



*Mission Performance Centre*



**ARGANS**



# SENTINEL-2/MSI COMMISSIONING RESULTS AND COMPARISON TO LANDSAT-8/OLI USING PICS/DIMTIRI DATABASE

B. ALHAMMOUD &

S2MPC-TEAM & DIMITRI-TEAM

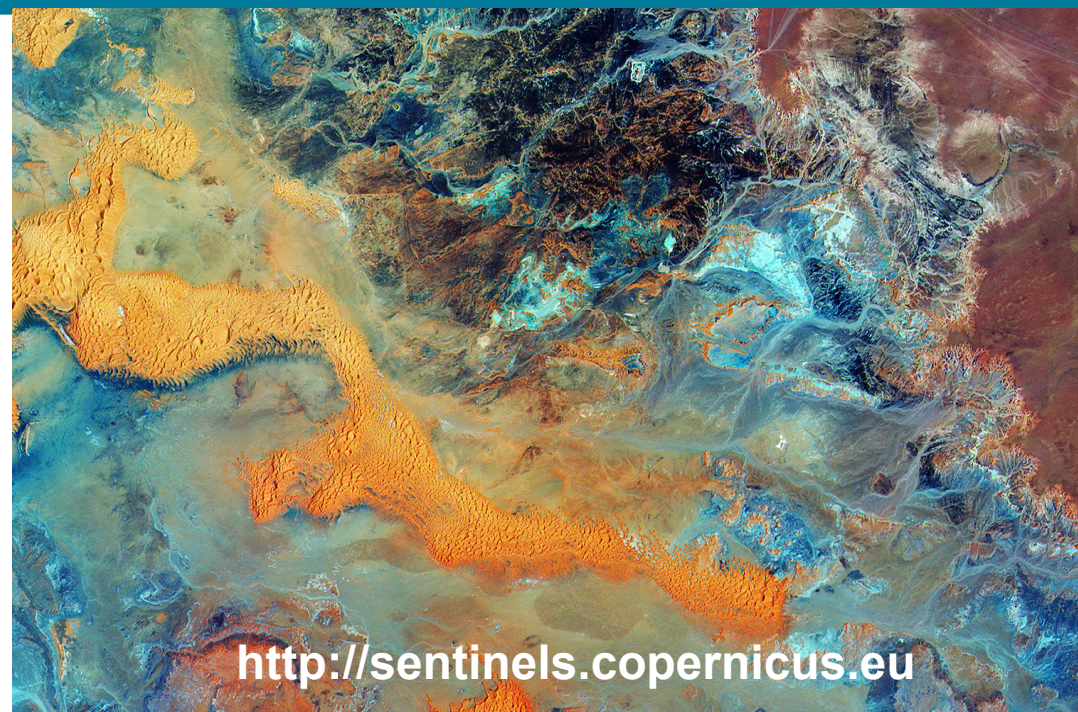
CEOS-WGCV-IVOS, BEIJING 18-21/07/2016





# AGENDA

- ➔ Overview of MSI characteristics
- ➔ DIMITRI Toolbox
- ➔ PICS subsampling analysis
- ➔ S2MPC-L1-VAL-RAD activity
- ➔ Conclusion

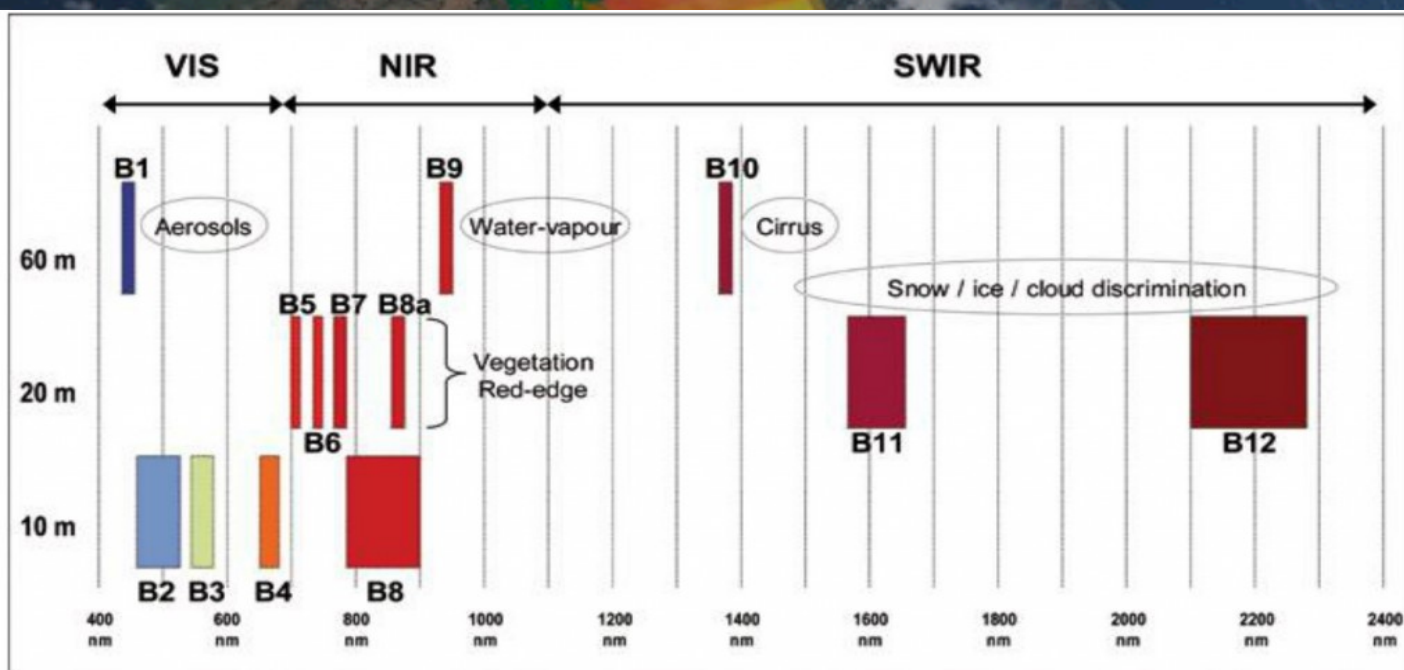




# OVERVIEW OF S2A/MSI CHARACTERISTICS



- ➔ Overview of MSI characteristics
- ➔ 13 VIS/NIR/SWIR spectral bands
- ➔ Spatial resolution: 10m / 20m (60 m for atmosphere calibration)
- ➔ Swath: 290 km
- ➔ 2 spacecraft on same orbit, S2A launched in June 2015, S2B within a year
- ➔ 180° apart: 5 days revisit at equator
- ➔ Systematic coverage between 84°N and 56°S





## DIMITRI

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



- › **DIMITRI: Database for Imaging Multi-Spectral Instruments and Tools for Radiometric Intercomparison** (Developed by ESA-ESTEC & ARGANS with support from Magellium).
- › It consists on 4 vicarious methods: Rayleigh, Glint, PICS and Sensor-to-Sensor Inter-calibration + 3 cloud screening modules

Sensors	Ocean sites	Desert Sites	Other sites
AATSR	SPG_OPTIMUM	ALGERIA-3	AMAZON
ATSR2	SIO_OPTIMUM	ALGERIA-5	DOME C
MERIS	NW_PACIFIC_OPTIMUM	LIBYA-1	UYUNI
MODIS-Aqua	NE_PACIFIC_OPTIMUM	LIBYA-4	TUZ GOLU
PARASOL	NW_ATLANTIC_OPTIMUM	MAURITANIA-1	BOUSSOLE
VEGETATION – 2	SW_ATLANTIC_OPTIMUM	MAURITANIA-2	Railroad Valley
VIIRS	MEDSEA_OPTIMUM		
MSI_A	NE_AUSTRALIA_OPTIMUM		
OLCI_A			
SLSTR_A			





# DIMITRI

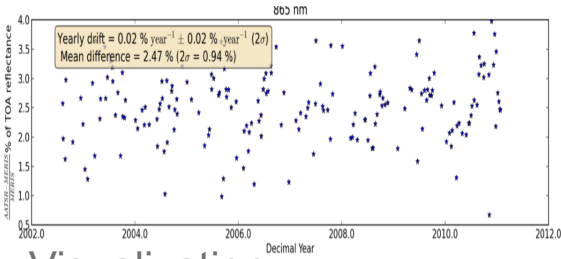
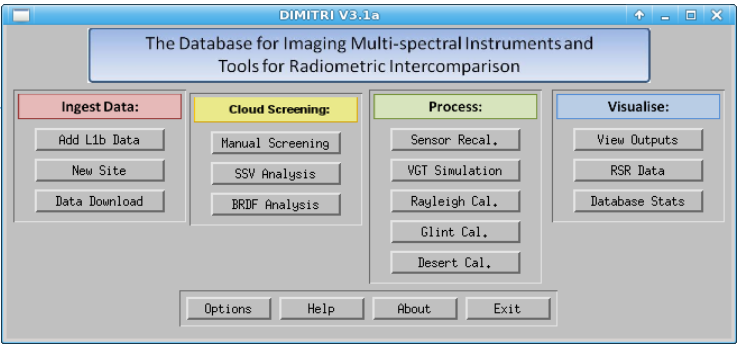
Database for Imaging Multi-spectral Instruments and Tools  
for Radiometric Intercomparison



