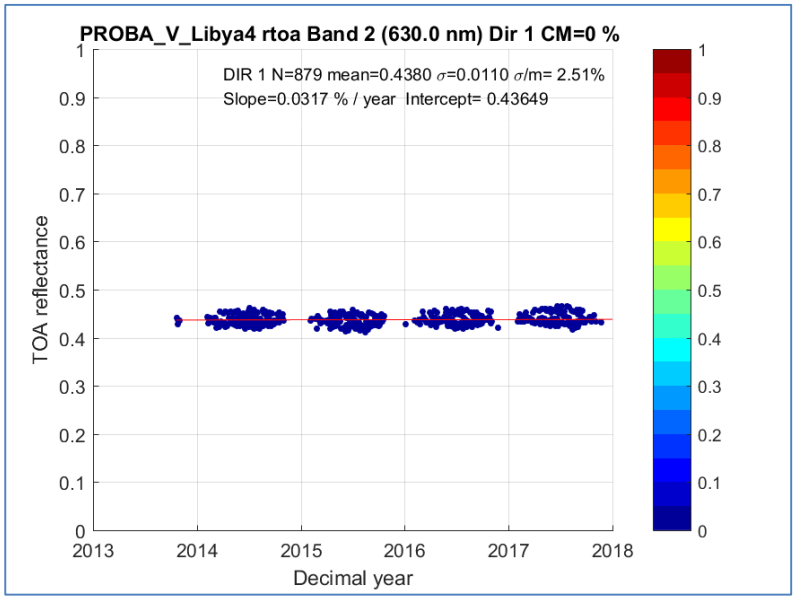
- Cloud screening is necessary in order to assess site stability
- Except for MODIS only official cloud mask at Level 1 is available
- Cloud detection is difficult over bright surfaces such as desert

Examples of time series with/without clouds









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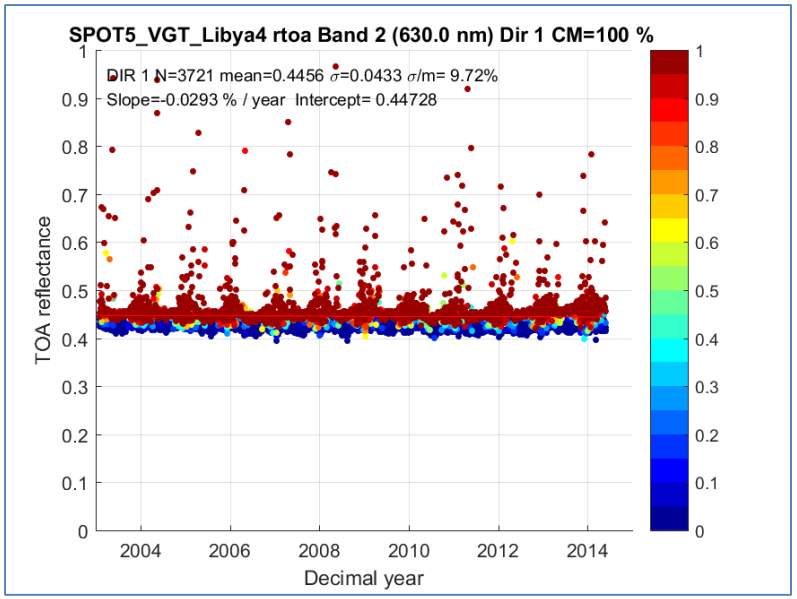

