Multi-sensors MSI-MODIS-OLCI-OLI Level-1 radiometry Intercomparison

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with support from S2MPC-team, S3MPC-team & DIMITRI-team

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Multi-sensors MSI-MODIS-OLCI-OLI Level-1 radiometry Intercomparison

Disclaimer

The work performed in the frame of this contract is carried out with funding by the European Union. The views expressed herein can in no way be taken to reflect the official opinion of either the European Union or the European Space Agency.

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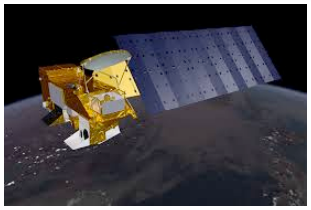
AGENDA

1. Overview of MSI/MODIS/OLCI/OLI capabilities
2. Vicarious methods in DIMITRI Toolbox
3. Intercomparison of MSI/MODIS/OLCI/OLI Level-1 radiometry over PICS
4. Results synthesis over MSI/MODIS/OLCI/OLI
5. Conclusions

(Mont St-Michel bay from Sentinel-2A on 20160716, Courtesy of S2MPC)

Overview of MSI/OLCI/OLI/MODIS capabilities



Aqua/MODIS 2002

LANDSAT-8/OLI 2013

Sentinel-2A/MSI 2015

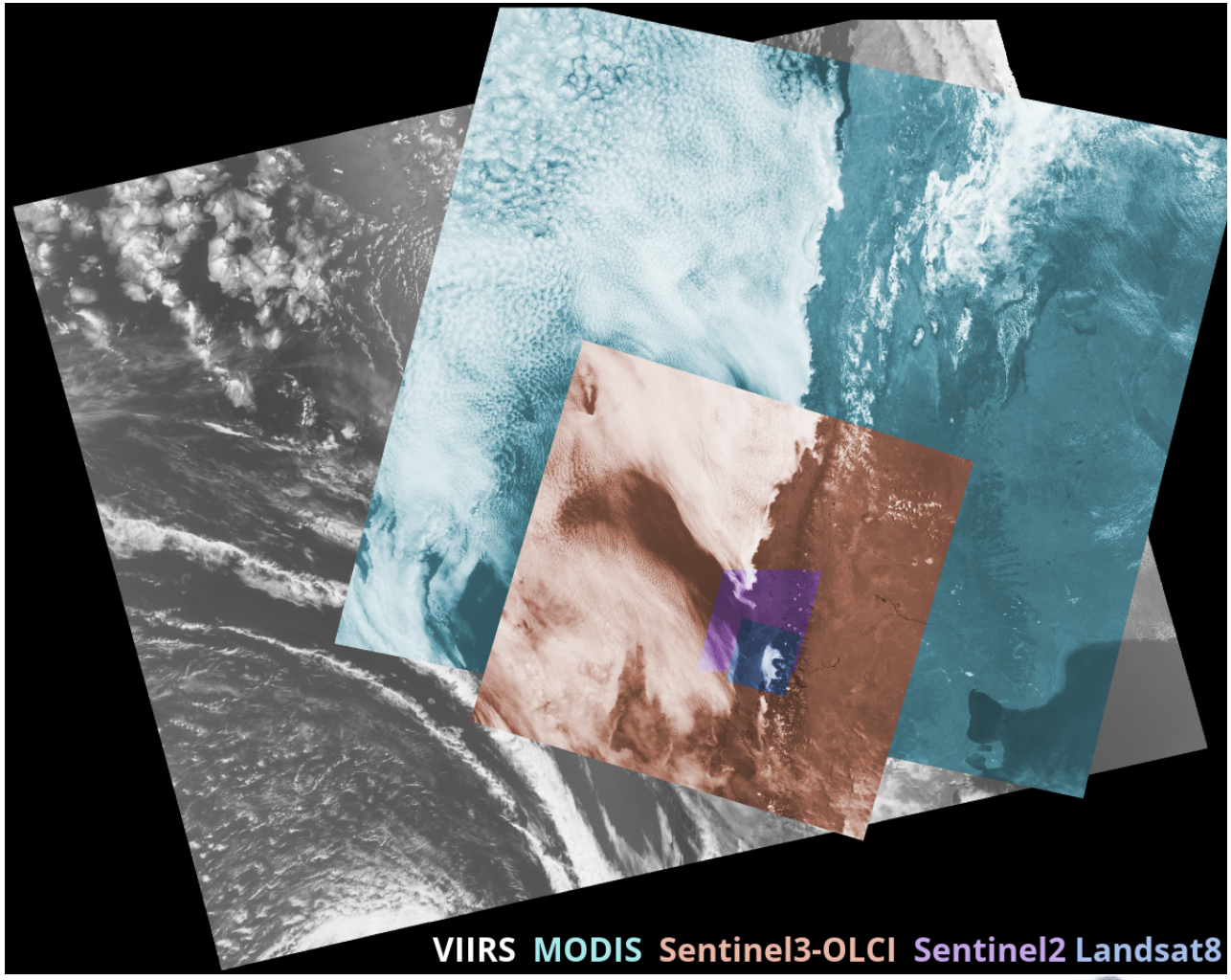
Sentinel-3A/OLCI 2016

SENSOR	Spectral resolution	Spatial-resolution (m)	Temporal resolution (Day)	Viewing Geometry	Swath (km)	Time crossing the Equator
MSI_A	13 (VIS/NIR/ SWIR)	10/20/60	10/5 (twin)	quasi-nadir	290	10:30 A.M. (LTDN)
OLI-TIRS	15 (VIS/NIR/ SWIR/TIRS)	15/30	16	Nadir	180	10:15 A.M (LTDN)
OLCI_A	21 (VIS/NIR)	300-1200	4/2 (twin)	off-nadir/ Max(VZA)=55°	1270	10:00 A.M (LTDN)
MODIS_A	36 (VIS/NIR/ SWIR/TIRS)	250/500/ 1000	1-2	Nadir-Off Nadir	2300	1:30 P.M (LTAN)

Overview of MSI/OLCI/OLI/MODIS characteristics

Example of swath coverage :

OLI : 180 km
MSI: 290 km
OLCI: 1270 km
MODIS: 2300 km
VIIRS: 3000 km

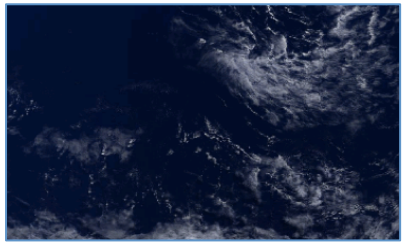
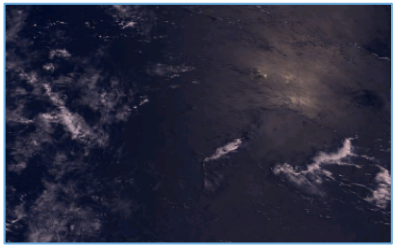
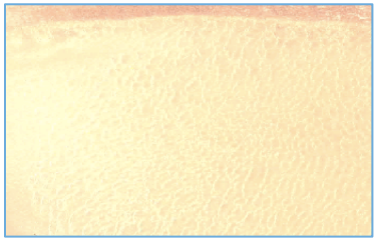
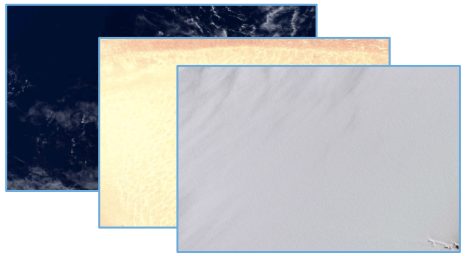