Input: L1B/L1C  
Database



OpenSearch  
Sensor  
ROI  
Year



Visualization

Process  
& Tools



CSV-Archive

Binary  
Database



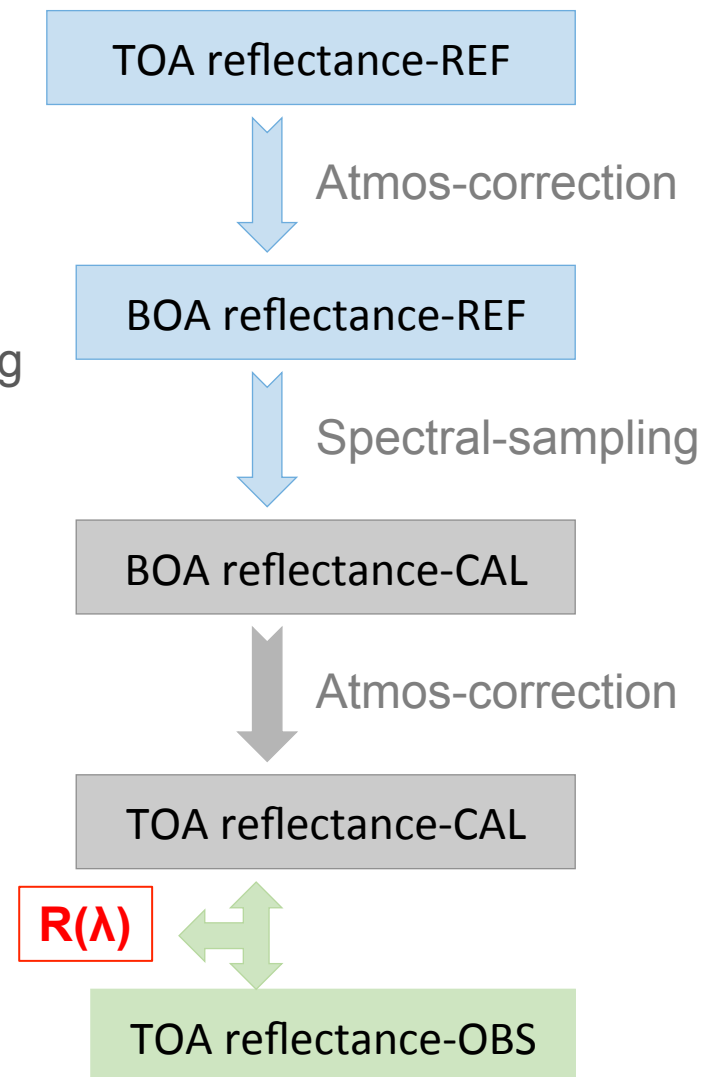
<http://calvalportal.ceos.org/tools>  
<https://dimitri.argans.co.uk>

➔ GOAL: To evaluate the long-term trends in S2A/MSI sensor performance to identify relative biases in the radiometric calibration

➔ METHOD OVERVIEW

- › Pseudo-invariant calibration sites (PICS) method following Bouvet (2014)
- › Use of MERIS as Reference sensor
- › Considering BRDF model (RPV-model)
- › Use MYSTIC in LibRadtran as Radiative Transfert Model
- › Meteorology data (WV and O3) from ERA-Interim
- › **Relative calibration coefficient:**

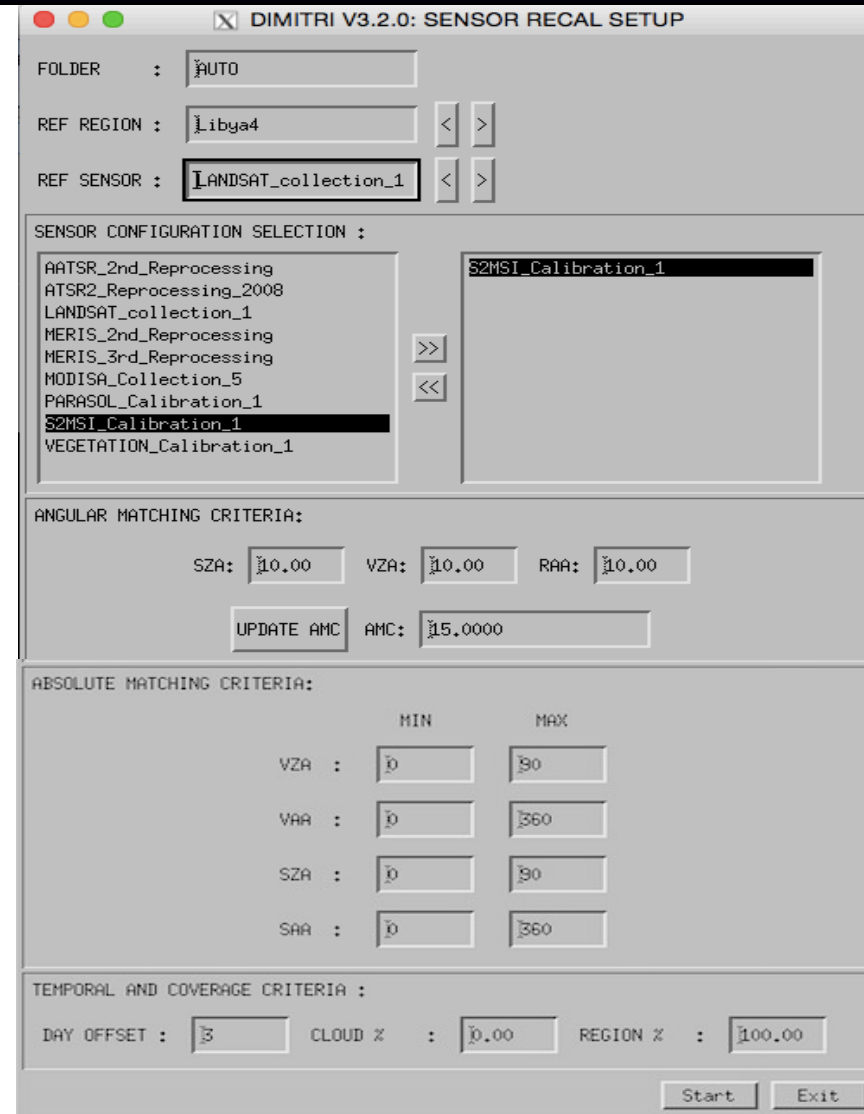
$$R(\lambda) = \rho^{\text{obs}} / \rho^{\text{sim}} ; \text{Uncertainty } \pm 5\% \text{ (B05 of } \pm 10\%)$$



➔ GOAL: Compare absolute radiometric response to other sensors.

### ➔ METHOD OVERVIEW

- › Following Bouvet et al (2006) : Direct comparison of TOA reflectance of two or more sensors.
- › User defined Reference sensor
- › User defined geometry “Angular Matching Criteria” (AMC)
- › No relative spectral response (RSR) adjustment considered
- › No surface BRDF considered
- › **Absolute calibration coefficient:**
- ›  $A(\lambda) = \rho^{\text{CAL}} / \rho^{\text{REF}}$

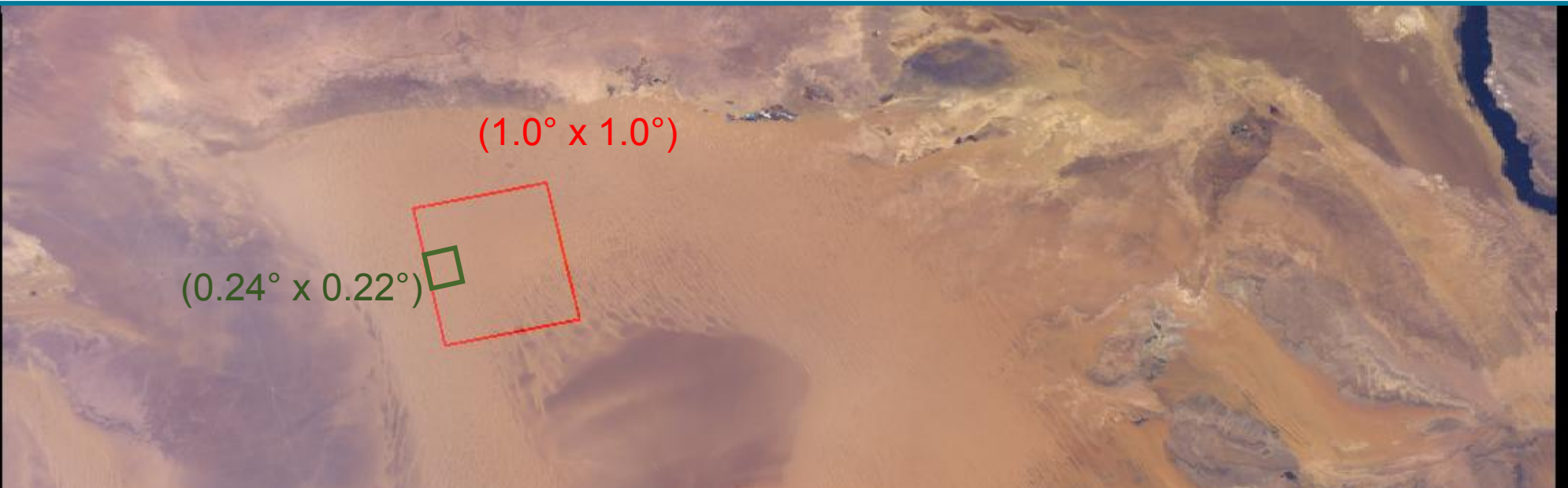




# IMPACT OF SUBSAMPLING PICS SITES OVER MERIS-3<sup>RD</sup>-REPROC



## → RGB-QL-MERIS Libya4-**Small/Large** sites



(1.0° x 1.0°)

(0.24° x 0.22°)