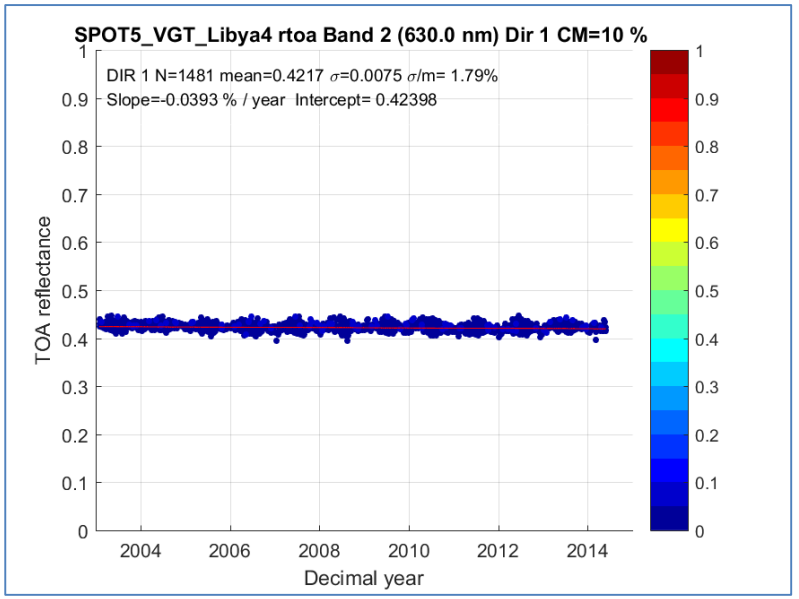

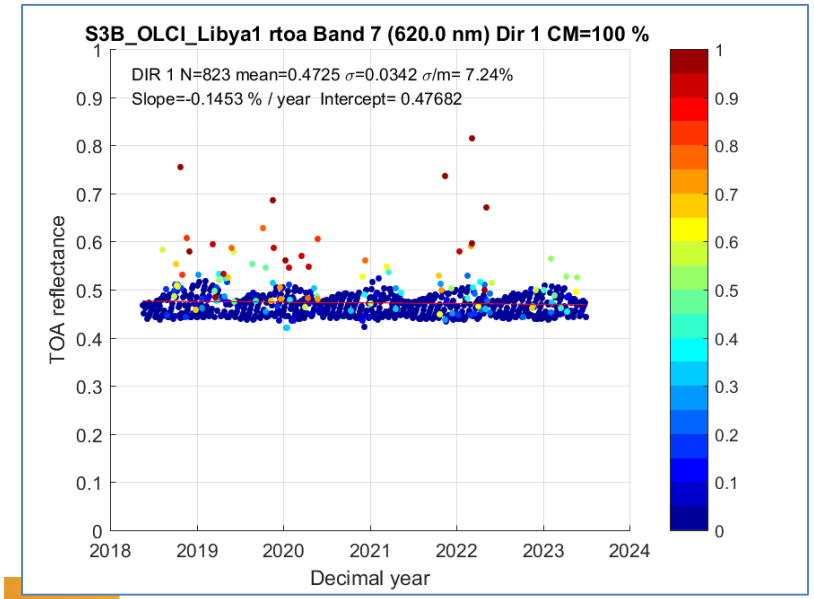

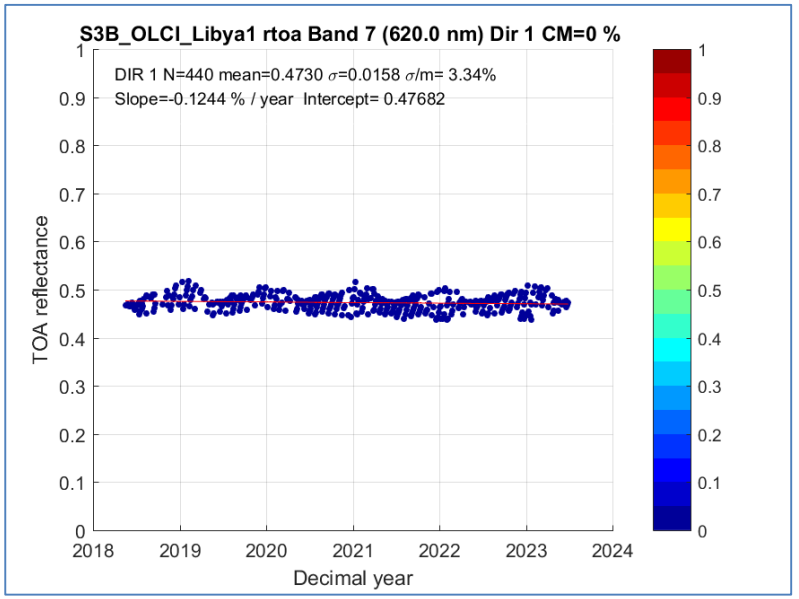

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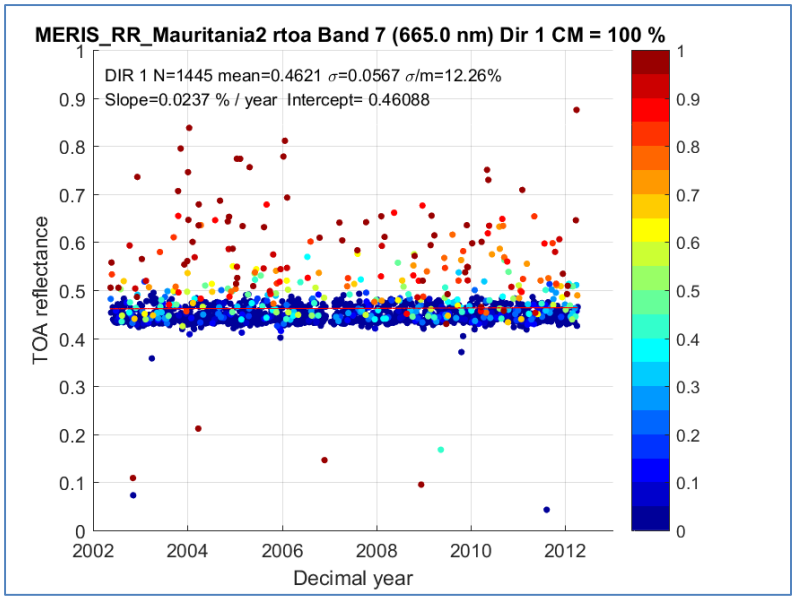
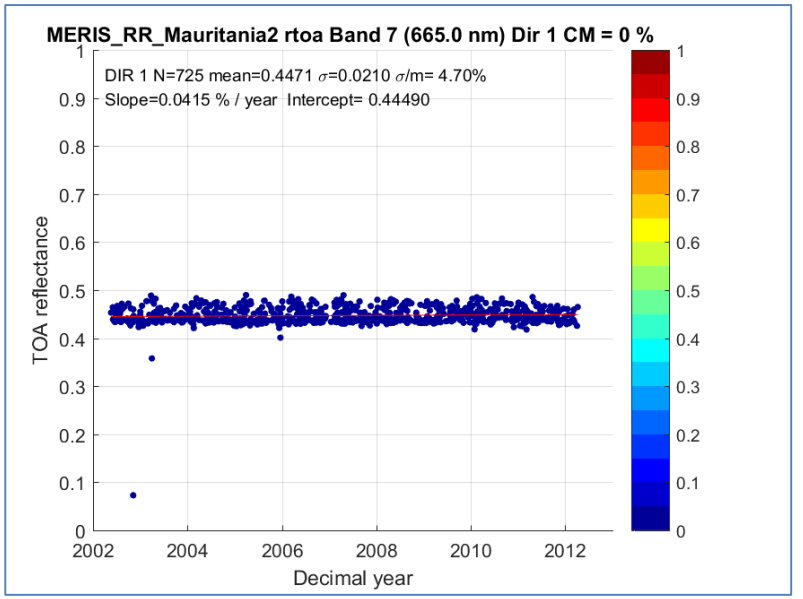
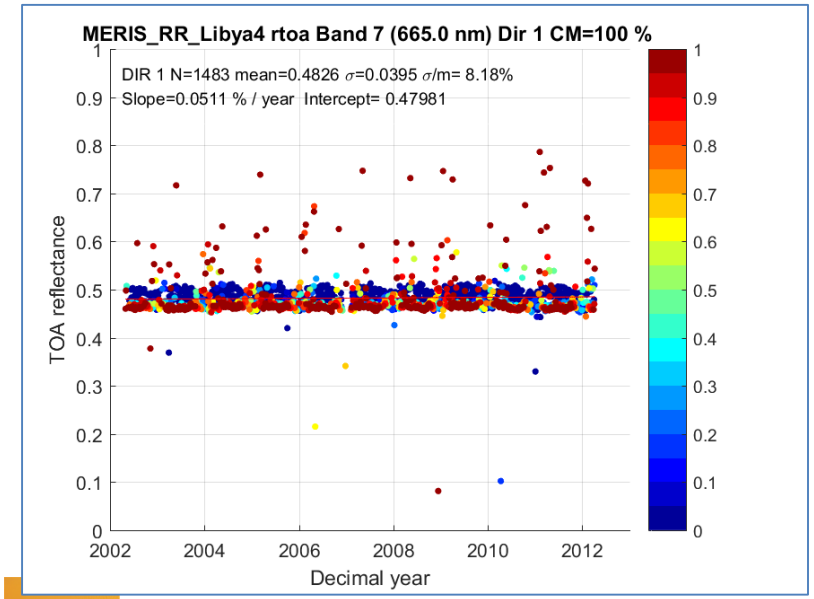
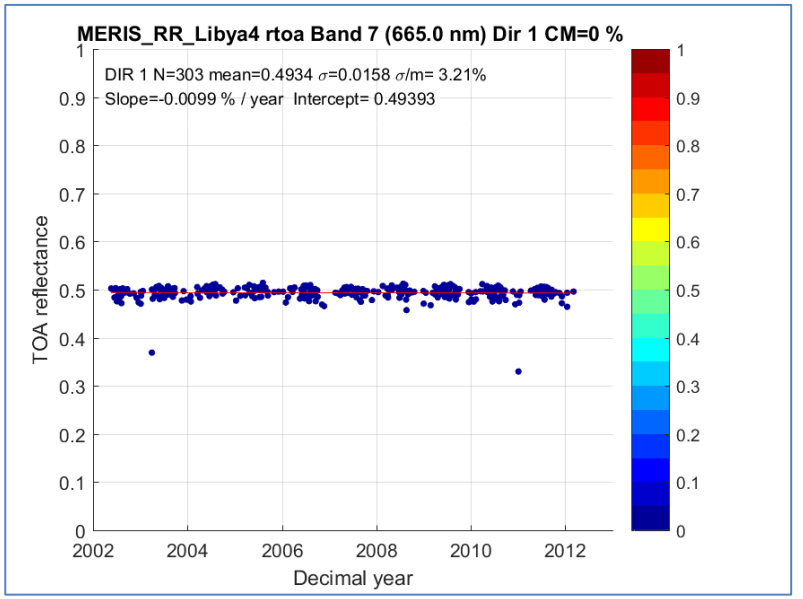