Credit: imagico.de

Overview of the VC methods in DIMITRI Toolbox

DIMITRI

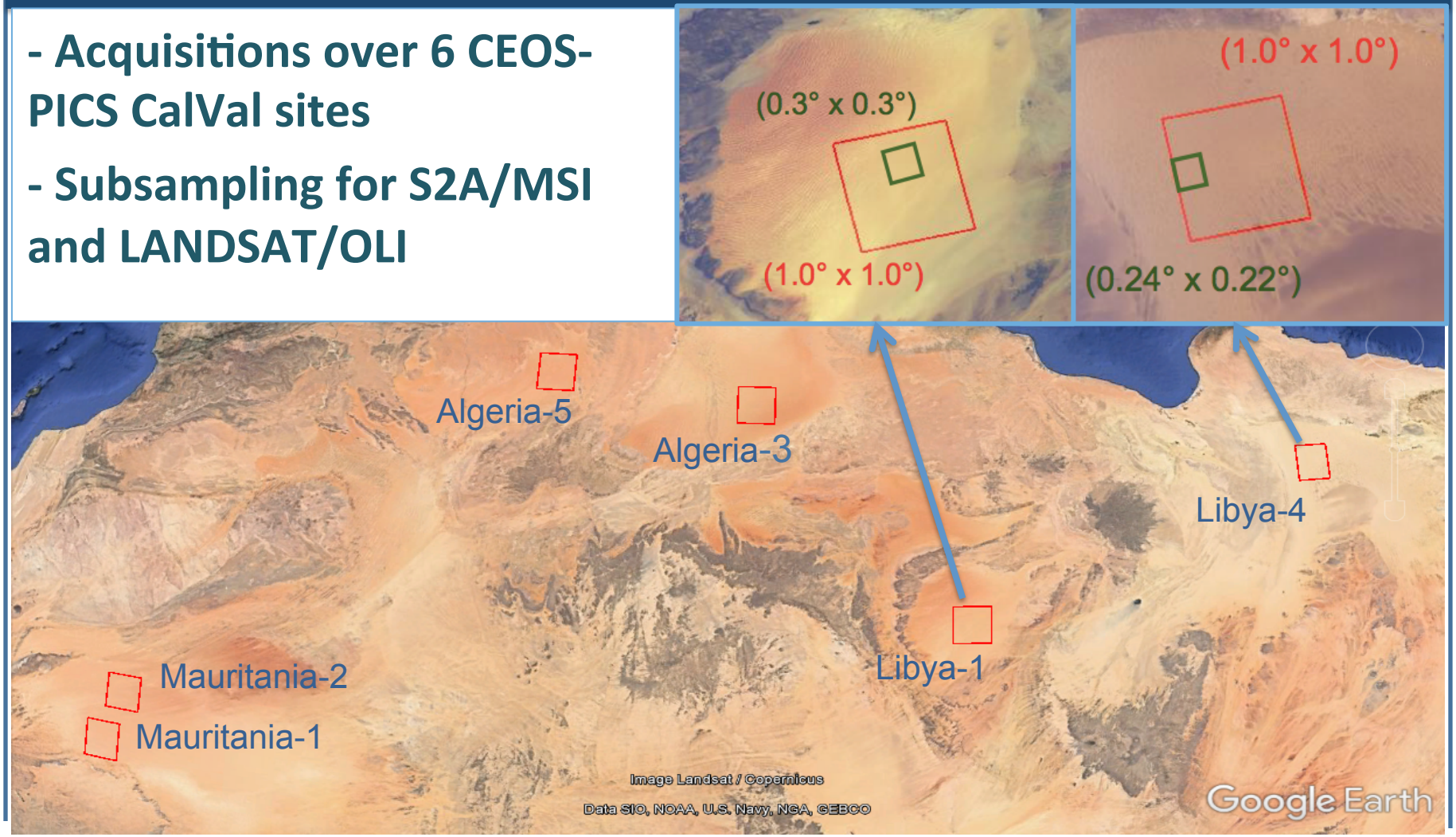
Database for Imaging Multi-spectral Instruments and Tools for Radiometric Intercomparison

Rayleigh scattering calibration	Sun-Glint inter-bands calibration	Desert (PICS) calibration	Sensor-to-Sensor intercalibration
Absolute calibration coefficient: as ρ^{obs}/ρ^{sim}	Absolute Inter-band calibration coefficient: as $\rho^{B(i)}/\rho^{B(ref)}$	Relative calibration coefficient: as ρ^{obs}/ρ^{sim} (MERIS as REF)	Absolute inter-calibration coefficient: as ρ^{obs}/ρ^{REF}
Vermote et al (1992); Hagolle et al (1999)	Hagolle et al (1999; 2004); Nicolas et al (2006)	Bouvet (2014)	Bouvet et al. (2006)
- Over VIS bands - Uncertainty <5% - Very stringent criteria	- Over VNIR bands - Uncertainty <2% - Very stringent criteria	- Over VNIR bands - Uncertainty <5% - Uses surface BRDF	- VIS, NIR & SWIR bands - Uncertainty <5% - Limited matchups

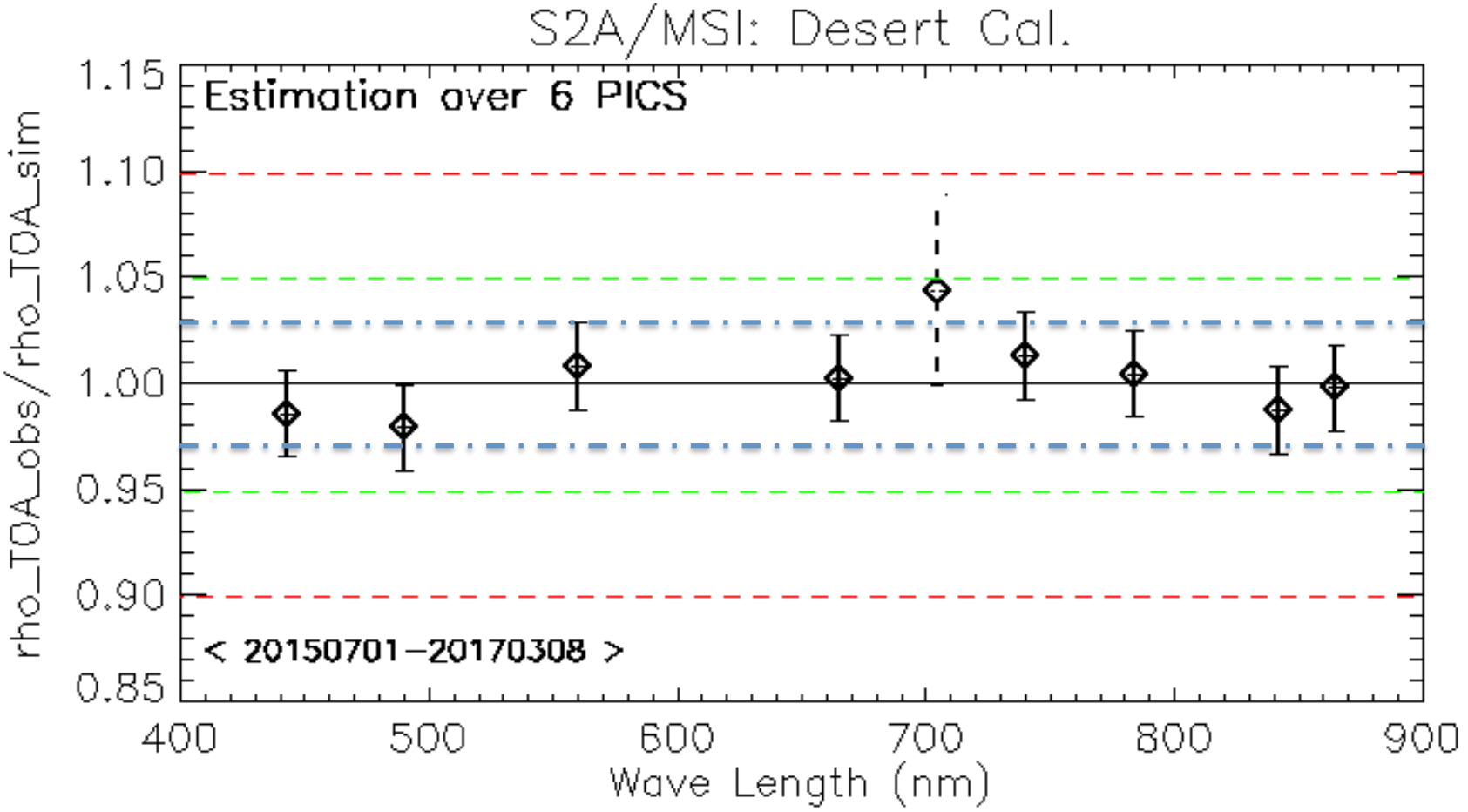
PICS Method: CEOS-CalVal Sites

- Acquisitions over 6 CEOS-PICS CalVal sites
- Subsampling for S2A/MSI and LANDSAT/OLI



