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CROSS-MISSIONS INTERCOMPARISON OF THE LEVEL-1 RADIOMETRIC PRODUCTS: SENTINEL-2, SENTINEL-3, LANDSAT-8, AND LANDSAT-9

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7th Sentinel-2 Validation Team Meeting
13 – 15 October 2025 | ESA – ESRIN | Frascati (RM), Italy

Agenda

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- Dataset and Tools
  - Desert-PICS method
- Cross mission intercomparison
  - MSI-A vs MSI-B
  - OLCI-A vs OLCI-B
  - SLSTR-A vs SLSTR-B
  - OLI vs OLI-2
  - MSI-A & B vs other sensors
- Conclusions and recommendations

Funded by the EU and ESA

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Dataset and Tools : Cal/Val Sites

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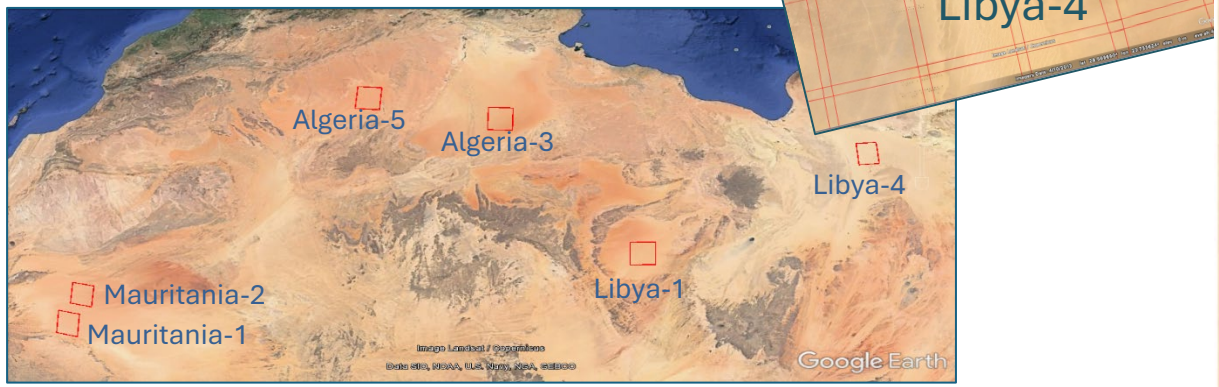
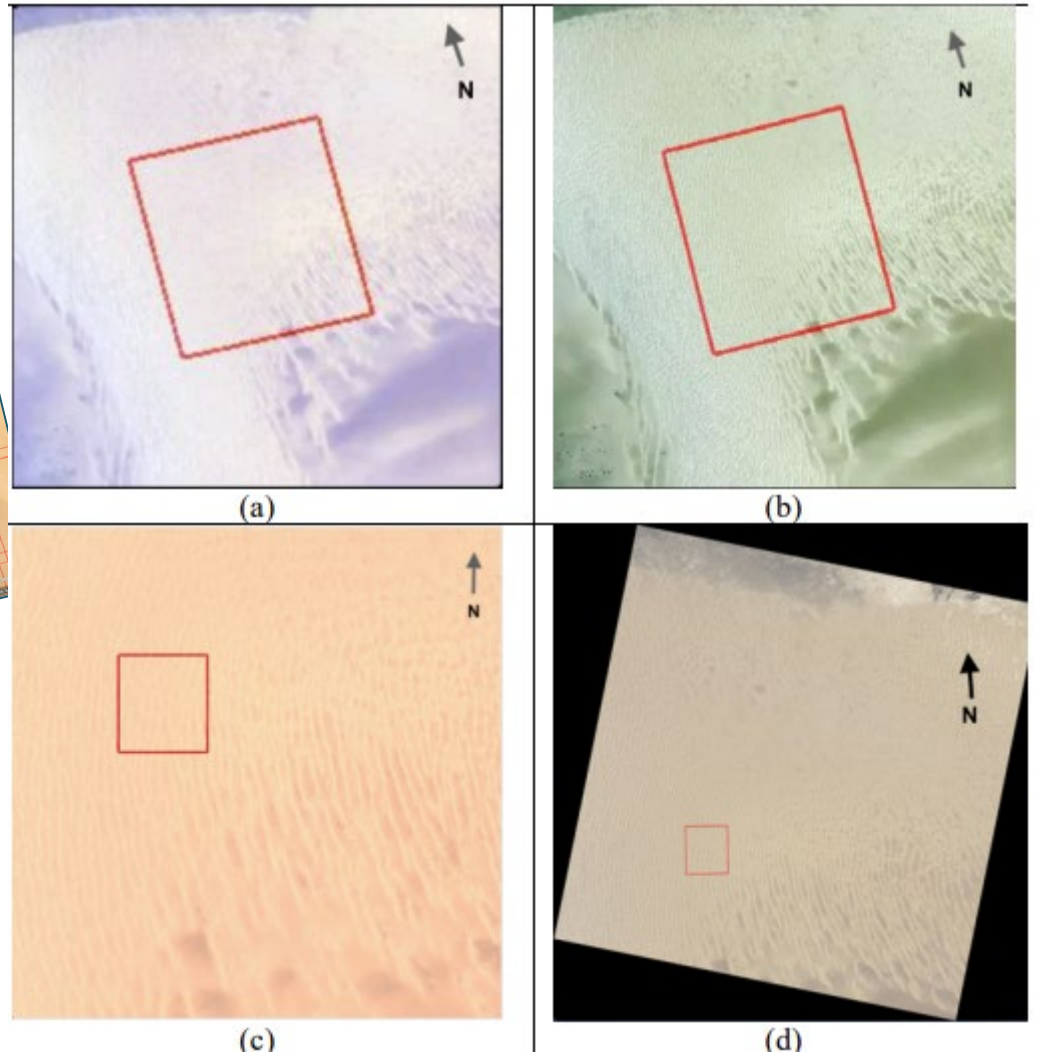
Desert-PICS: Libya4 CalVal Site