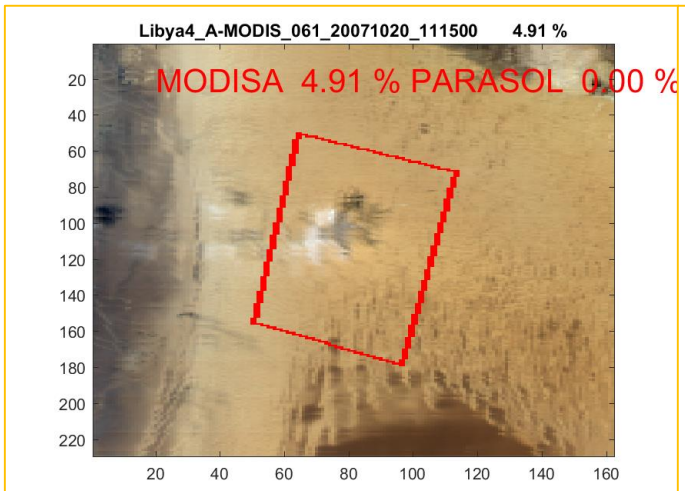


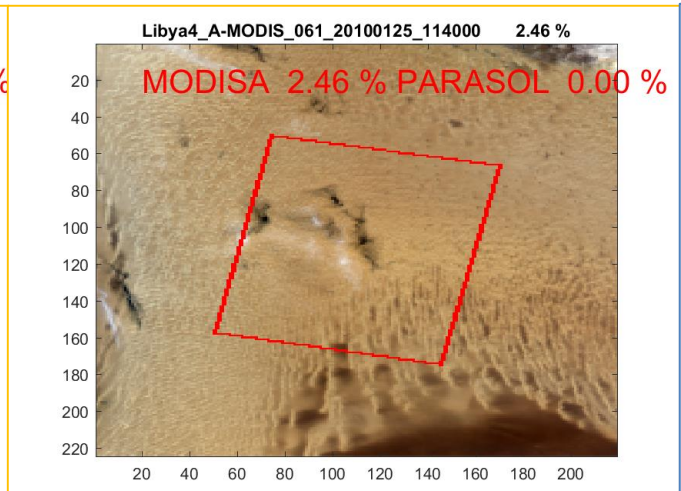


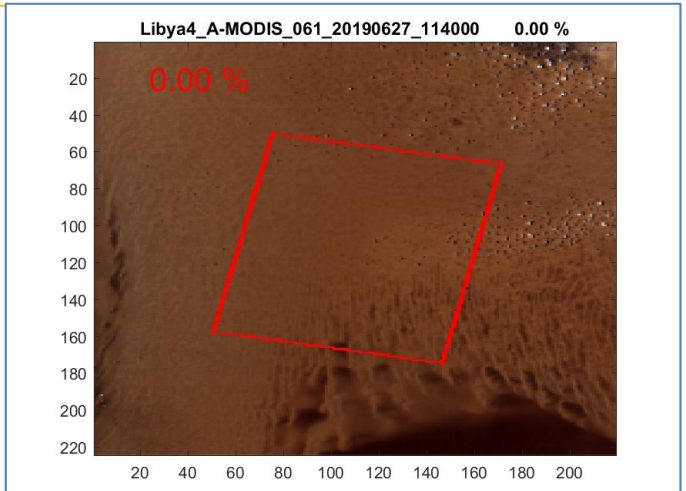


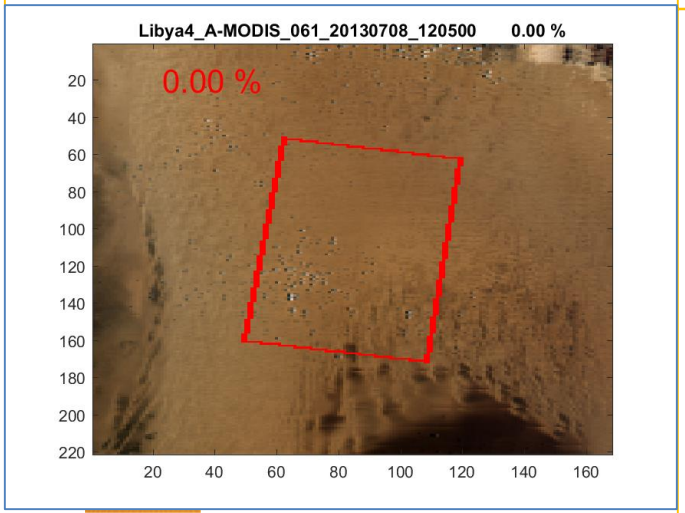
Confidence in MODIS cloud mask

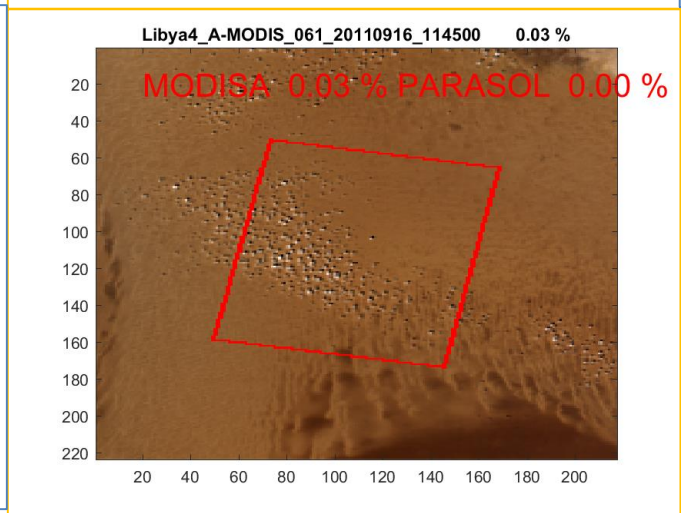
- MODIS Cloud Mask level 2 product appears to be rather good over deset areas
- Underdetection is more problematic than over detection, in particular when cloud coverage is low

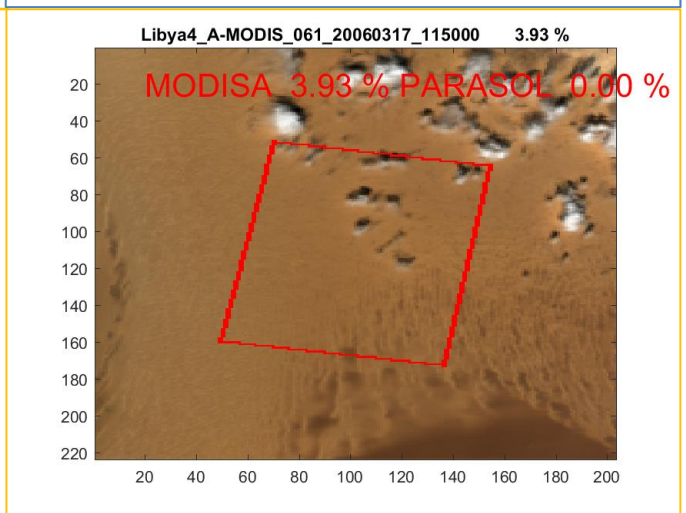






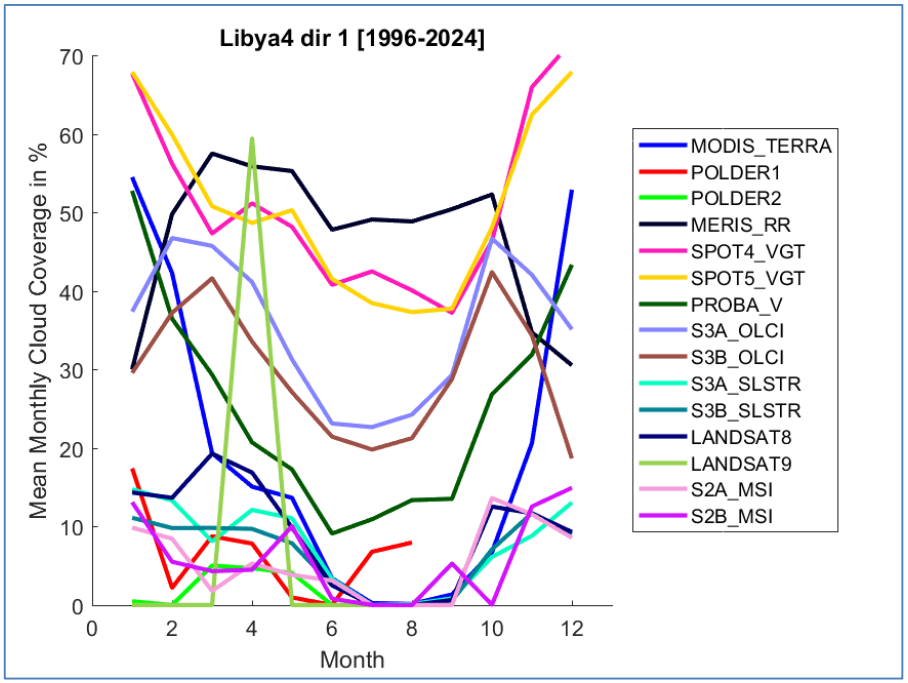






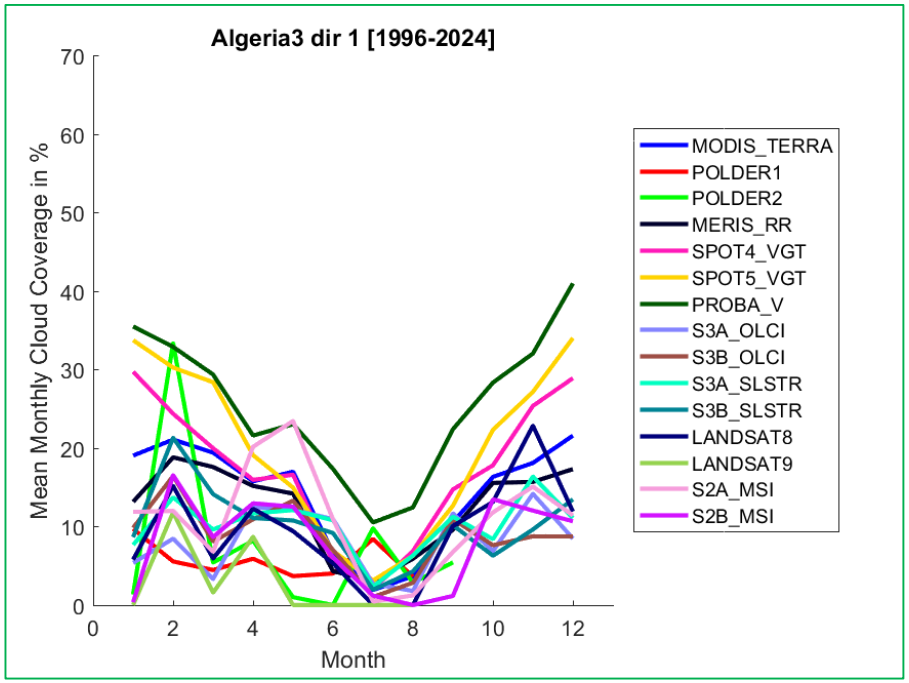
Comparison of cloud coverage estimated by different sensors over 2 sites