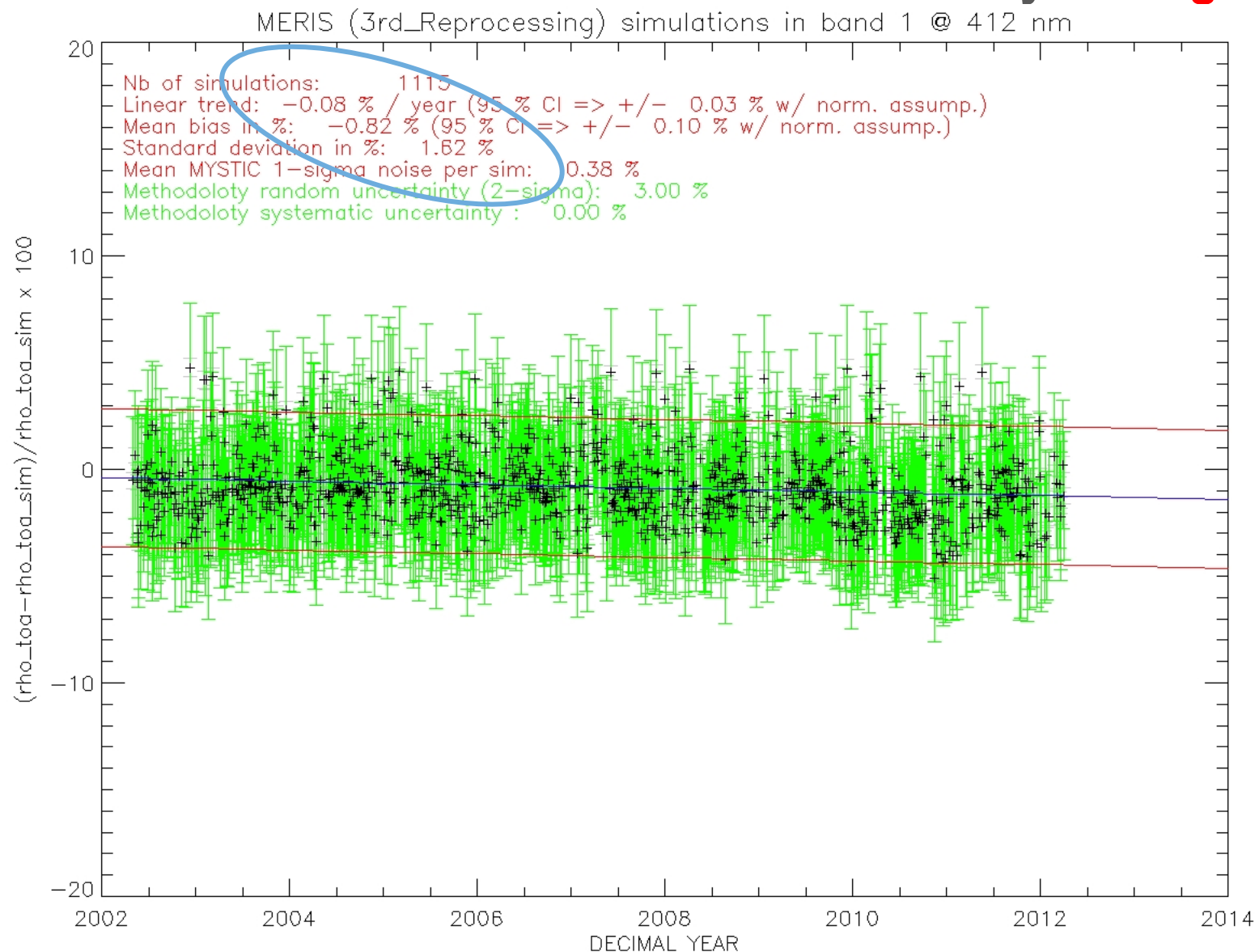


(0.3° x 0.3°)

(1.0° x 1.0°)

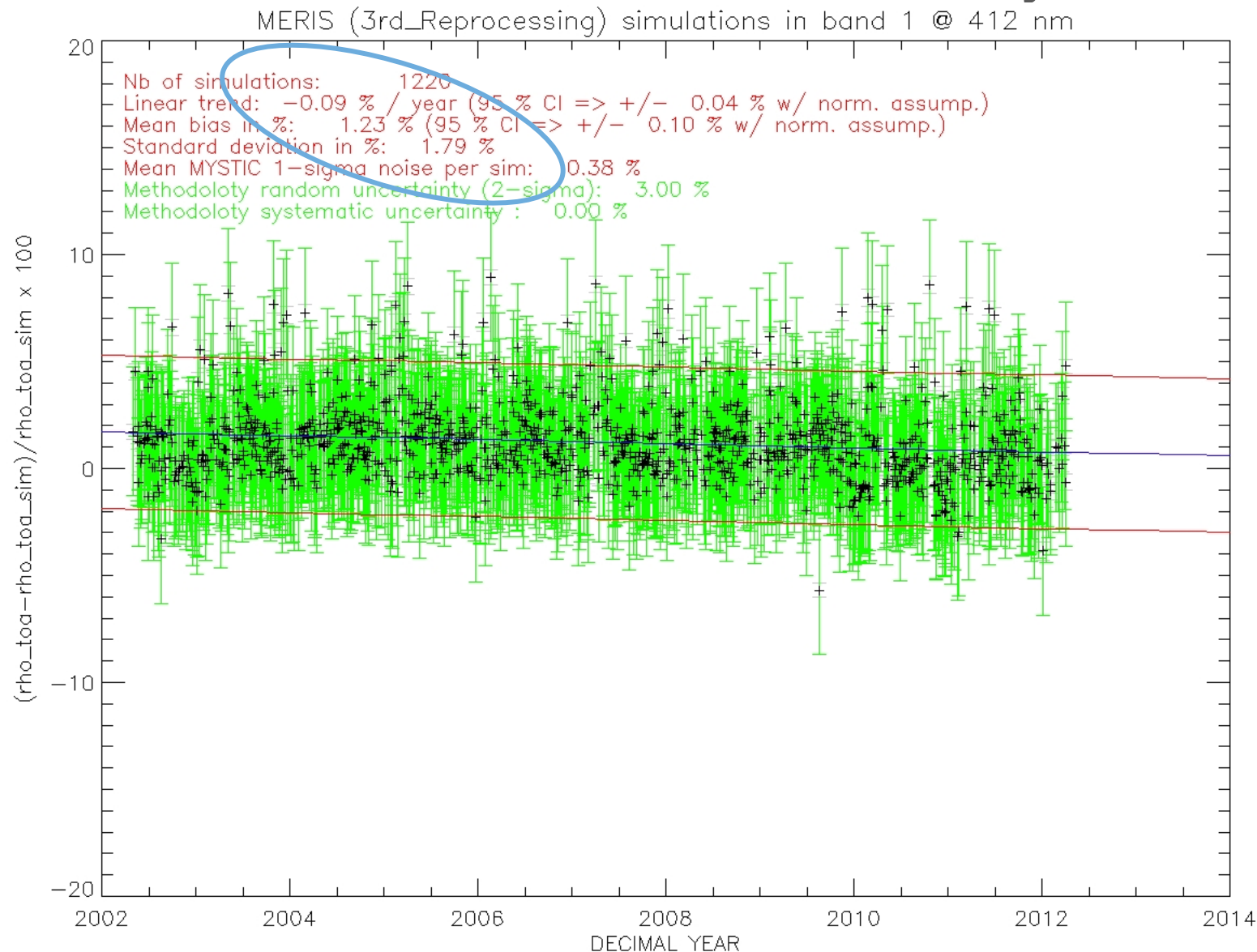


## ➔ Example of Relative difference in (%) of observed to simulated reflectance from MERIS 2002-2012 archive over Libya4-**Large** site



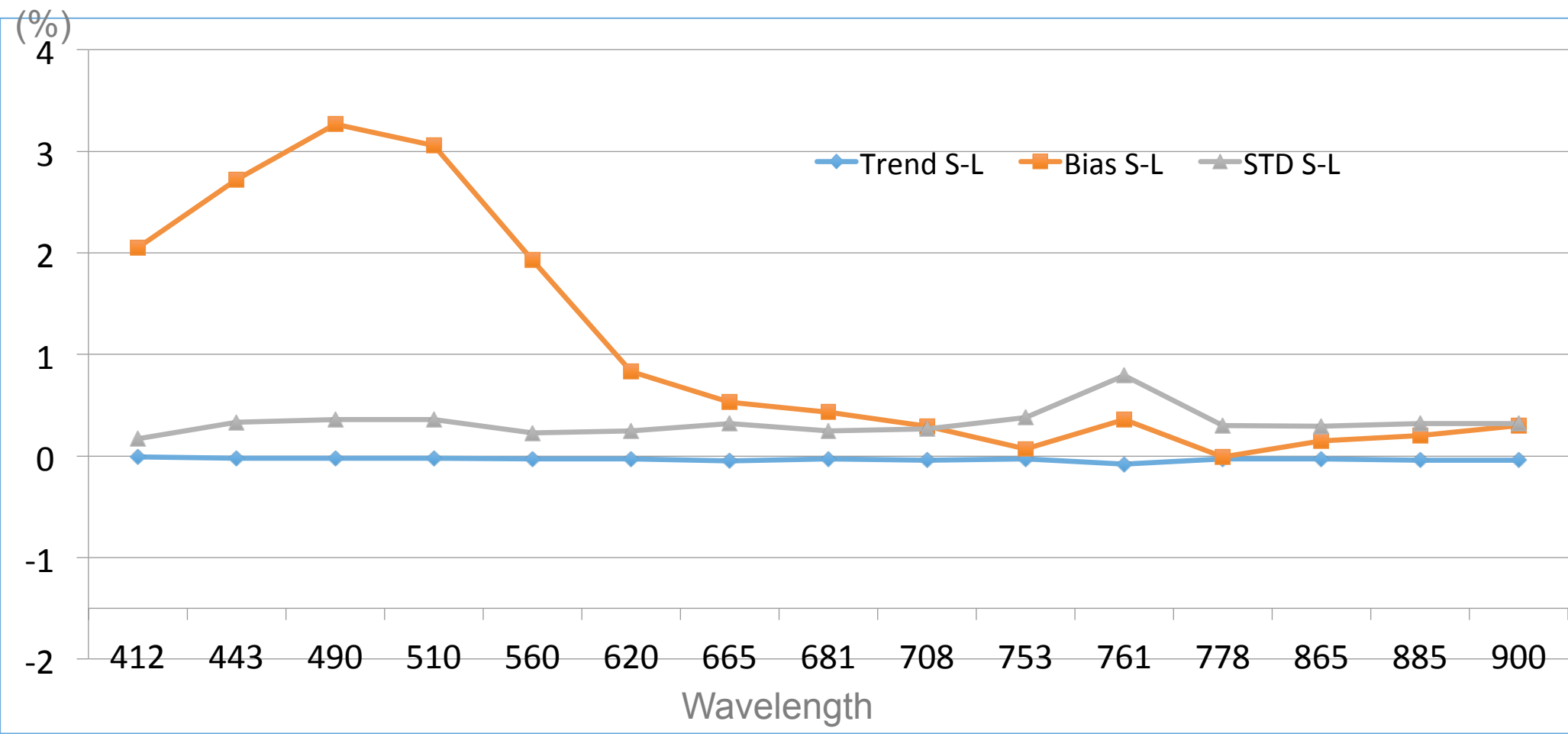


## ➔ Example of Relative difference in (%) of observed to simulated reflectance from MERIS 2002-2012 archive over Libya4-**Small** site





➔ Absolute difference in (%) of trend, bias and stddev from Small-to-Large sites from MERIS 2002-2012 archive over Libya4