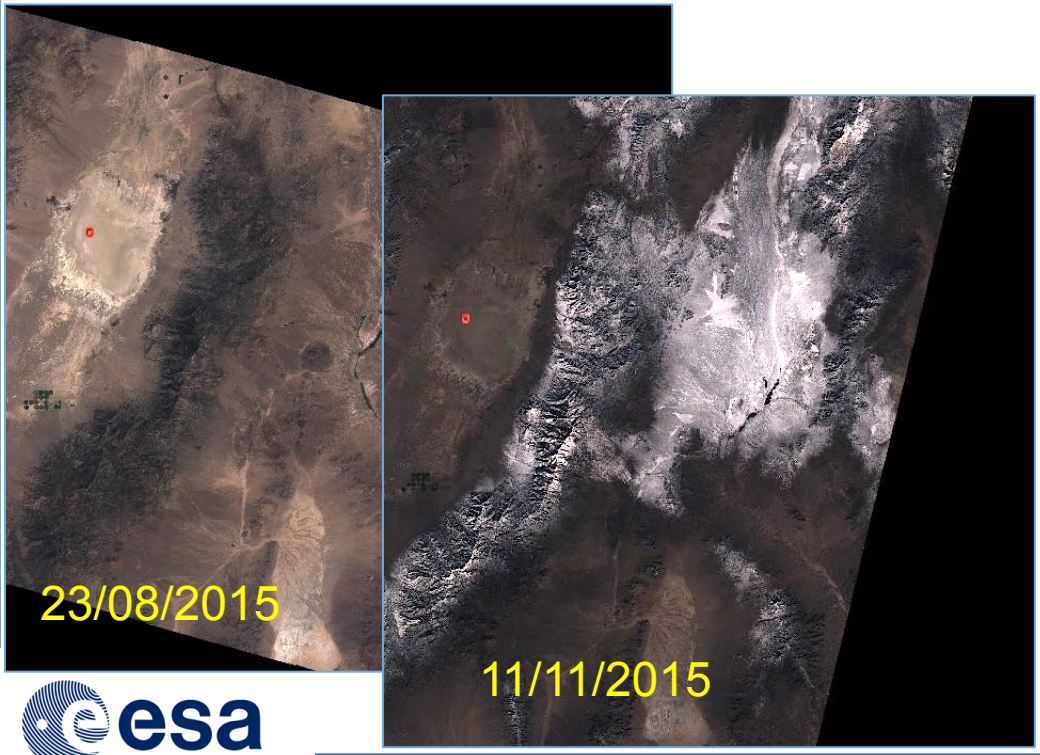
PICS Method: Application on S2A/MSI.

- **The ratio of observed/simulated TOA reflectance**



Ground-reflectance based Method: Application on S2A/MSI

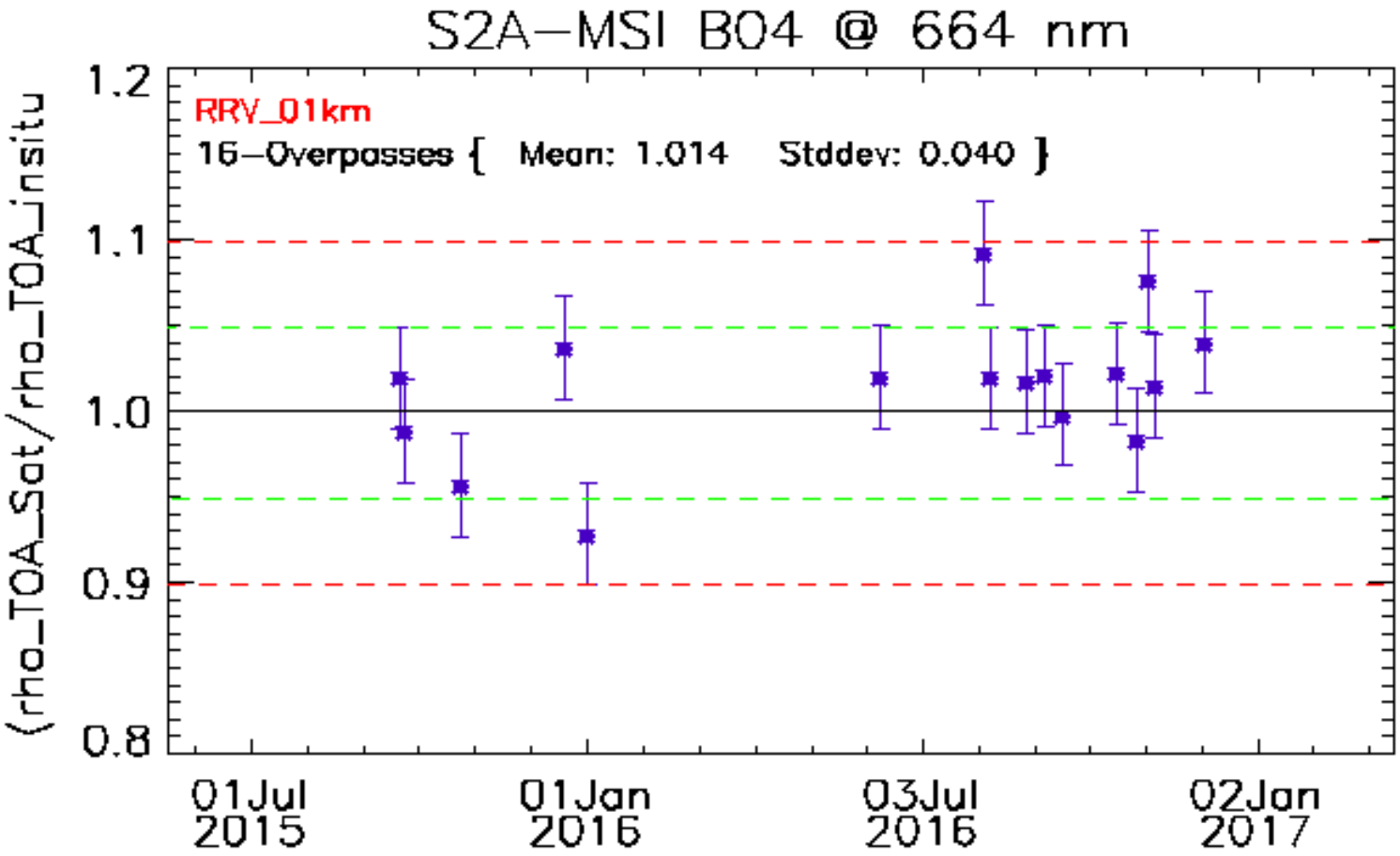
- S2A/MSI-L1C (Tile : T11SPC)
- In-situ measurements are provided by NASA via ESA
- 19 overpasses (available), 3 overpasses were excluded



Date	PB	Abs/Rel Orbit
23/08/15	2.04 (Reproc)	0882/027
19/09/15	2.04 (Reproc)	1268/127
22/09/15	2.04 (Reproc)	1311/027
22/10/15	2.04 (Reproc)	1740/027
11/11/15	2.04 (Reproc)	2026/027
18/12/15	**2.01**	2555/127
31/12/15	**2.01**	2741/027
08/06/16	2.04	5029/027
04/08/16	2.04	6130/127
07/08/16	2.04	5887/027
14/08/16	2.04	5987/127
27/08/16	2.04	6173/027
06/09/16	2.04	6316/027
16/09/16	2.04	6459/027
16/10/16	2.04	6888/027
26/10/16	2.04	7031/027
02/11/16	2.04	7131/127
05/11/16	2.04	7174/027
02/12/16	2.04	7560/127