Mean monthly cloud coverage over Libya4 site



Very high discrepancies for Libya 4

Mean monthly cloud coverage over Algeria3 site

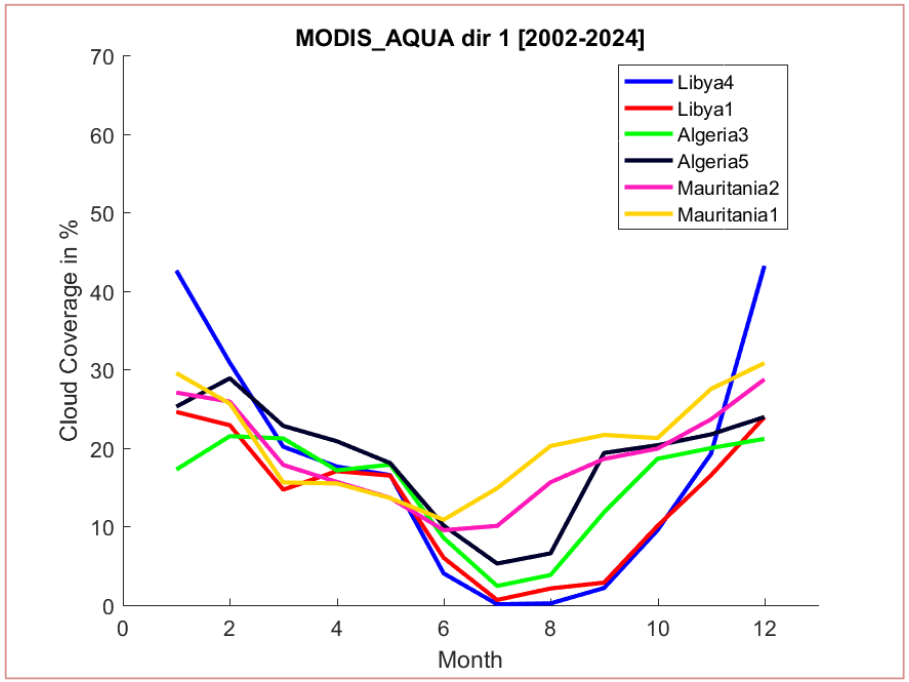


More consistent for Algeria 3

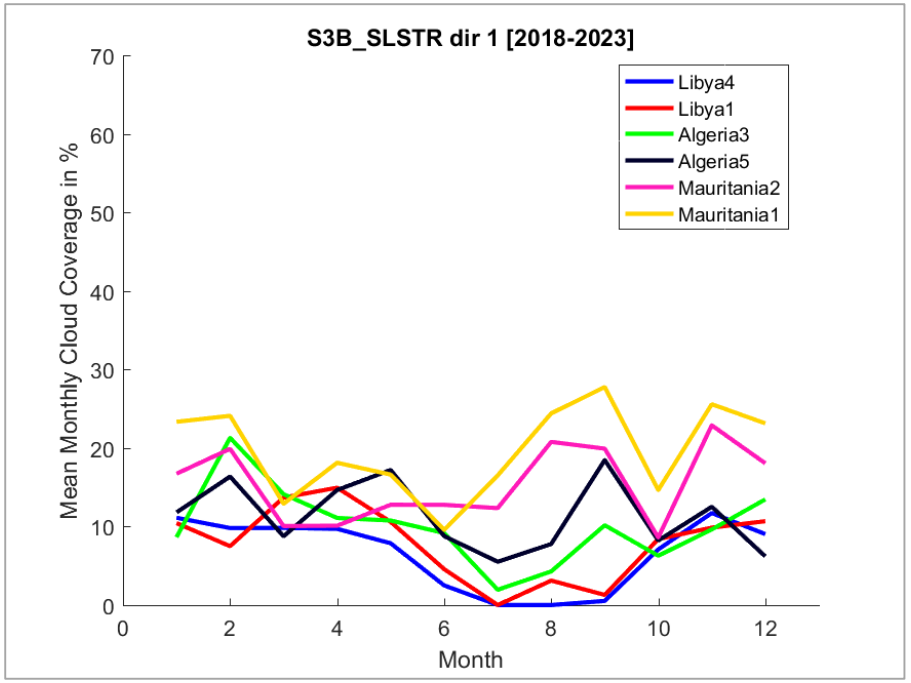
NB: Level 1 cloud mask used except for MODIS (level 2 MOD/MYD 035)

Comparison of PICS cloud coverage as seen by 2 different sensors

PICS mean monthly cloud coverage estimated by MODIS Aqua



PICS mean monthly cloud coverage estimated by Sentinel 3B SLSTR



Rather consistent for all sites: lowest in summer

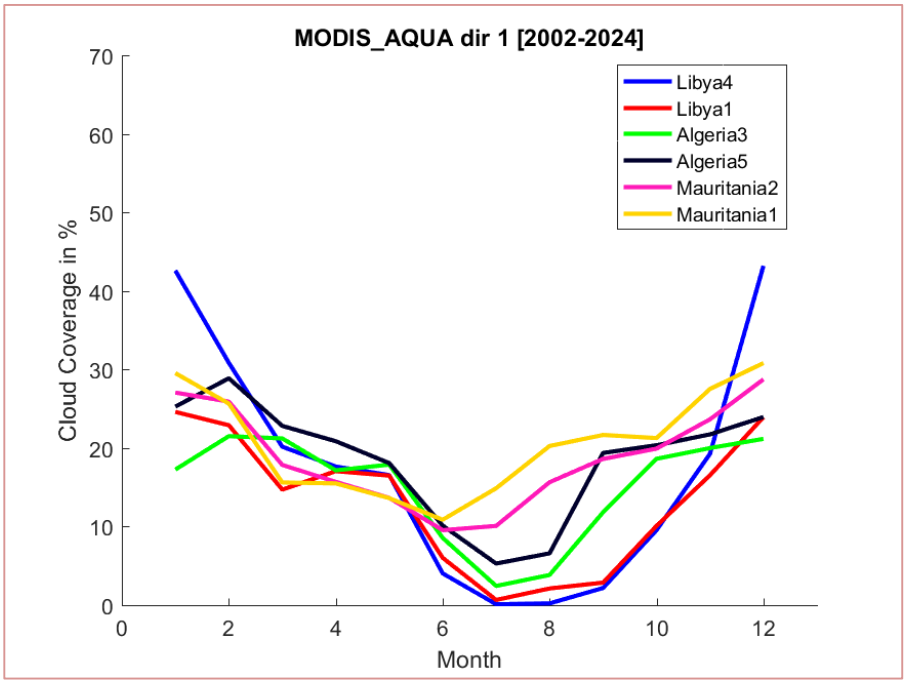
- More significant for Libya 4
- Much less for Mauritania1