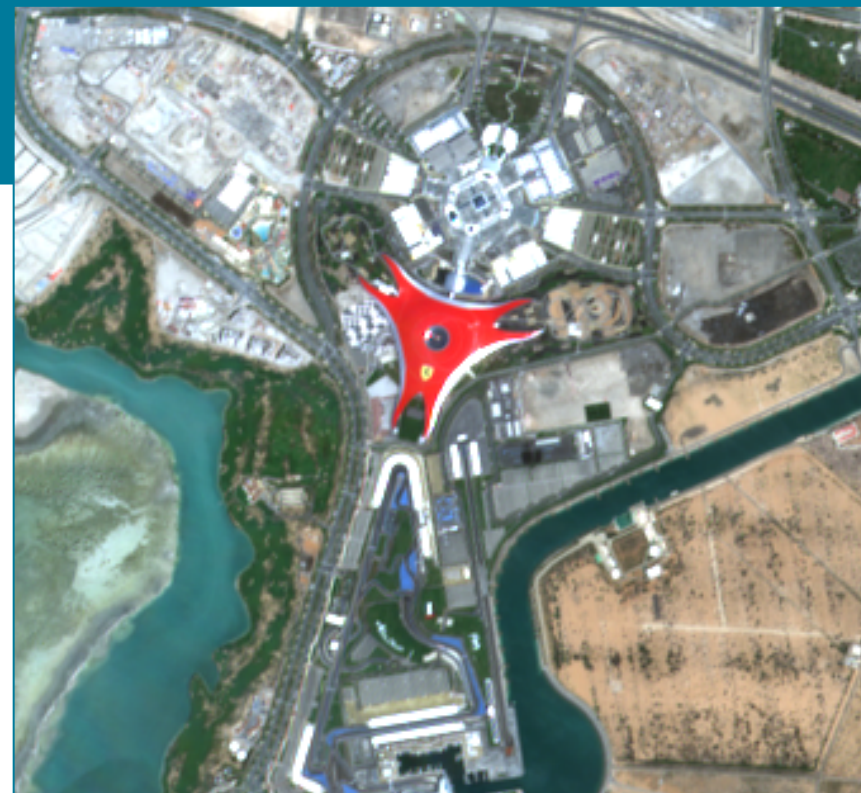


# IMPACT OF SUBSAMPLING PICS SITES: APPLICATION ON S2A/MSI.

Ferrari World, Abu Dhabi, UAE

S2A: R020\_V20160419T065754

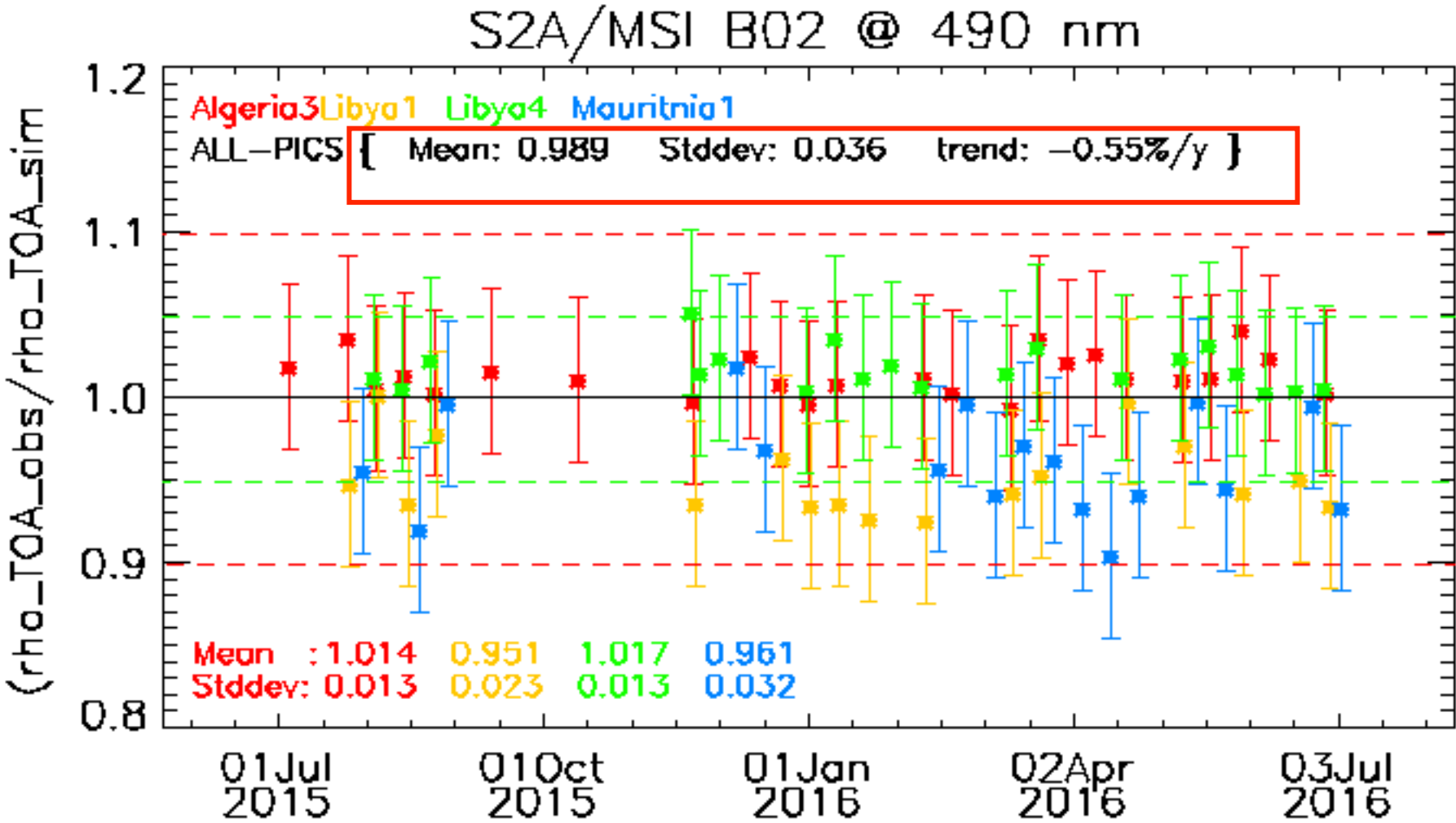
Courtesy of O. Thepaut (S2MPC)





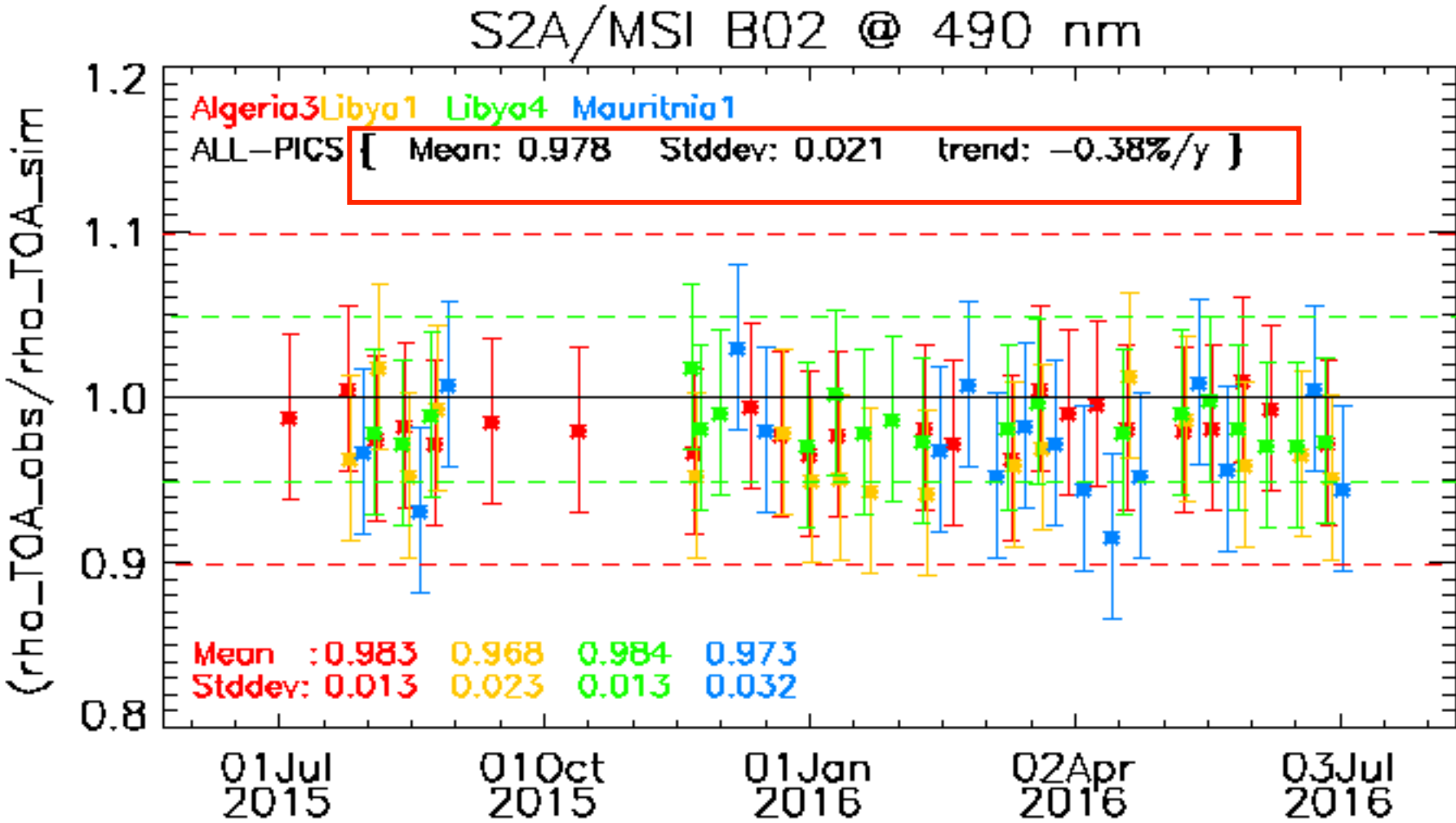
# APPLICATION ON S2A/MSI RESULTS OVER PICS CALVAL SITES.