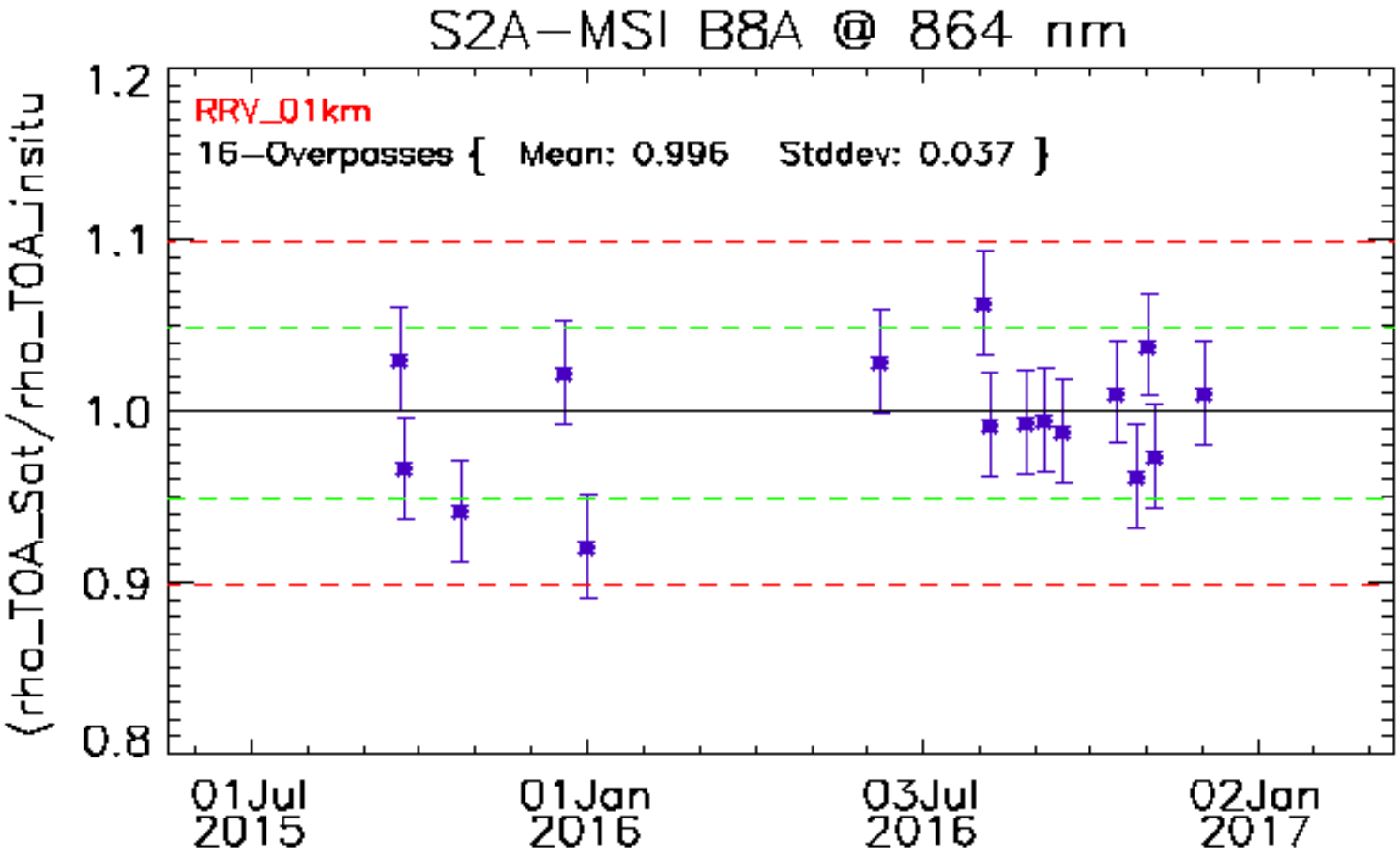
Ground-reflectance based Method: Application on S2A/MSI

- **Time-Series TOA ratios Observation/Reference**



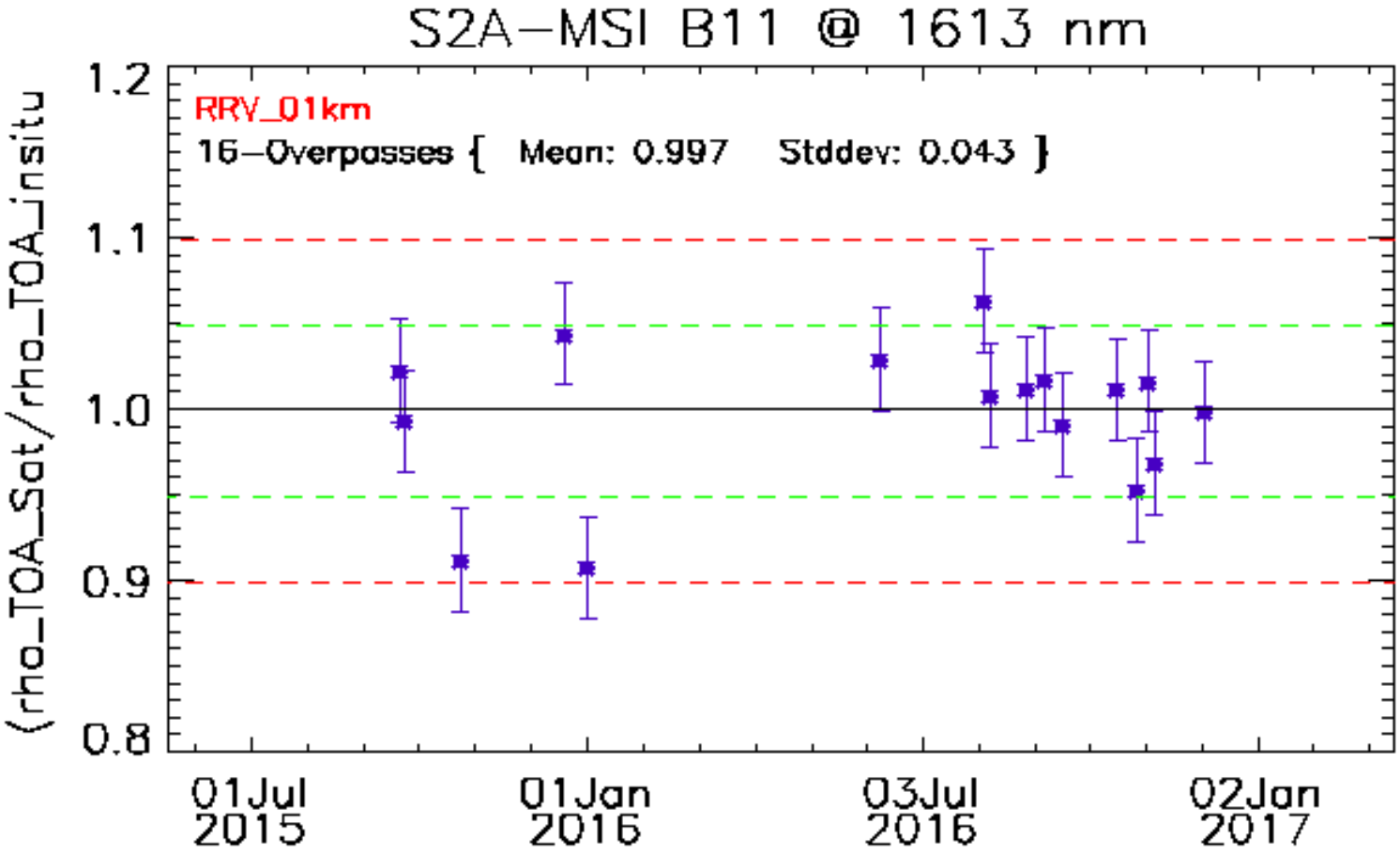
Ground-reflectance based Method: Application on S2A/MSI