Rather consistent for all sites

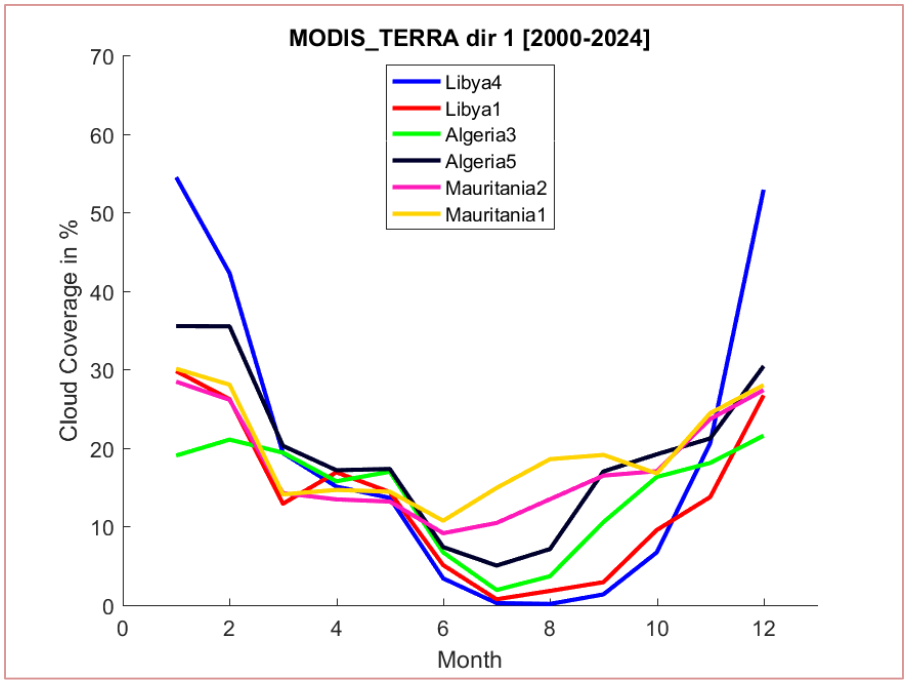
- Except Mauritania1
- No strong differences all along the year

Comparison of PICS cloud coverage for morning and afternoon overpass

PICS mean monthly cloud coverage estimated by MODIS Aqua



PICS mean monthly cloud coverage estimated by MODIS Terra

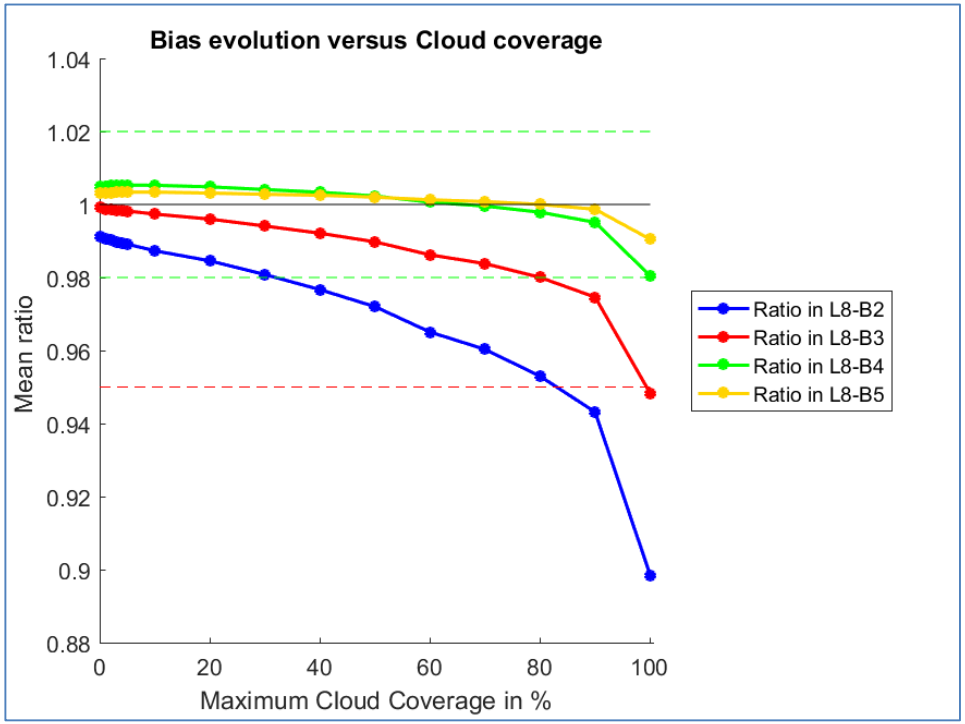


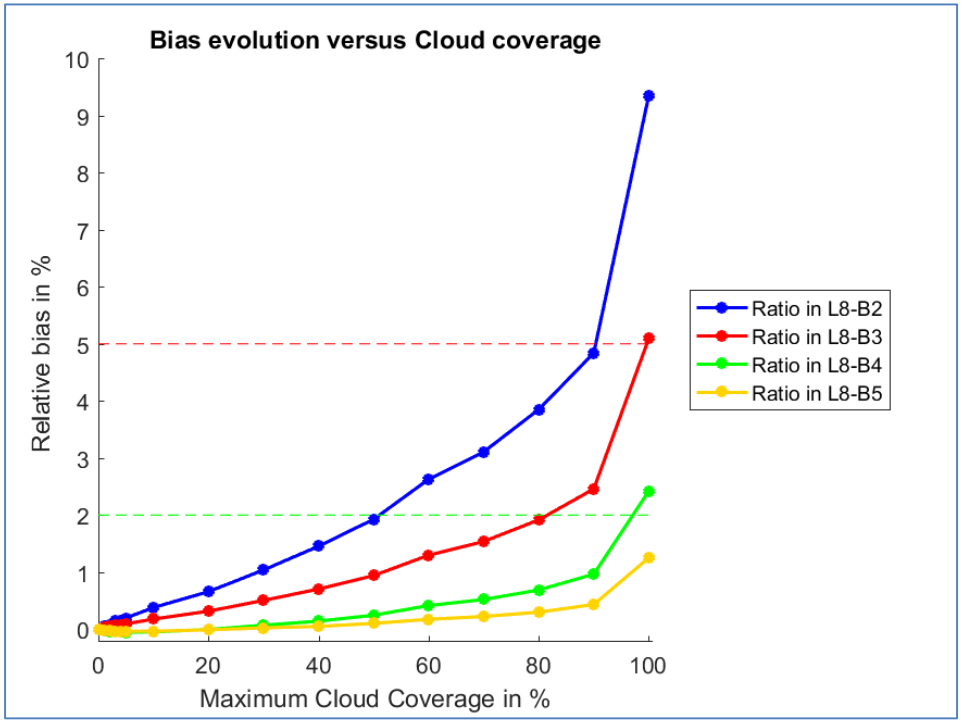
Low differences between morning and afternoon overpasses

Impact of cloud/cloud shadow underestimation

- Intercalibration performed with different levels of cloud screening
- Cloud underestimation introduces a bias
  - Main effect for the blue band (low reflectance)
  - Less than 2% for NIR band