➔ The ratio of observed/simulated TOA\_reflectance from S2A/MSI over Small-PICS

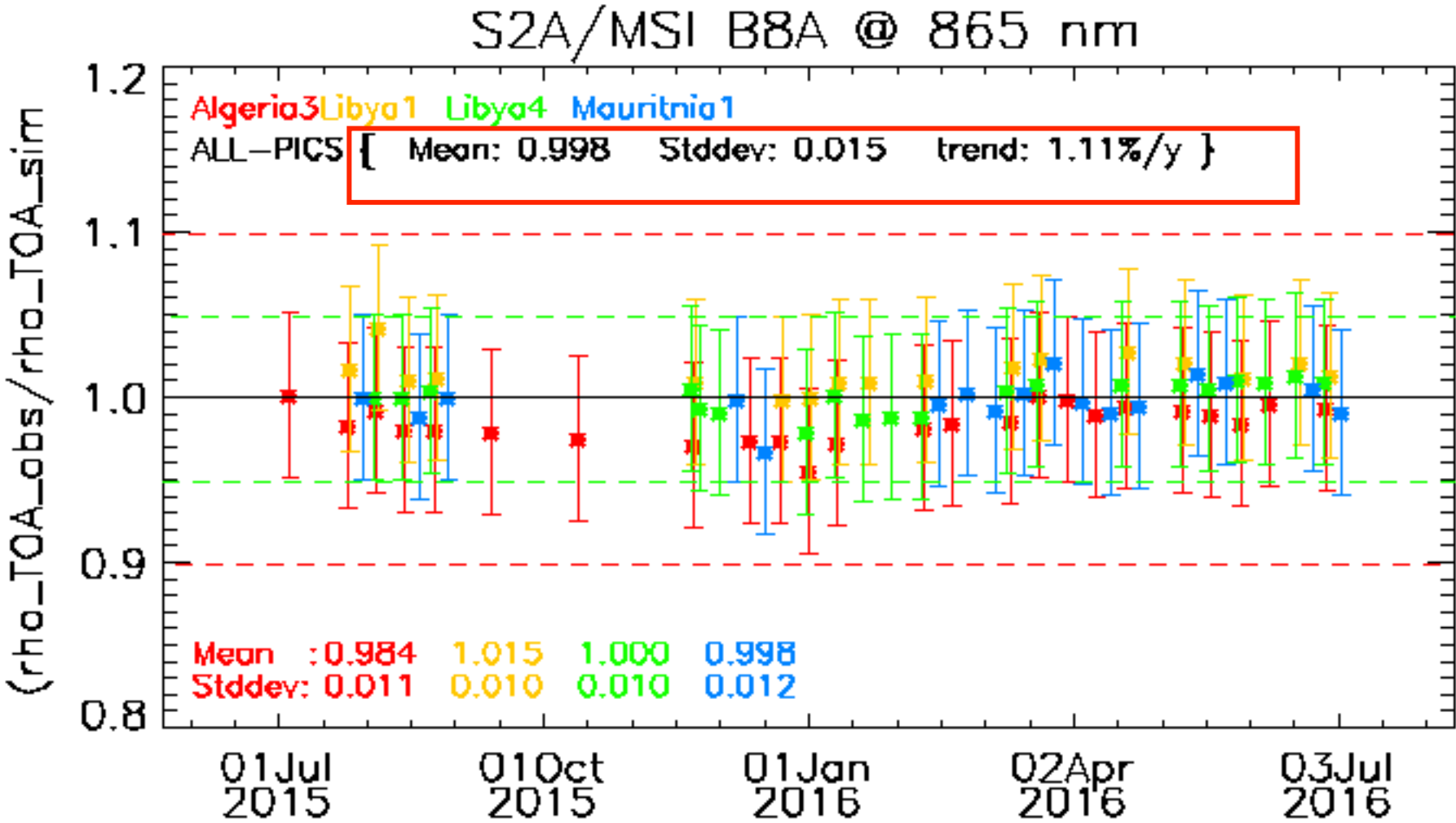


# APPLICATION ON S2A/MSI RESULTS OVER PICS CALVAL SITES.

➔ The ratio of observed/simulated TOA\_reflectance from S2A/MSI over Small-PICS+SHIFT



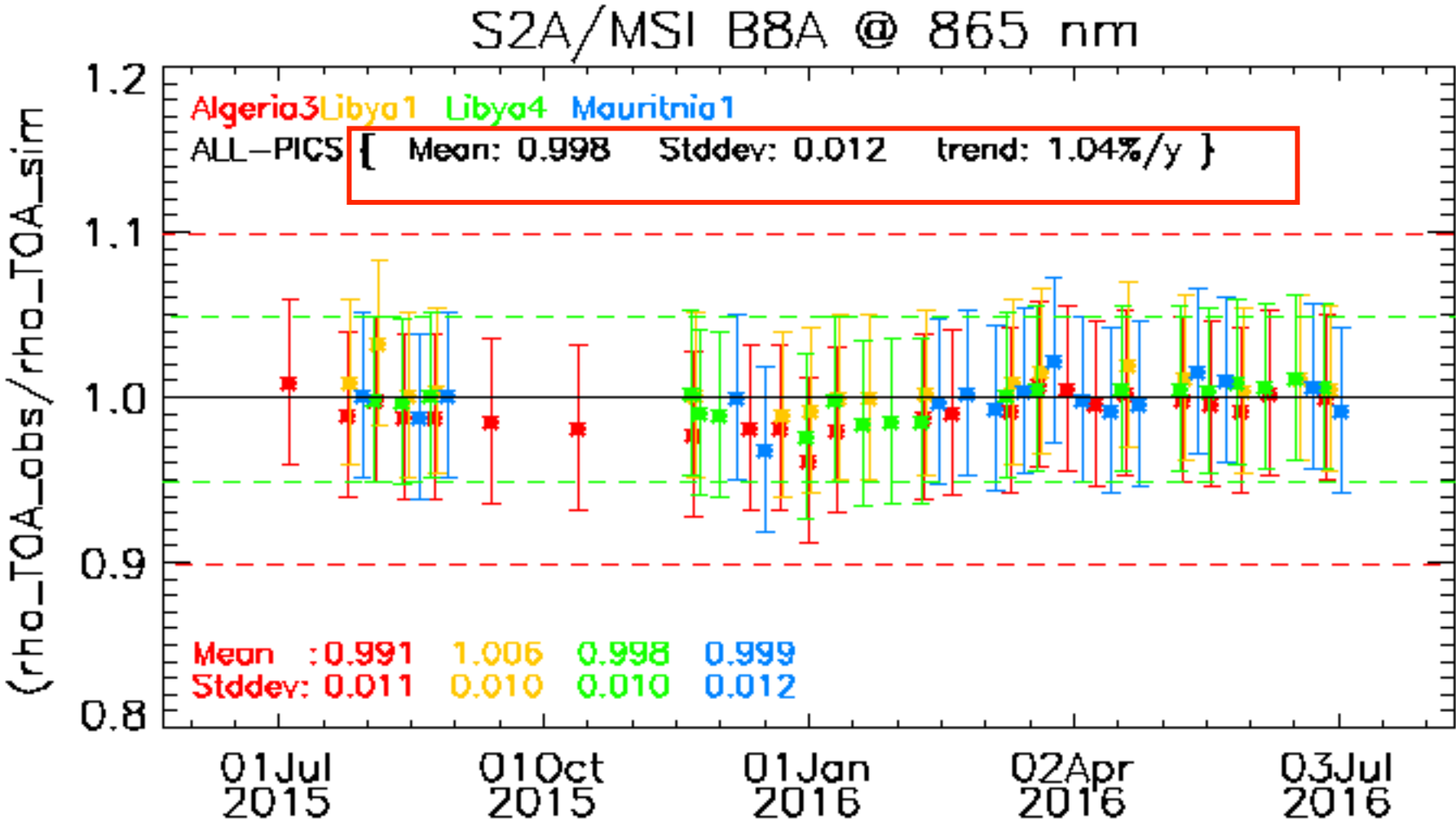
➔ The ratio of observed/simulated TOA\_reflectance from S2A/MSI over Small-PICS



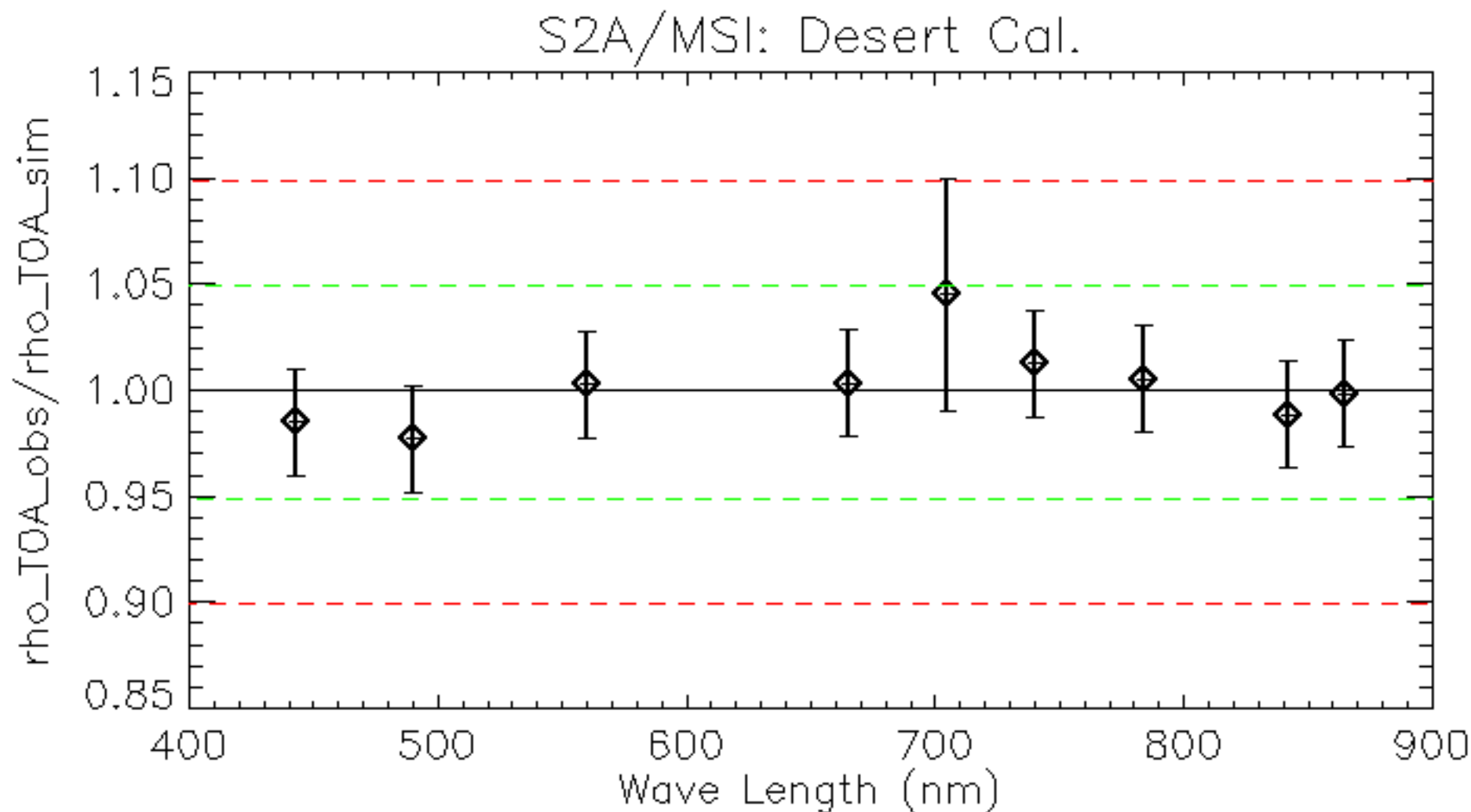


# APPLICATION ON S2A/MSI RESULTS OVER PICS CALVAL SITES.

➔ The ratio of observed/simulated TOA\_reflectance from S2A/MSI over **Small-PICS+SHIFT**