- **Time-Series TOA ratios Observation/Reference**



Ground-reflectance based Method: Application on S2A/MSI

- **Time-Series TOA ratios Observation/Reference**

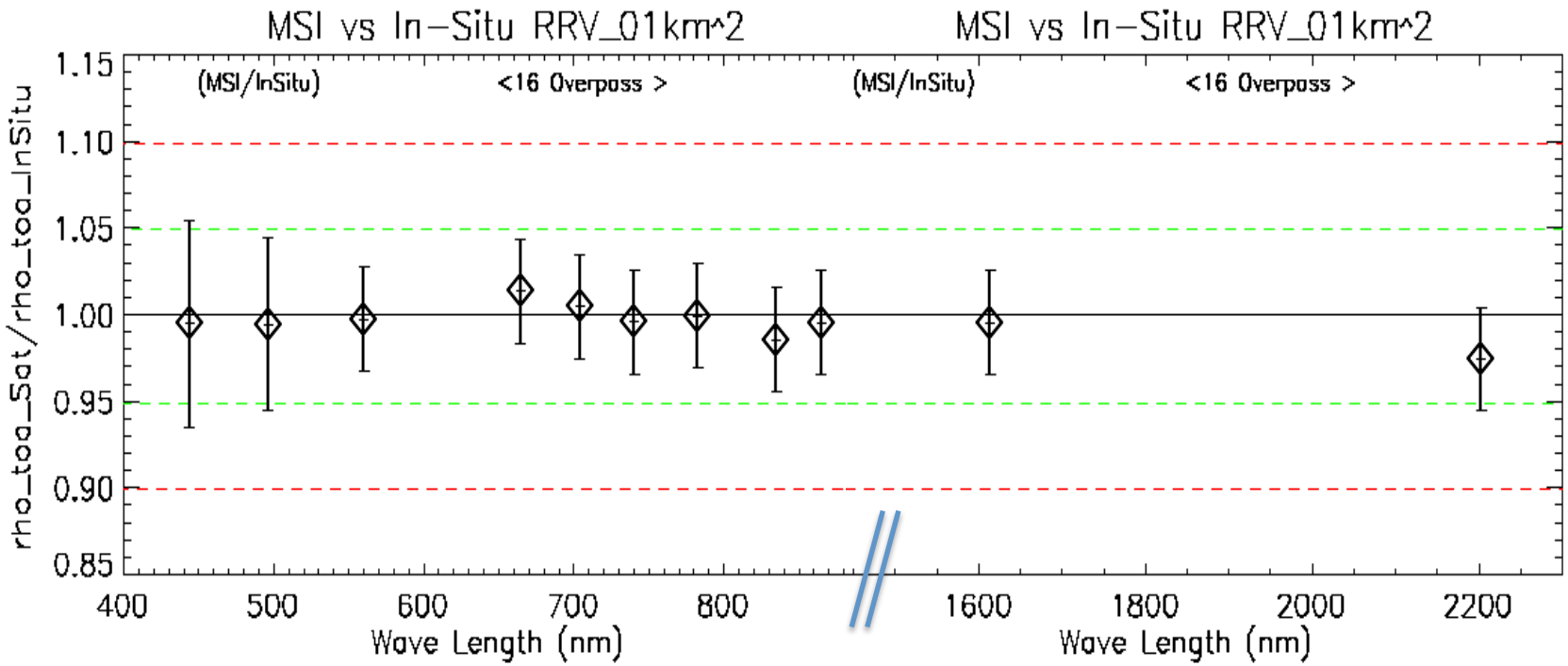


Ground-reflectance based Method: Application on S2A/MSI

- **Time-Series TOA ratios Observation/Reference**

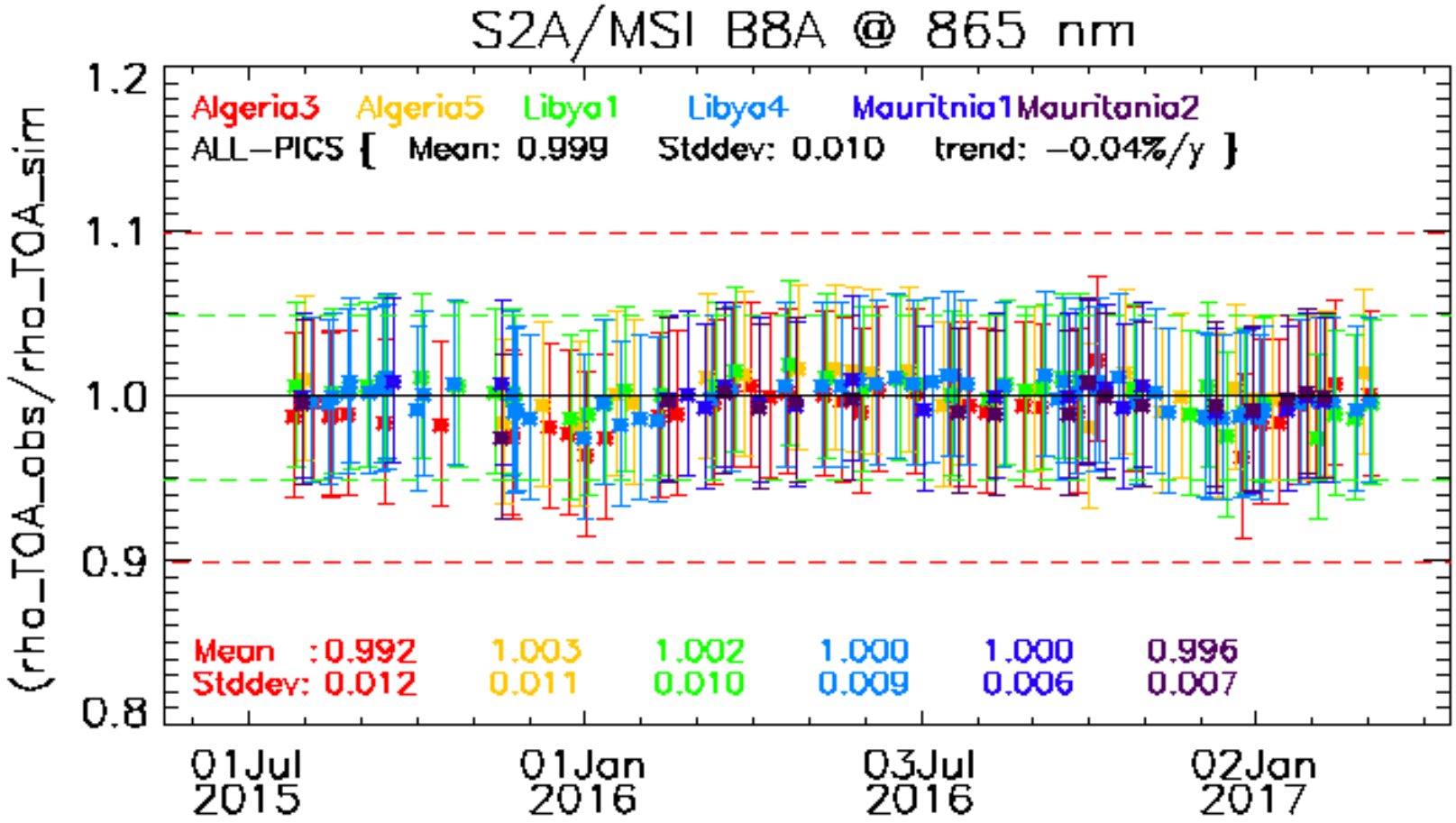
VNIR

SWIR



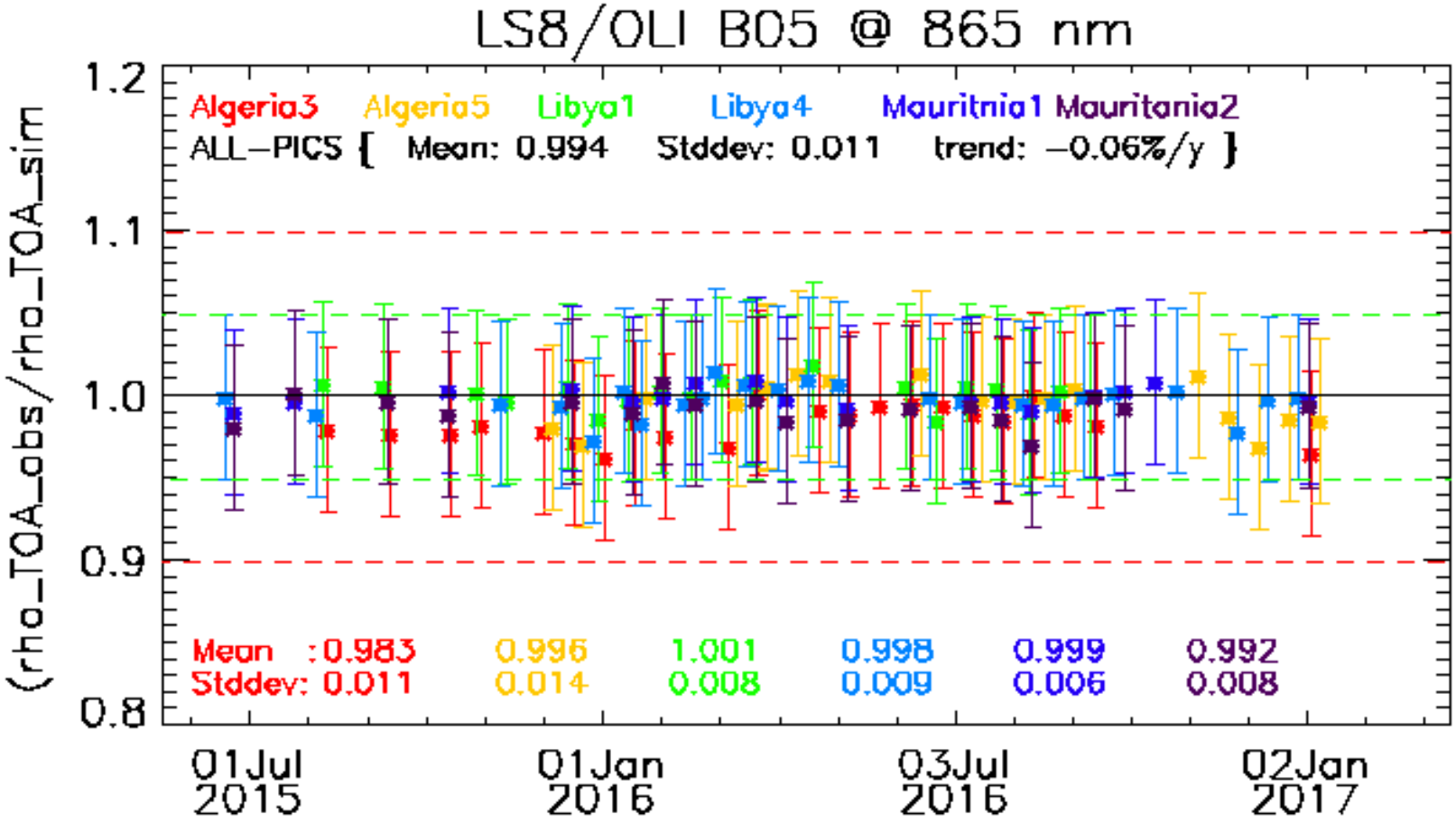
PICS Method: Application on S2A/MSI.