Libya4 site

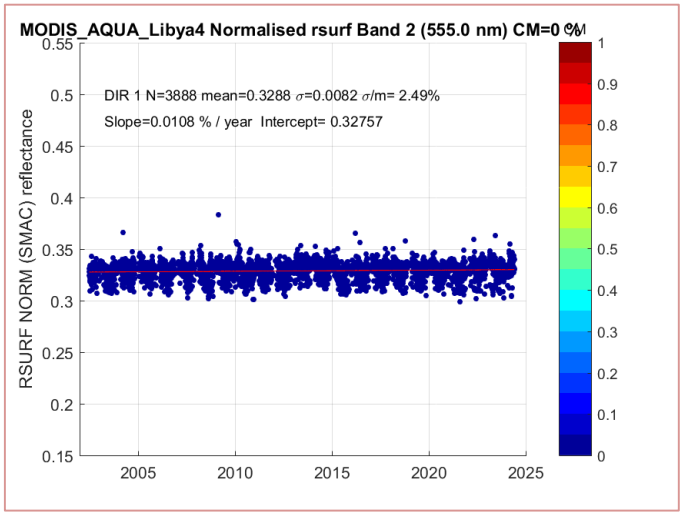


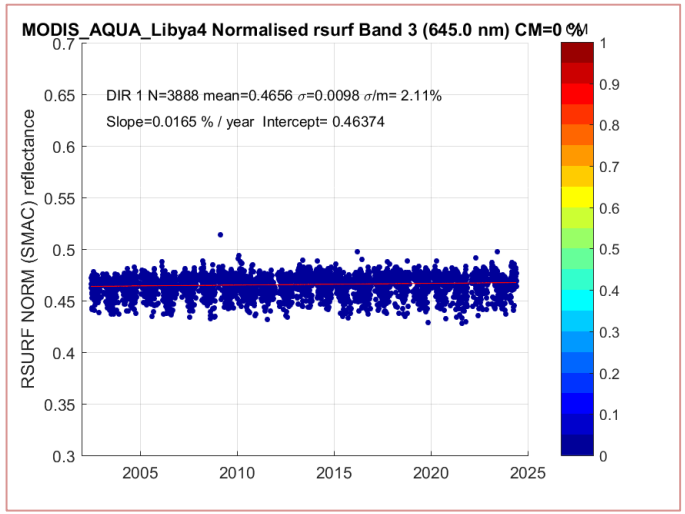


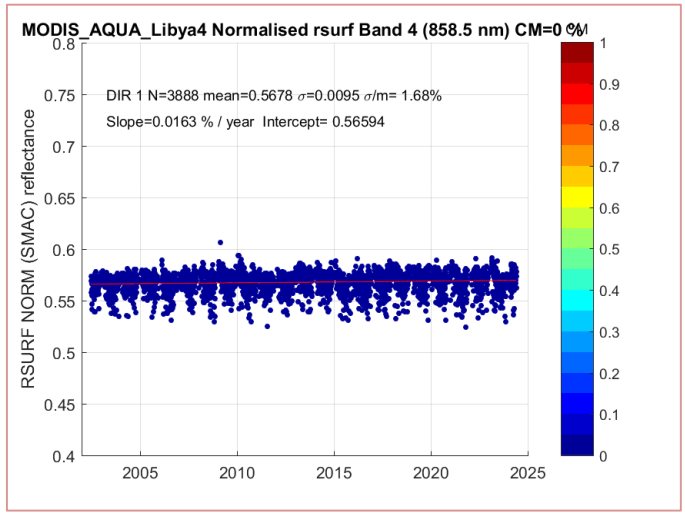
Task 6
Sites stability

For 1 site (Libya4), 1 sensor (MODIS AQUA)

BOA normalised reflectance in Green, Red, and NIR channels

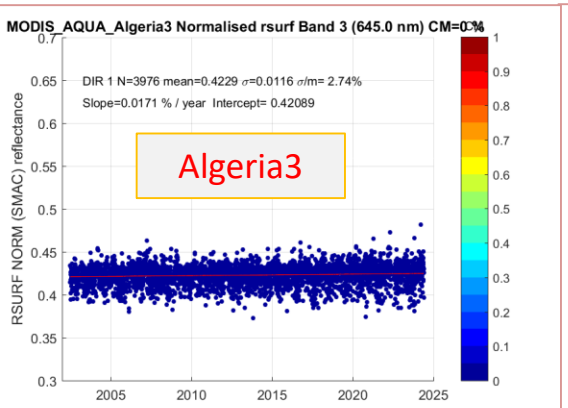


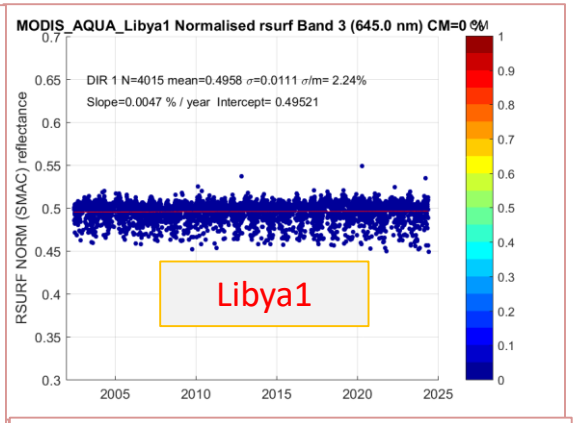


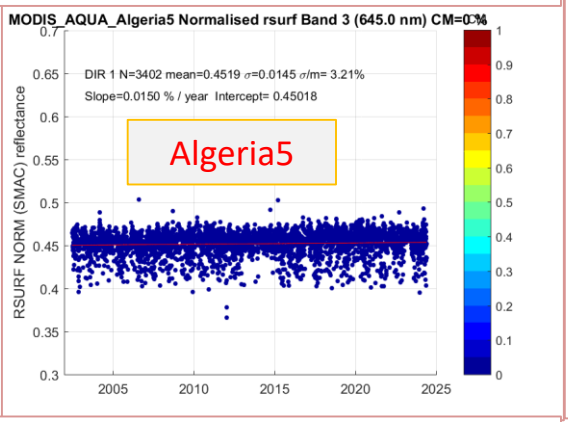


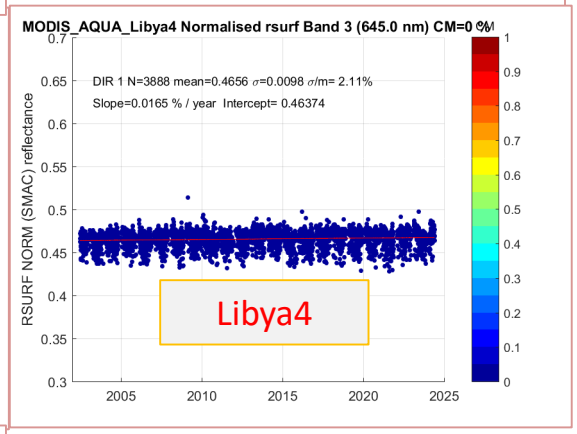
Band	Npt	mean	std	cv (%)	Slope %/year	ao	rmse	r
555	3888	0.329	0.0082	2.494	0.01	0.328	0.008	0.082
645	3888	0.466	0.0098	2.111	0.02	0.464	0.010	0.105
858.5	3888	0.568	0.0095	1.680	0.02	0.566	0.009	0.107

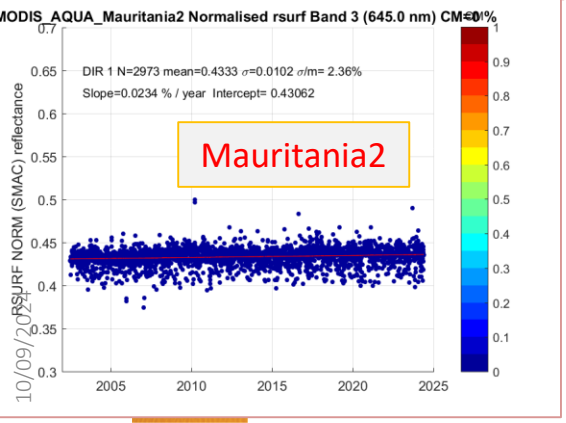
MODIS AQUA stability (Band 4 (645 nm)) – 5 PICS











Libya4

Band	Npt	mean	std	cv (%)	Slope %/year	ao	rmse	r
555	3888	0.329	0.0082	2.494	0.011	0.328	0.008	0.082
645	3888	0.466	0.0098	2.111	0.017	0.464	0.010	0.105
858.5	3888	0.568	0.0095	1.680	0.016	0.566	0.009	0.107

Algeria3

Bande	Npt	mean	std	cv (%)	Slope %/year	ao	rmse	r
555	3976	0.232	0.0105	4.528	0.010	0.231	0.010	0.061
645	3976	0.423	0.0116	2.735	0.017	0.421	0.012	0.092
858.5	3976	0.529	0.0110	2.076	0.022	0.527	0.011	0.126

Algeria5

Bande	Npt	mean	std	cv (%)	Slope %/year	ao	rmse	r
555	3402	0.232	0.0117	5.021	0.005	0.232	0.012	0.029
645	3402	0.452	0.0145	3.215	0.015	0.450	0.014	0.065
858.5	3402	0.563	0.0153	2.724	0.014	0.561	0.015	0.057

Libya1

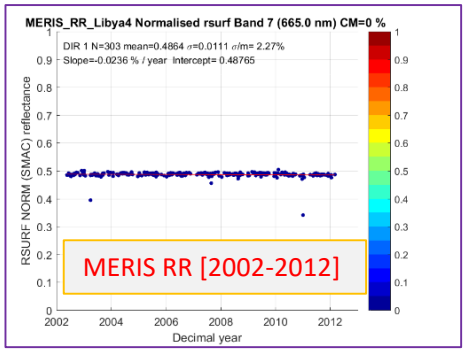
Bande	Npt	mean	std	cv (%)	Slope %/year	ao	rmse	r
555	4015	0.290	0.0090	3.090	0.004	0.289	0.009	0.029
645	4015	0.496	0.0111	2.236	0.005	0.495	0.011	0.027
858.5	4015	0.605	0.0086	1.419	0.007	0.604	0.009	0.049