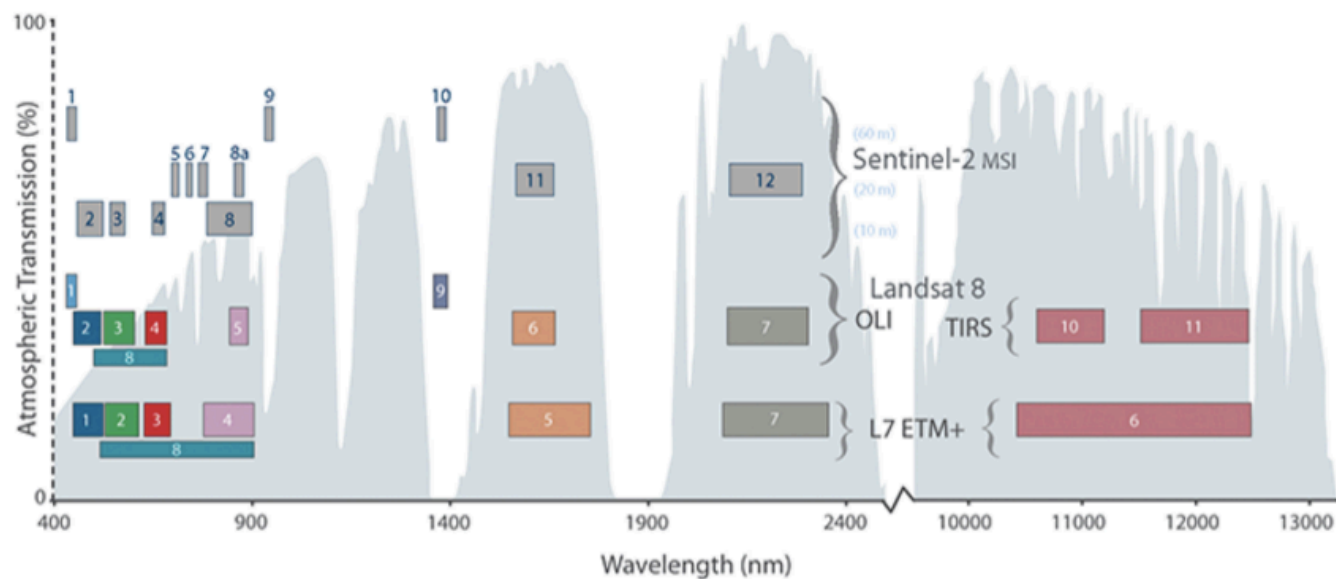


- ➔ The ratio of observed/simulated TOA\_reflectance from S2A/MSI over **Algeria3, Libya1, Libya4 and Mauritania1**



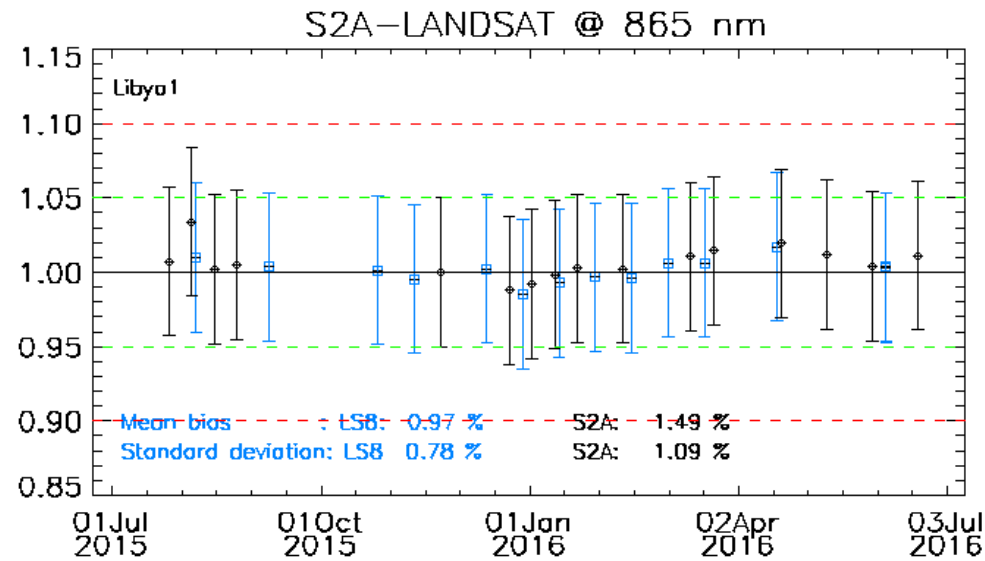
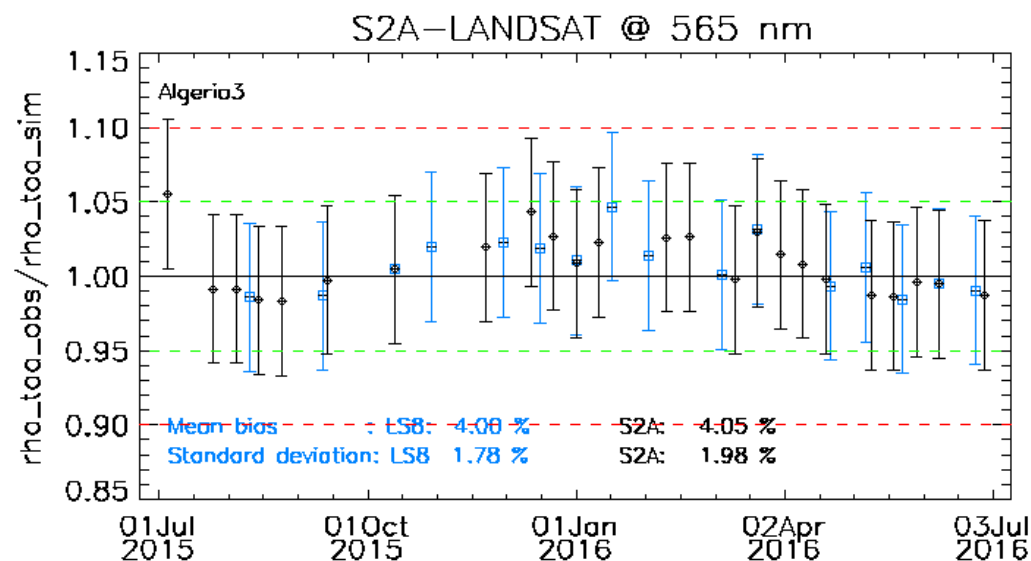
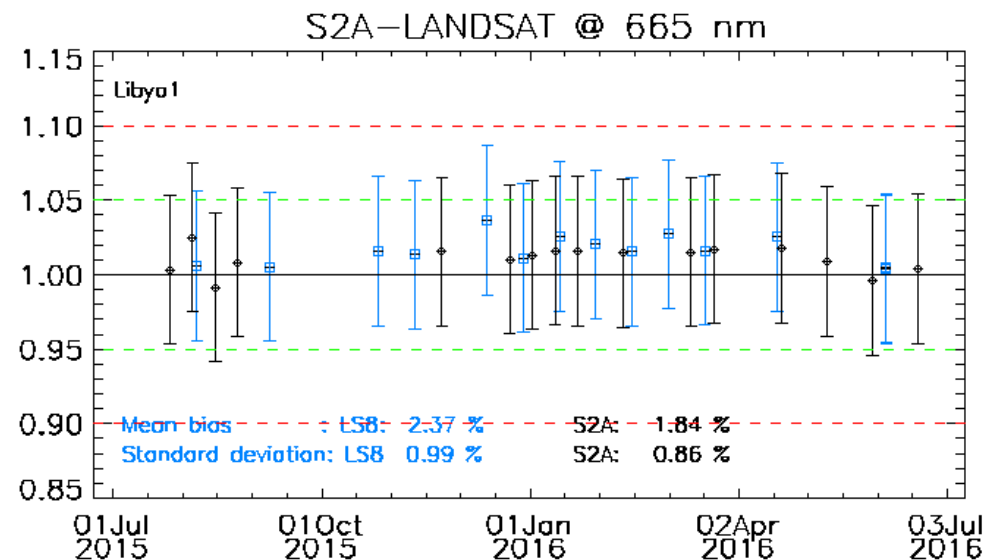
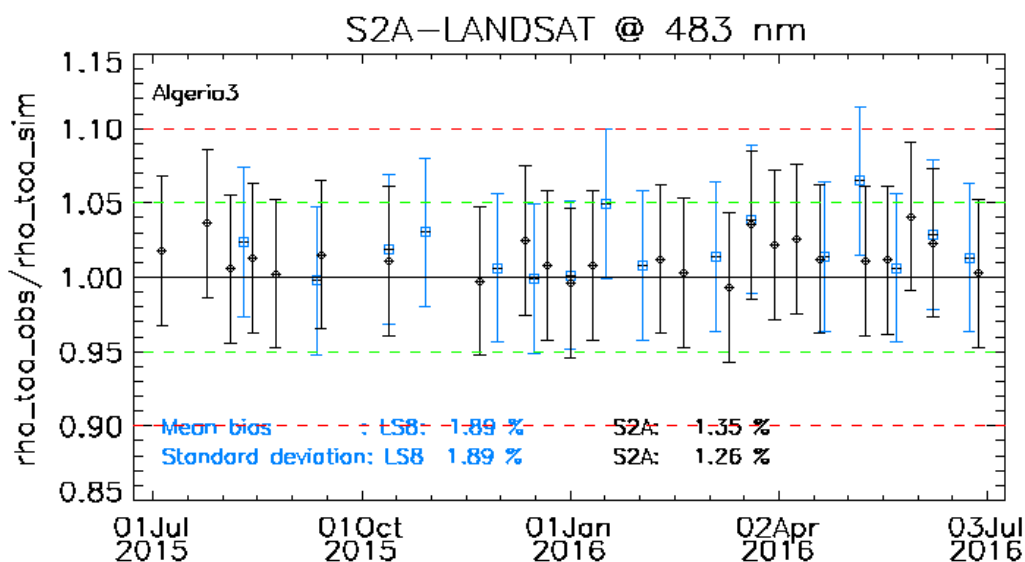
# CROSS MISSION INTER-COMPARISON: S2A/MSI VS. LS8/OLI