- The ratio of observed/simulated TOA reflectance



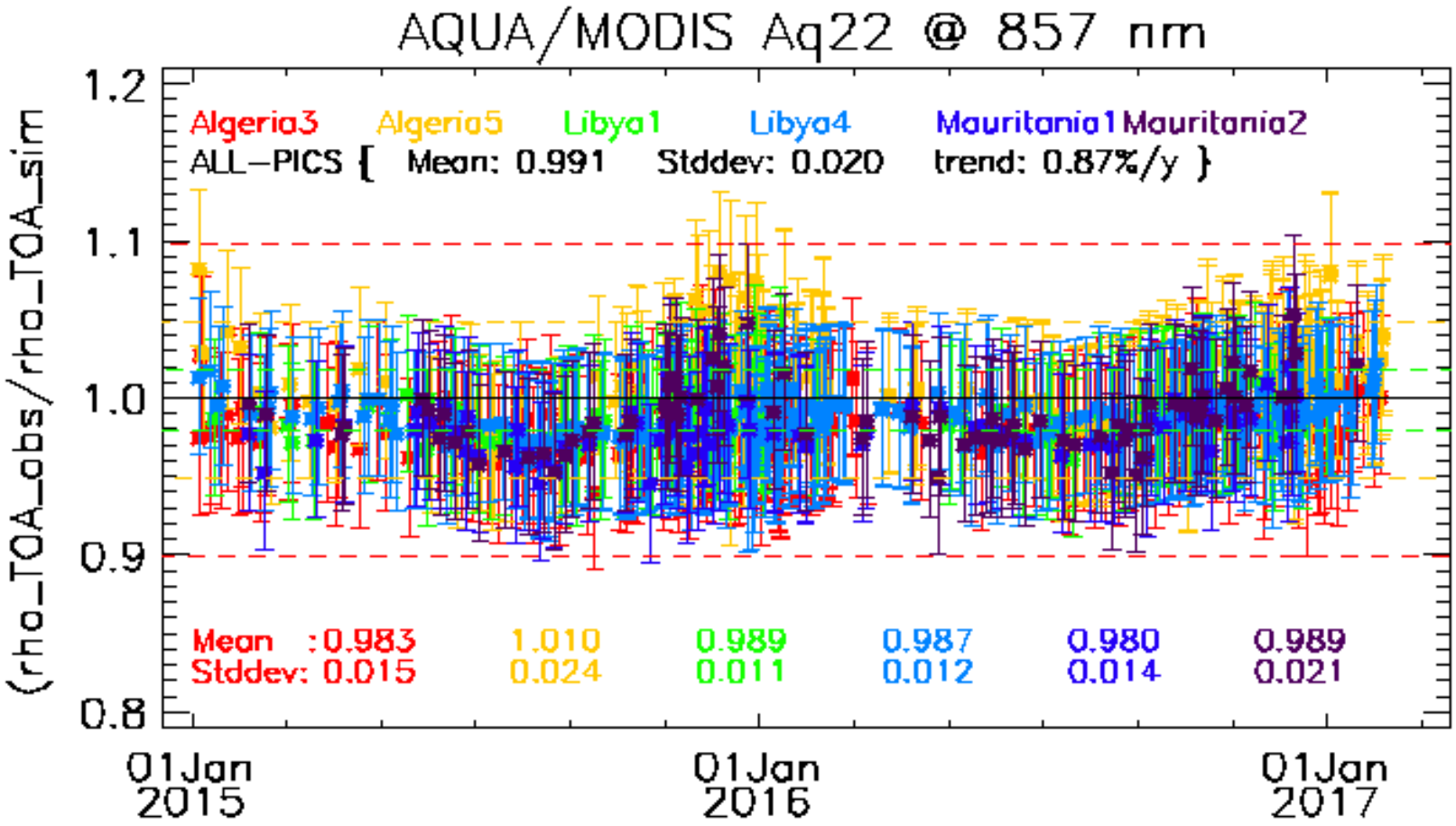
PICS Method: Application on LANDSAT/OLI.

- The ratio of observed/simulated TOA reflectance



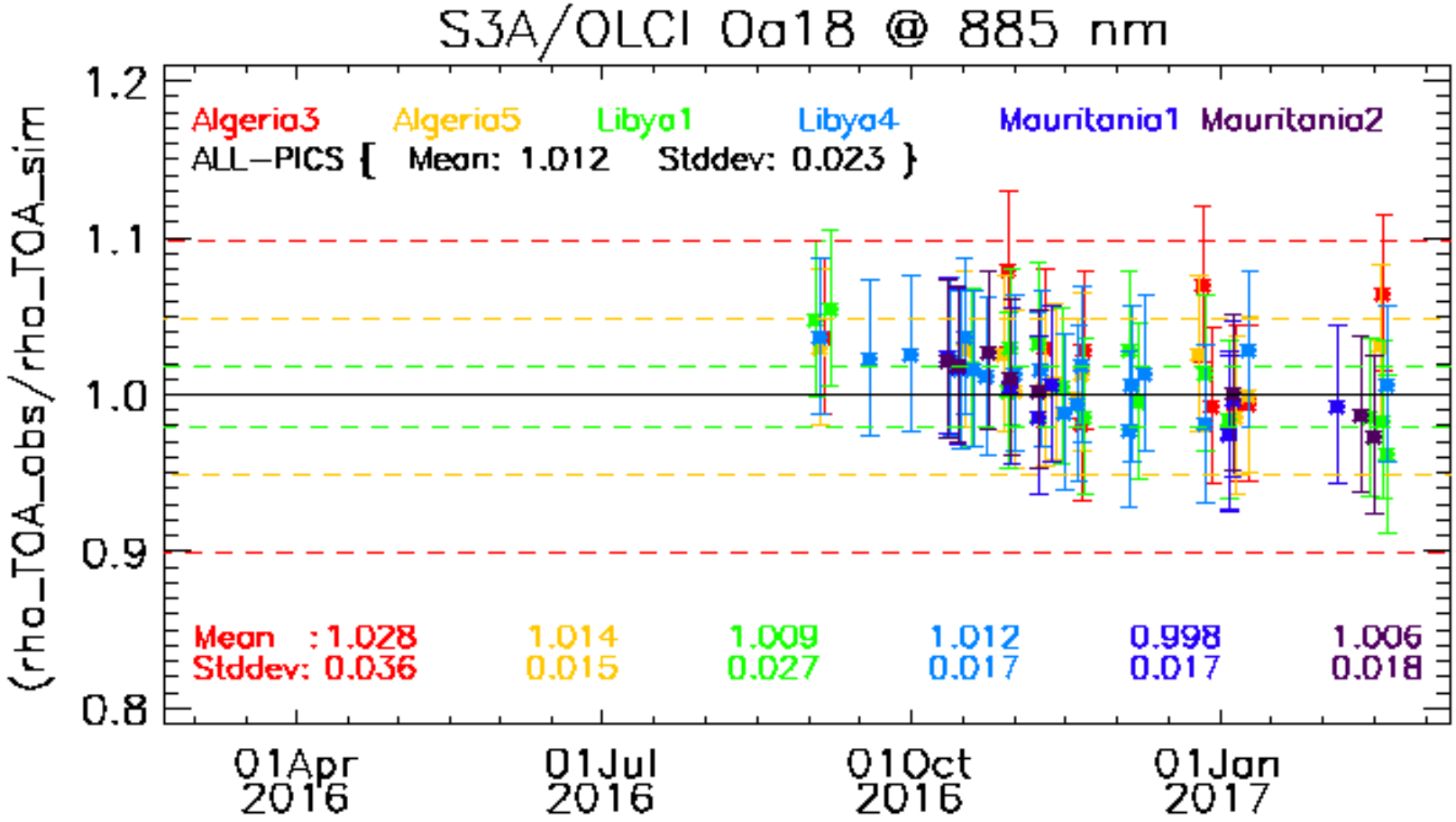
PICS Method: Application on Aqua/MODIS.