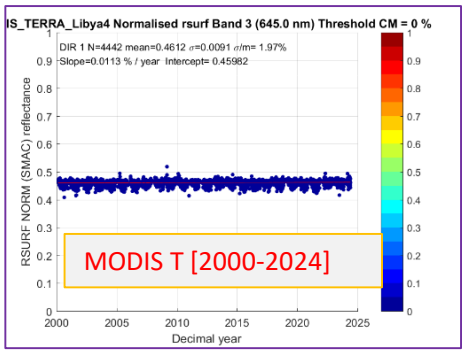
Mauritania2

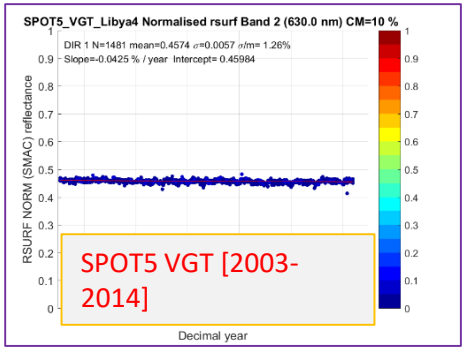
Bande	Npt	mean	std	cv (%)	Slope %/year	ao	rmse	r
555	2973	0.245	0.0119	4.863	0.018	0.242	0.012	0.097
645	2973	0.433	0.0102	2.355	0.023	0.431	0.010	0.144
858.5	2973	0.539	0.0098	1.822	0.027	0.536	0.010	0.174

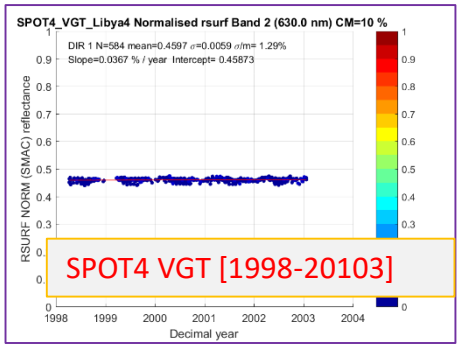
Statistics confirm the excellent sensor calibration and indicate that the sites have not evolved over this 22-year period.
Libya1 and Algeria5 sites highlight virtually no variation.

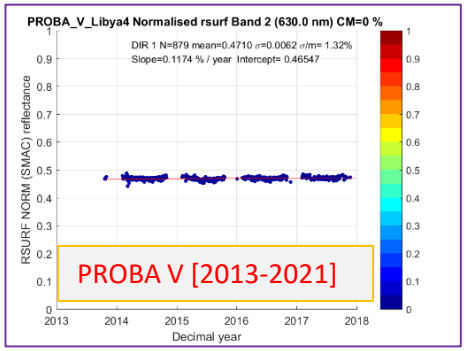
All sensors (Band 4 - 645 nm) Libya4 site