- ➔ Why OLI?
- ➔ PICS Method
- ➔ Match-up Method



# INTER-COMPARISON MSI/OLI OVER PICS SITES (1/4)

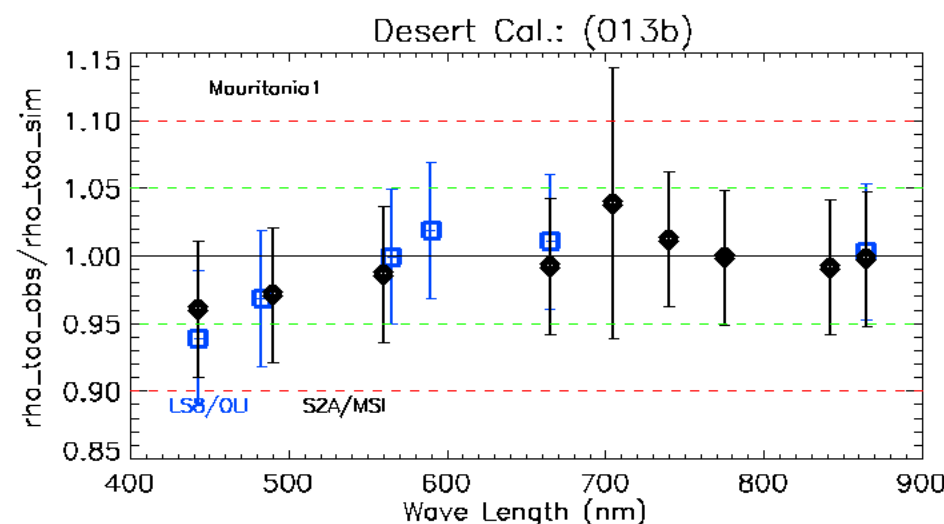
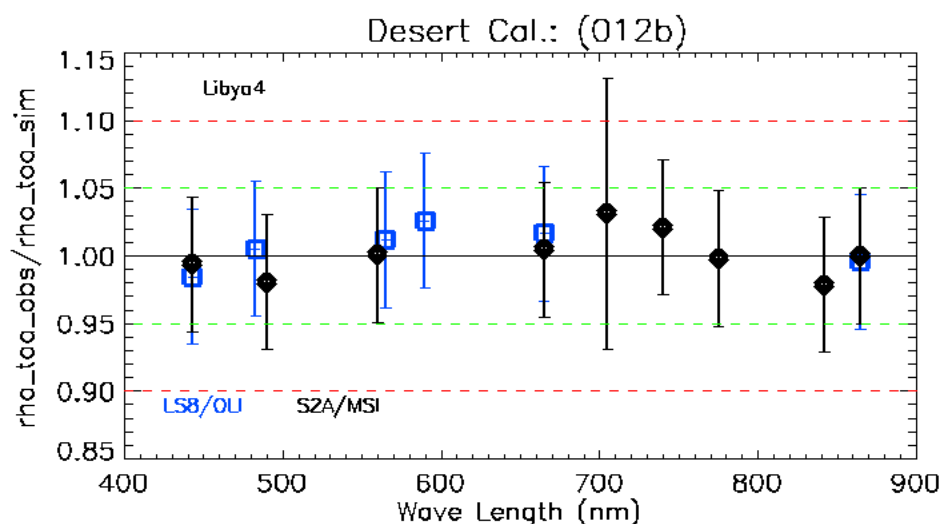
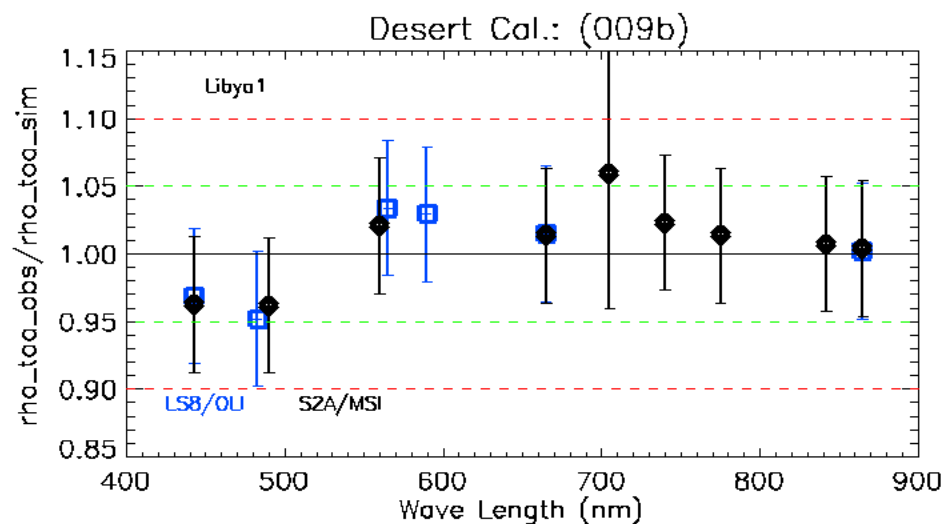
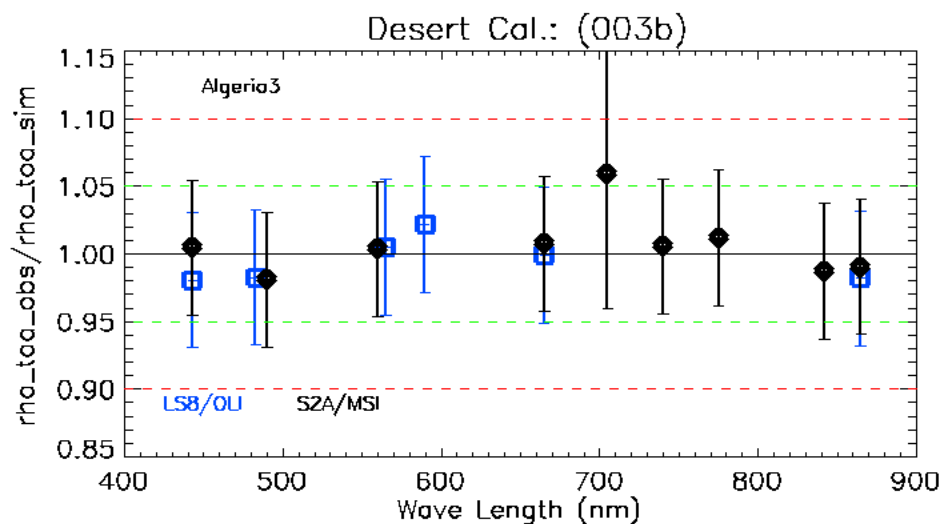
➔ Time series of the ratio of observed/simulated TOA\_reflectance from MSI & OLI over **Algeria3, Libya1**





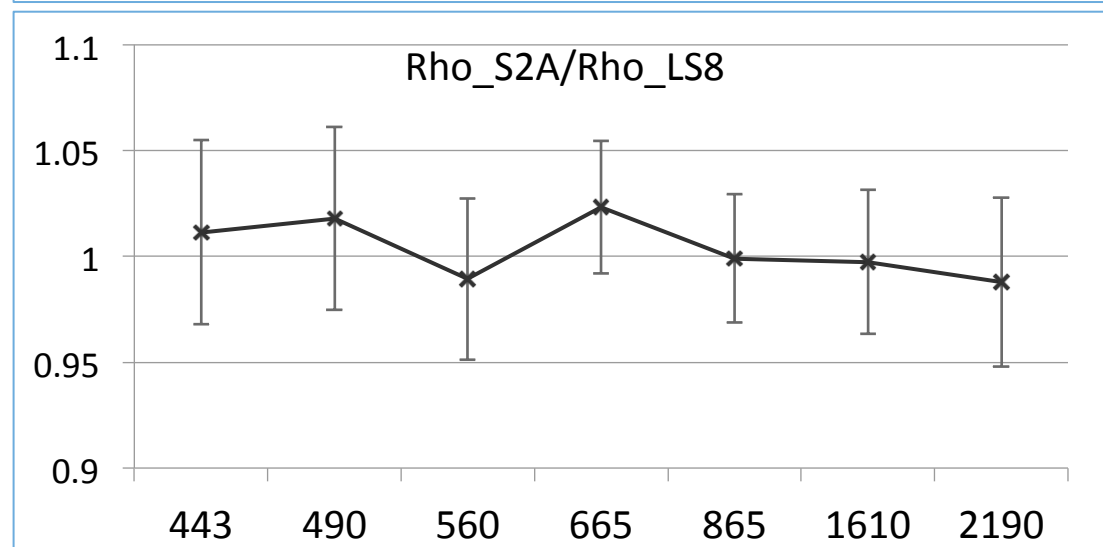
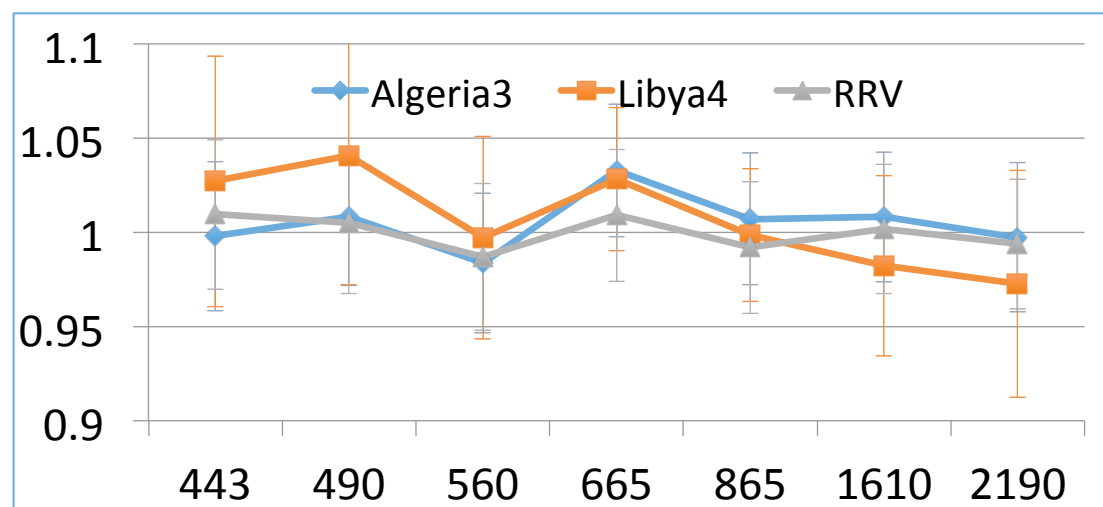
# INTER-COMPARISON MSI/OLI OVER PICS SITES (2/4)