- The ratio of observed/simulated TOA reflectance



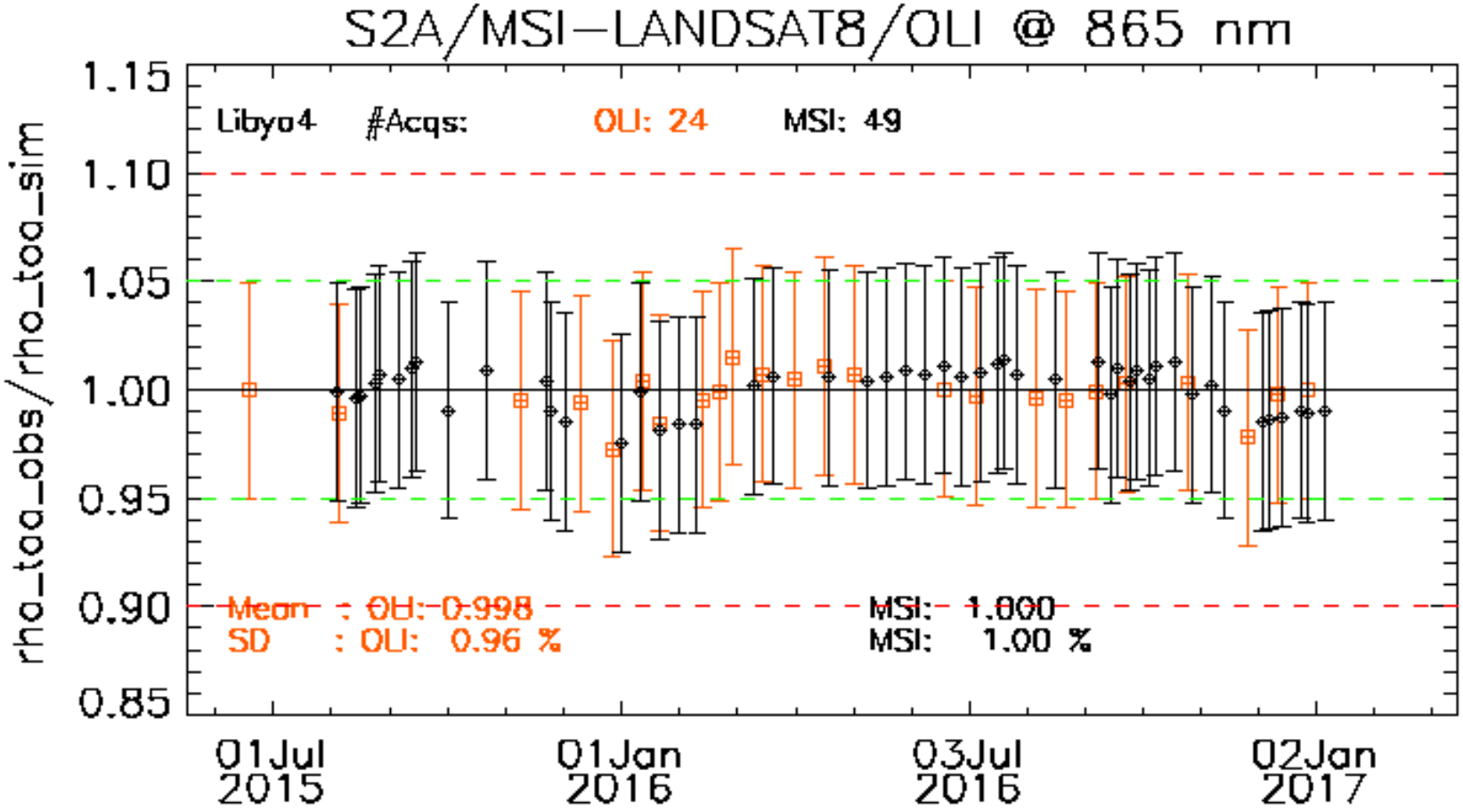
PICS Method: Application on S3A/OLCI

- The ratio of observed/simulated TOA reflectance



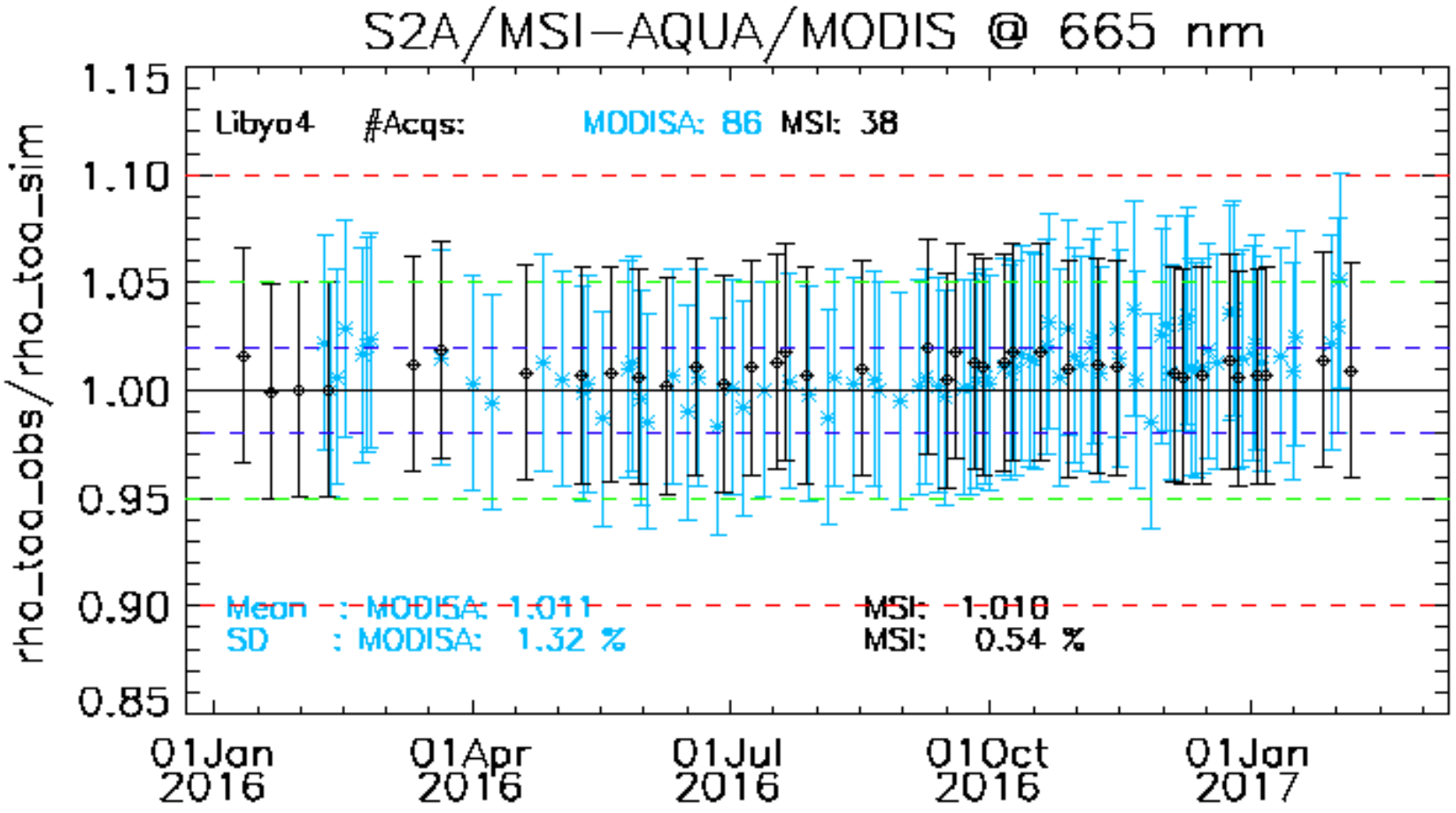
Intercomparison: MSI/OLI

- The ratio of observed/simulated TOA reflectance



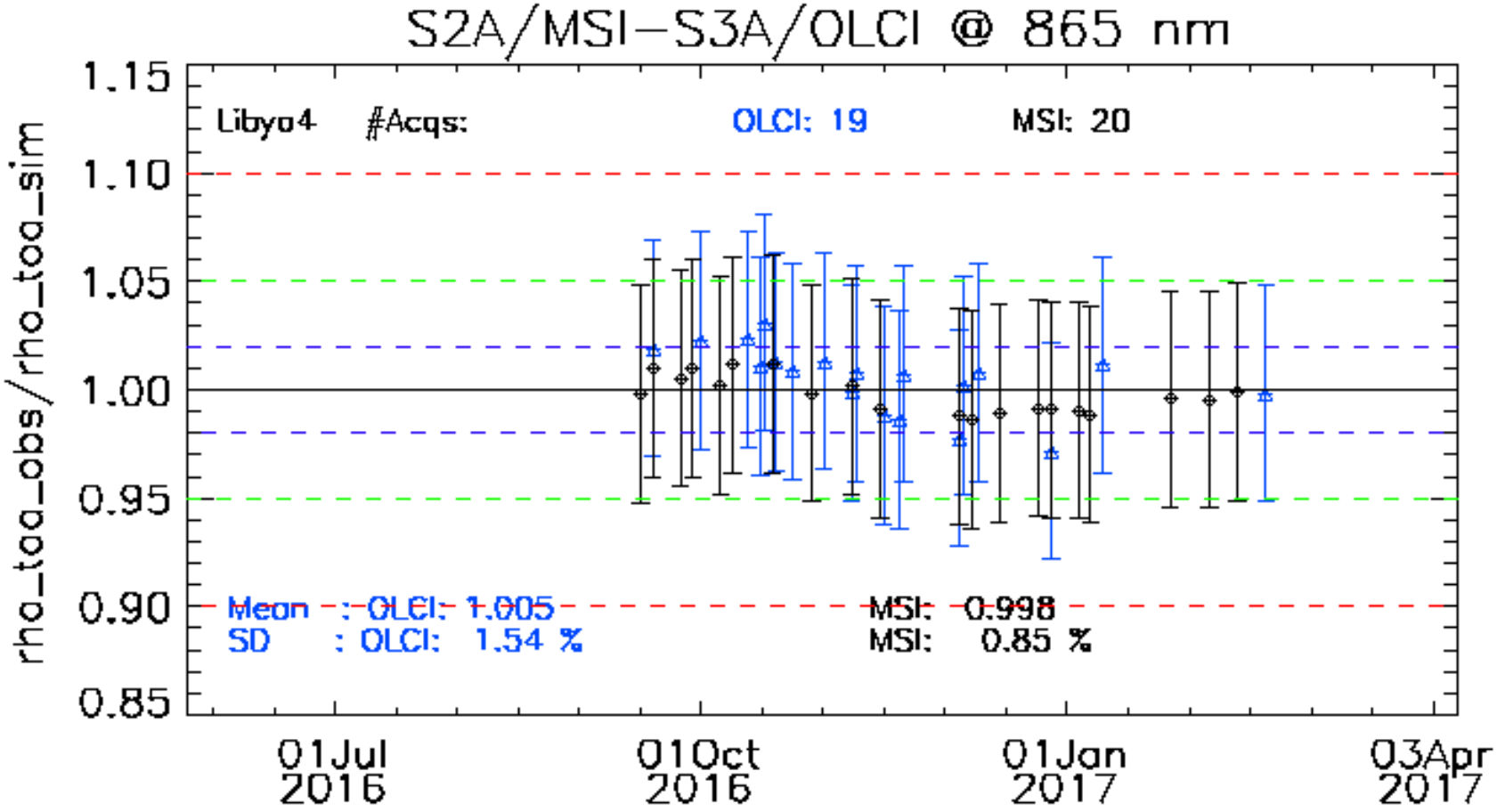
Intercomparison: MSI/MODIS-A

- The ratio of observed/simulated TOA reflectance



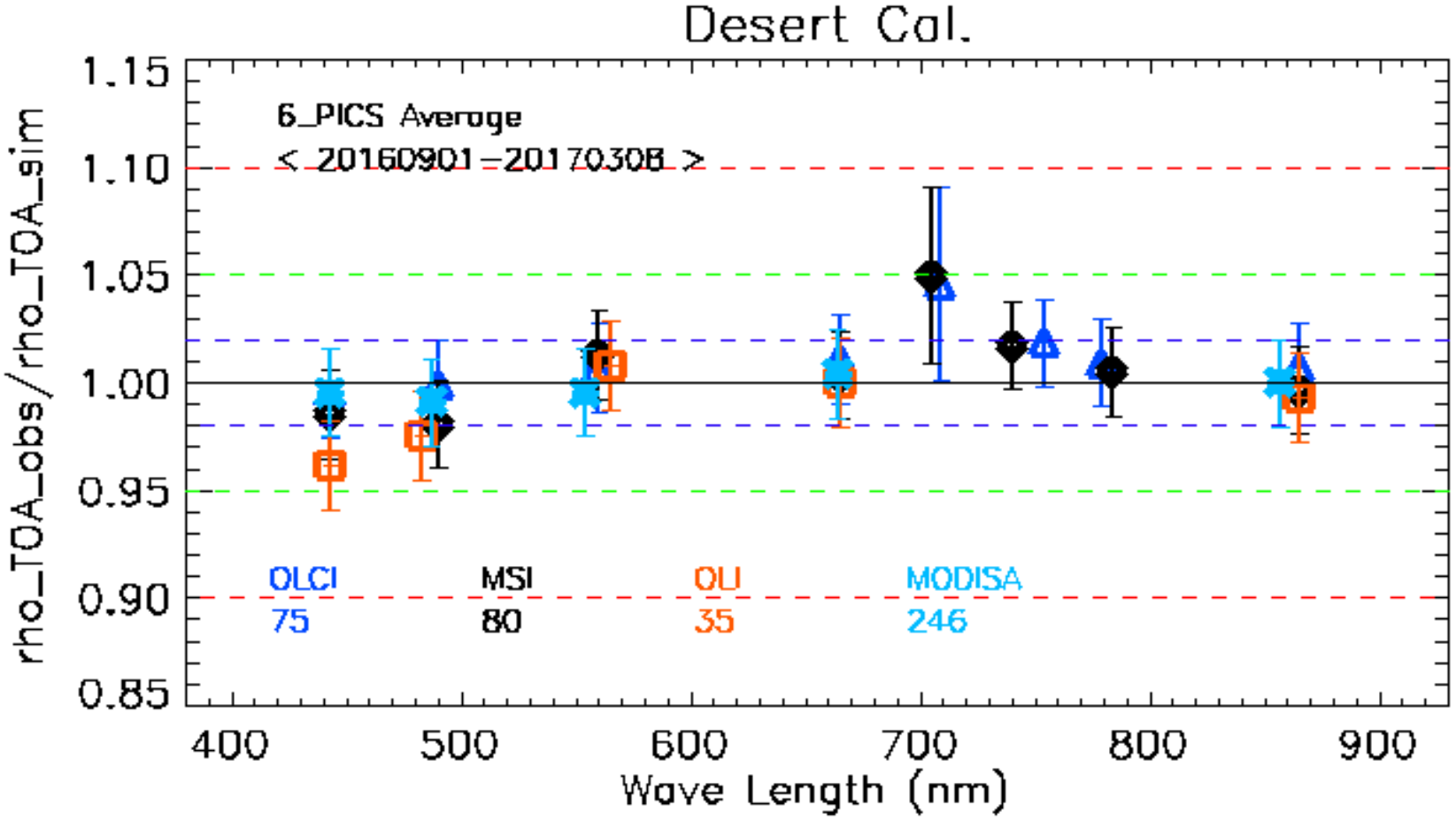
Intercomparison: MSI/OLCI

- The ratio of observed/simulated TOA reflectance



Intercomparison: MSI/MODISA/OLCI/OLI

- The ratio of observed/simulated TOA reflectance



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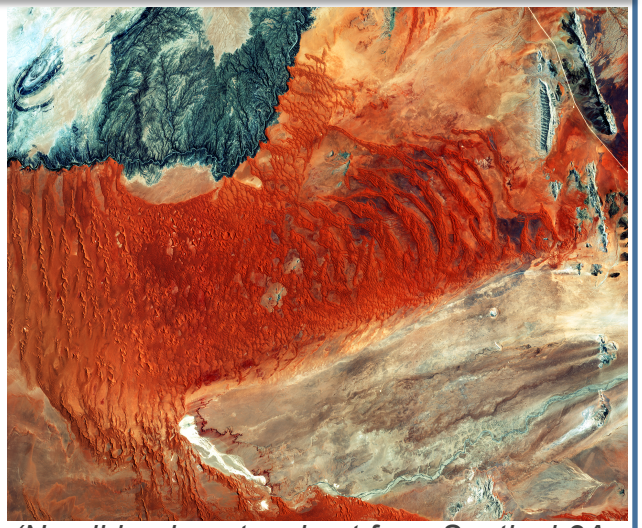
CONCLUSION

1. MSI shows an excellent calibration and image quality: Consistency and good stability
2. OLCI provides a good L1 products and shows good calibration since November 2016 (PB002)
3. Both sensors show a good agreement with OLI and MODISA over the comparison period



(Namibia_desert_subset from Sentinel-2A Credit: Copernicus Sentinel data 2016)

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Thank you for your attention

Thanks to

- **ESA, EUMETSAT and Copernicus**
- **S2MPC, S3MPC and DIMITRI teams**
- **RADCATS dataset were provided by the NASA Landsat Cal/Val Team as part of the ESA expert users effort**

(Mont St-Michel bay with low-tide from Sentinel-2A on 20160716T110923, Courtesy of S2MPC)

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