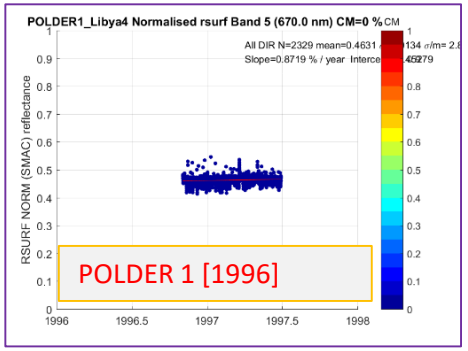


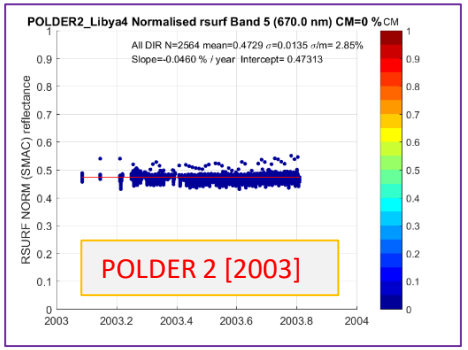


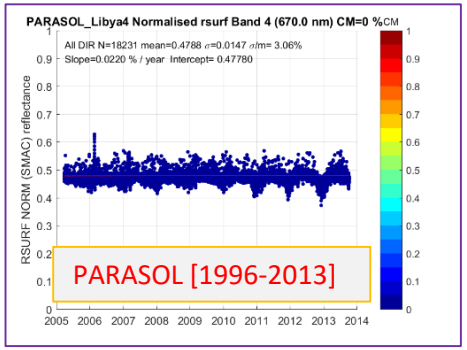


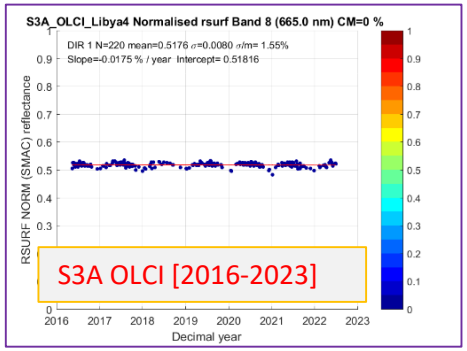


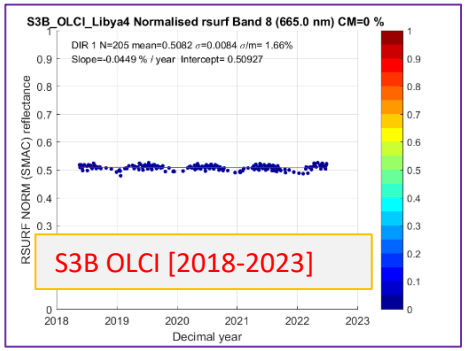


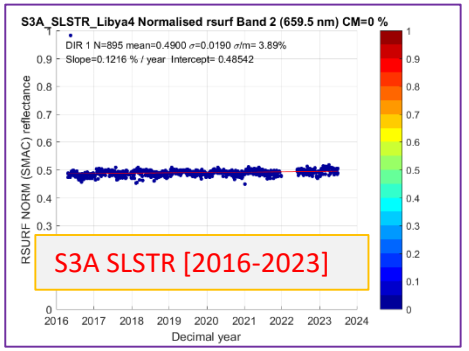


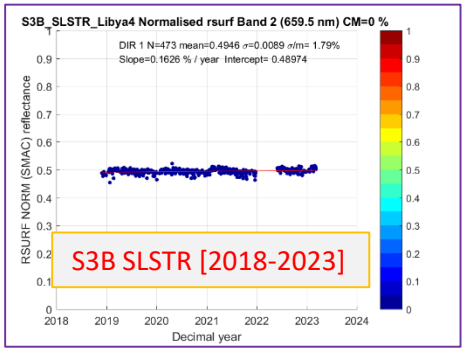












Statistics : for Libya4, all sensors

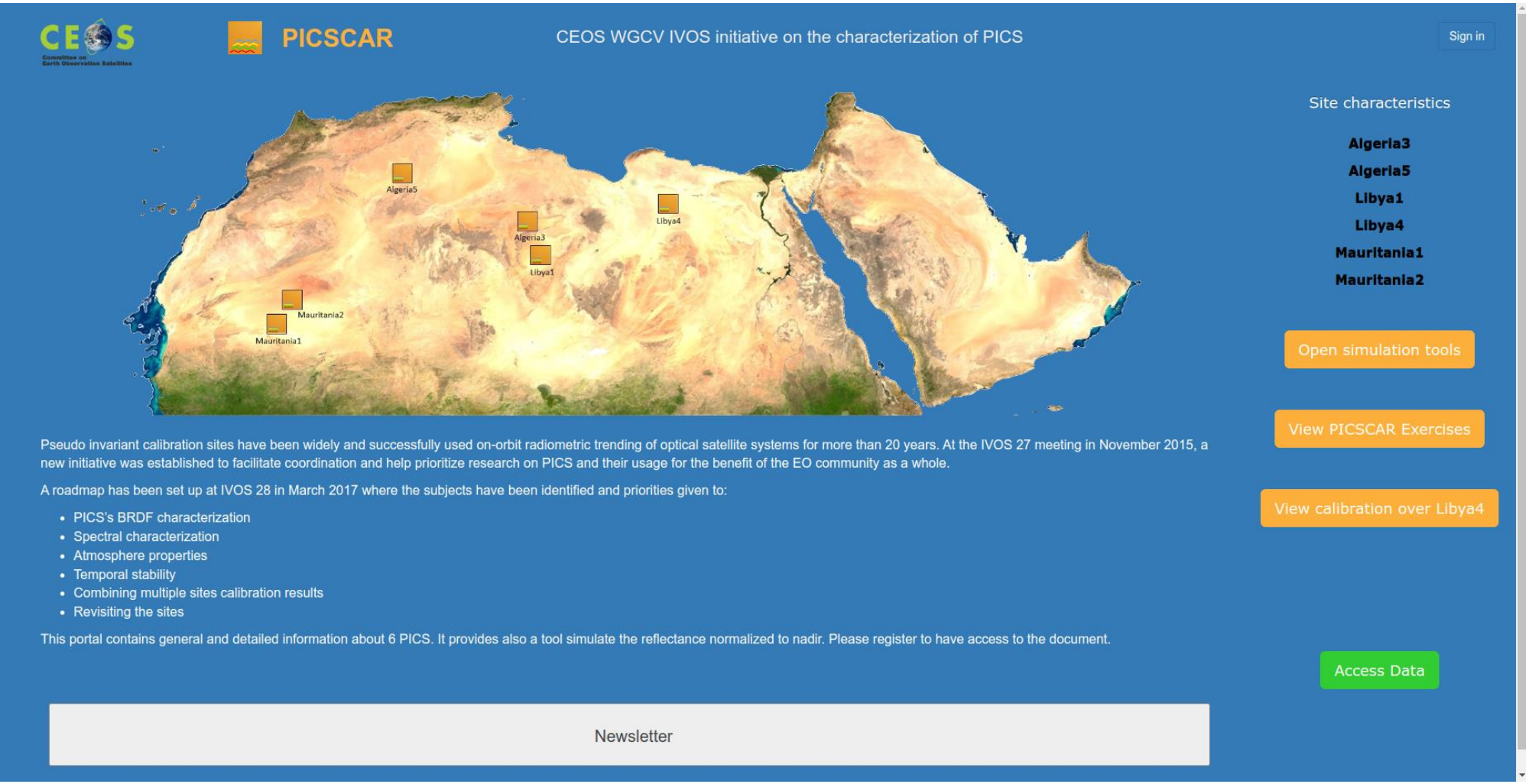
	Green Band			Red Mean			NIR Mean		
	mean	std	Slope %/year	mean	std	Slope %/year	mean	std	Slope %/year
MERIS	0.345	0.011	-0.015	0.486	0.011	-0.024	0.576	0.023	0.013
MODISA	0.329	0.008	0.011	0.466	0.010	0.017	0.568	0.010	0.016
MODIST	0.329	0.008	0.007	0.461	0.009	0.011	0.570	0.010	0.012
OLCIA	0.374	0.006	-0.021	0.518	0.008	-0.018	0.609	0.009	-0.020
OLCIB	0.367	0.007	-0.029	0.508	0.008	-0.045	0.601	0.010	-0.035
PARASOL	0.351	0.015	0.053	0.479	0.015	0.022	0.563	0.015	0.025
POLDER1	0.330	0.015	0.570	0.463	0.013	0.872	0.542	0.014	0.848
POLDER2	0.334	0.014	-0.316	0.473	0.013	-0.046	0.553	0.014	-0.016
PROBAV				0.471	0.006	0.117	0.563	0.008	0.084
SLSTRA	0.352	0.015	0.194	0.490	0.019	0.122	0.587	0.013	0.316
SLSTRB	0.356	0.007	0.249	0.495	0.009	0.163	0.587	0.011	0.345
VGT1				0.460	0.006	0.037	0.547	0.006	-0.026
VGT2				0.457	0.006	-0.042	0.547	0.007	0.020
LANDSAT8	0.351	0.004	-0.057	0.485	0.005	-0.058	0.583	0.006	-0.070
LANDSAT9	0.350	0.006	2.116	0.484	0.006	2.697	0.581	0.008	3.711
S2A_MSI	0.353	0.041	0.125	0.499	0.032	0.079	0.587	0.025	0.048
S2B_MSI	0.352	0.034	0.388	0.495	0.034	0.378	0.580	0.052	0.520

What to be done now ?

What to be done now

- Cloud coverage to be checked for each site/each sensor to remove all potential cloud underdetection and cloud shadow in the data base
- Adjust a new BRDF model
  - PARASOL Data with an improved cloud screening
  - Completed by other sensors information
  - New inversion method
- Site spectral characterization
  - Comparison of existing methods
  - Use of hyperspectral data and sand laboratory characterisation

PICSCAR Portal update for data distribution

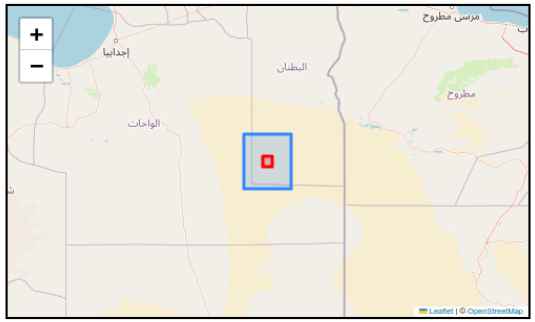


PICSCAR Portal update for data distribution

CEOS WGCV IVOS initiative on the characterization of PICS

Sign in

Home | Algeria3 | Algeria5 | Libya1 | Libya4 | Mauritania1 | Mauritania2



site	Libya4 (Standard Site)	Libya4 (Small Site)
centralLatitude	28.55	28.55
centralLongitude	23.39	23.39
minimum Latitude	28.05	28.45
maximumLatitude	29.05	28.65
minimumLongitude	22.89	23.29
maximumLongitude	23.89	23.49

Sensor selection

MERIS

Reprocessing version: **4th reprocessing**

Product description

☐ **Small site** ☑ **Standard site**

☐ **Statistics** ☑ **ROI Extract**

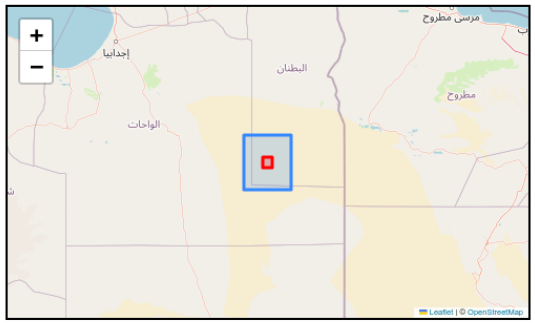
Date range selection

07/05/2024 - 08/05/2024

Receive data

PICSCAR Portal update for data distribution

Home | Algeria3 | Algeria5 | Libya1 | Libya4 | Mauritania1 | Mauritania2



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Sensor selection

MERIS

Reprocessing version: **4th reprocessing**

☐ **Small site** ☑ **Standard site**

☐ **Statistics** ☑ **ROI Extract**

Date range selection

07/05/2024 - 08/05/2024

July 2024

	Su	Mo	Tu	We	Th	Fr	Sa
27	30	1	2	3	4	5	6
28	7	8	9	10	11	12	13
29	14	15	16	17	18	19	20
30	21	22	23	24	25	26	27
31	28	29	30	31	1	2	3
32	4	5	6	7	8	9	10

August 2024

	Su	Mo	Tu	We	Th	Fr	Sa
31	28	29	30	31	1	2	3
32	4	5	6	7	8	9	10

Product description

```
netcdf
file:/C:/Users/bebert/PC/Projet/PICSCAR/DB_Img/Libya4_MODISA_061_2008/Liby
4_A-MODIS_061_20080101_111000.nc {
  dimensions:
    nb_products = 1;
    nb_bands = 38;
    nb_rows = 126;
    nb_columns = 49;
    char_length = UNLIMITED;   // (6 currently)
  variables:
    char site_name(char_length=6);
      :standard_name = "Libya4";
      :long_name = "Libya4 standard site";
      :_ChunkSizes = 4096U; // uint

  group: Product {
    variables:
      float bands_wavelength(nb_bands=38);
        :long_name = "Central wavelengths in nm : 645, 858.5, 469, 555,
1240, 1640, 2130, 412.5, 443, 488, 531, 551, 667, 667, 678, 678, 748,
869.5, 905, 936, 940, 3750, 3750, 3959, 4050, 4465, 4515, 1375, 6715, 7325
8550, 9730, 11030, 12020, 13335, 13635, 13935, 14235";
        :standard_name = "Band names : B01, B02, B03, B04, B05, B06, B07,
B08, B09, B10, B11, B12, B13lo, B13hi, B14lo, B14hi, B15, B16, B17, B18,
B19, B20, B21, B22, B23, B24, B25, B26, B27, B28, B29, B30, B31, B32, B33,
B34, B35, B36";
```

All information request could be sent to:

PICSCAR@magellium.fr