➔ The ratio of observed/simulated TOA\_reflectance from MSI & OLI over **Algeria3, Libya1, Libya4 and Mauritania1**



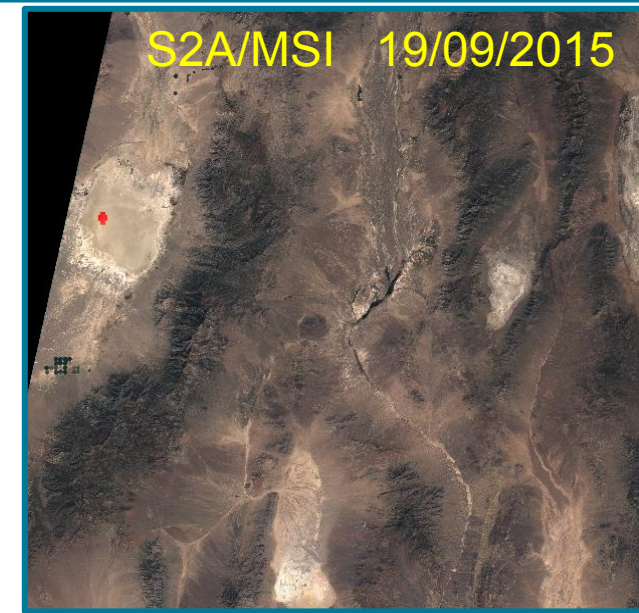
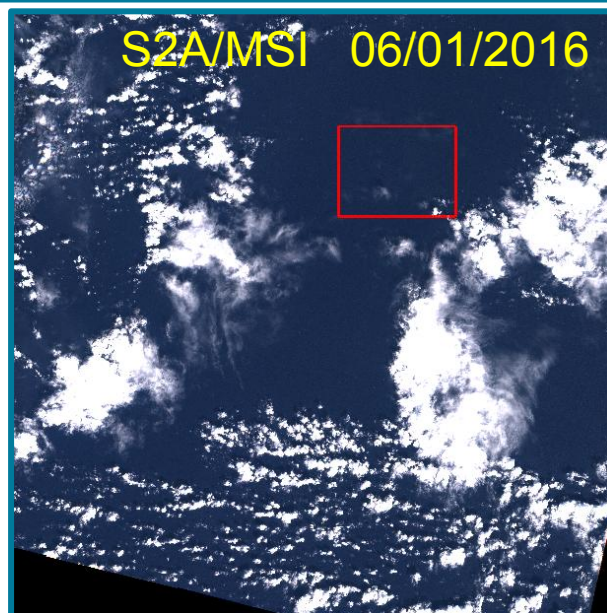
## ➔ Match-ups Over Algeria3 Libya4 & RRV

- › S2A/MSI L1C
- › LS8/OLI L1T
- › 18 match-ups
- › Day-offset: 11 days
- › No RSR adjustment
- › Included in the uncertainty



# ABSOLUTE RADIOMETRY VICARIOUS VALIDATION

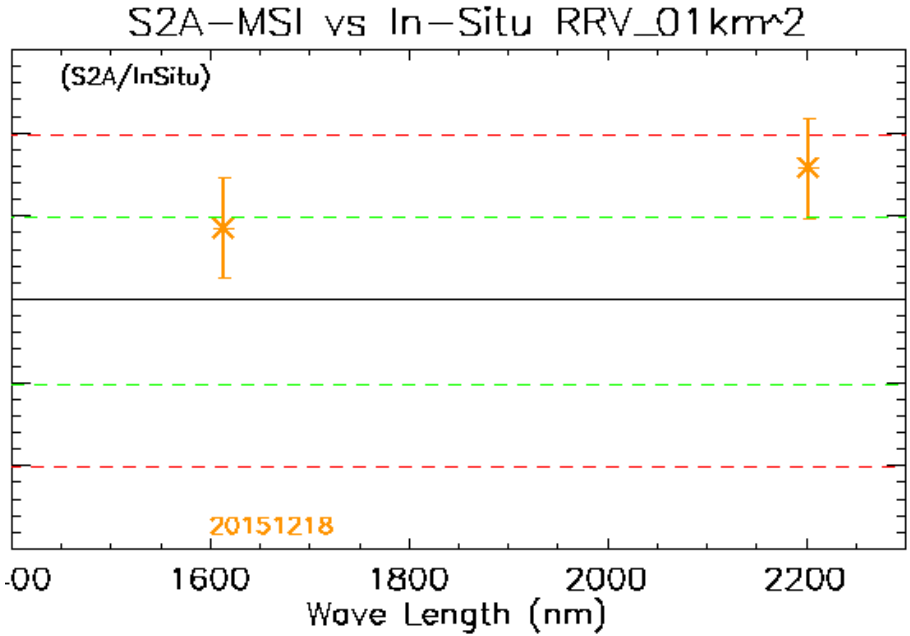
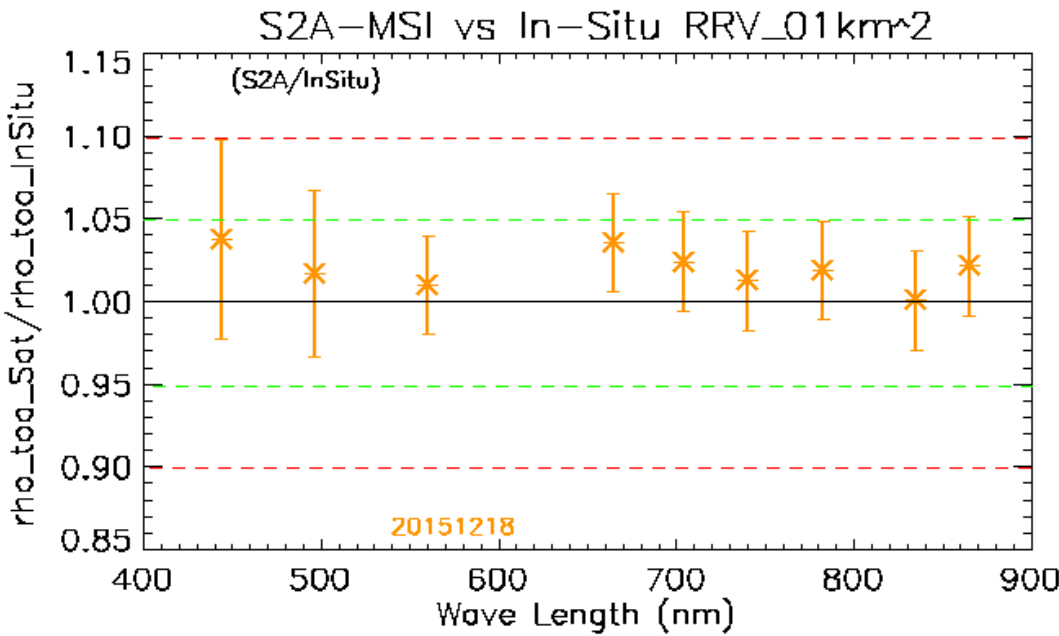
- ➔ Rayleigh Scattering method (DIMITRI)
- ➔ Ground-reflectance-based approach (RadCalNet)



# ABSOLUTE RADIOMETRY VICARIOUS VALIDATION

- ➔ Rayleigh Scattering over 4 sites
  - ➔ Baseline >02.00 (Nov.15-Apr.16)
- ➔ Ground-reflectance-based measurements of only one overpass over RRV on 18<sup>th</sup> Dec.15

Band: Wave-length (nm)	Rayleigh Scattering Vic-Cal. Coefficient	Ground Reflectance-Based Vic-Cal. Coefficient
B01 (443)	1.030 (4.2)	1.050 (6.0)
B02 (490)	1.020 (4.1)	1.037 (5.0)
B03 (560)	1.021 (4.1)	1.031 (3.0)
B04 (665)	1.024 (4.2)	1.048 (3.0)
B05 (705)	NA	1.033 (3.0)
B06 (740)	NA	1.024 (3.0)
B07 (783)	NA	1.039 (3.0)
B08 (842)	NA	1.011 (3.0)
B8A (865)	NA	1.031 (3.0)







# CONCLUSION

- ➔ The impact of site-subsampling is more pronounced over VIS range than the NIR one
- ➔ MSI shows very good radiometry performance (within  $\pm 5\%$  mission req.)
- ➔ MSI shows very good stability with time and consistency over PICS
- ➔ MSI shows very good agreement with OLI over PICS.
- ➔ More analysis to assess the homogeneity of the PICS sites is needed.





**THANK YOU FOR YOUR ATTENTION!**

**THANKS TO ESA,  
S2MPC-TEAM & DIMITRI-TEAM,  
RADCATS DATA WERE PROVIDED BY THE NASA  
LANDSAT CAL/VAL TEAM AS PART OF THE ESA  
EXPERT USERS EFFORT**

**THANKS TO CEOS-WGCV-IVOS FOR THIS INVITATION.**

<http://sentinels.copernicus.eu>