- MSI-A, B & C: **L1C**
- OLCI-A & OLCI-B: **L1B-RR-NT**
- SLSTR-A & B: **L1-RBT-NT**
- OLI/OLI2: **L1TP**





Dataset & Tools

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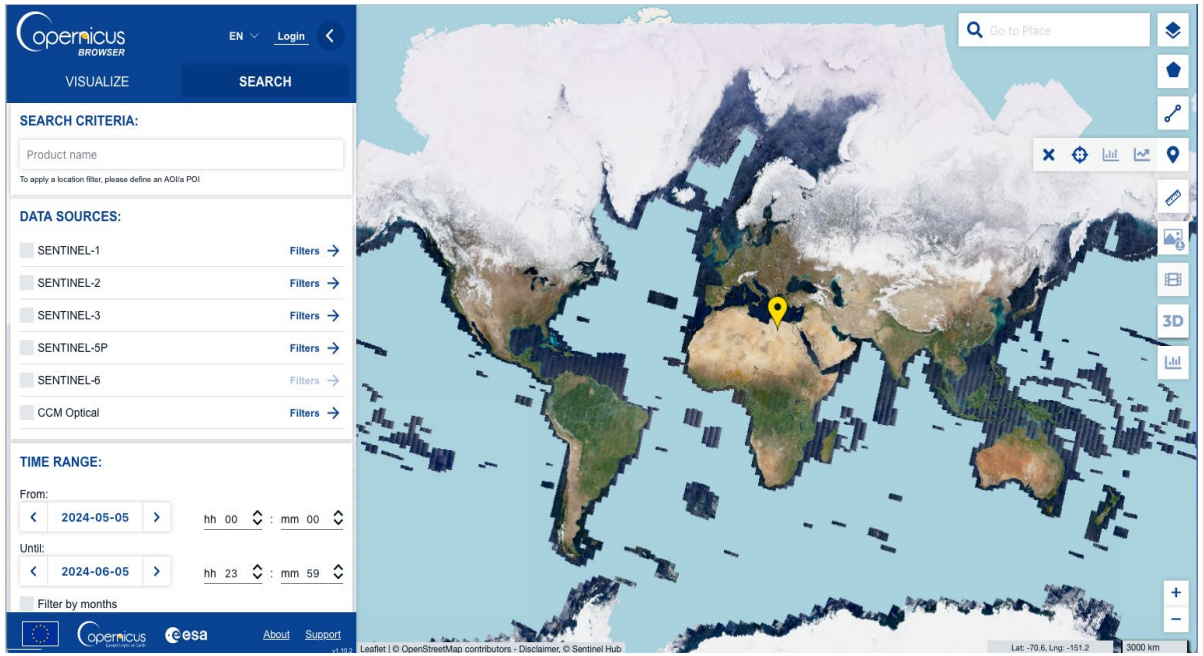

Copernicus portal: CDSE

Sentinel-2/MSI, Sentinel-3/OLCI & SLSTR:

L1C/L1B: TOA reflectance + AUX-data

2015-present

USGS portal: Earth Explorer

LANDSAT/OLI:

L1TP Collection-2: TOA reflectance + AUX-data

2013-present

Dataset & Tools: DIMITRI

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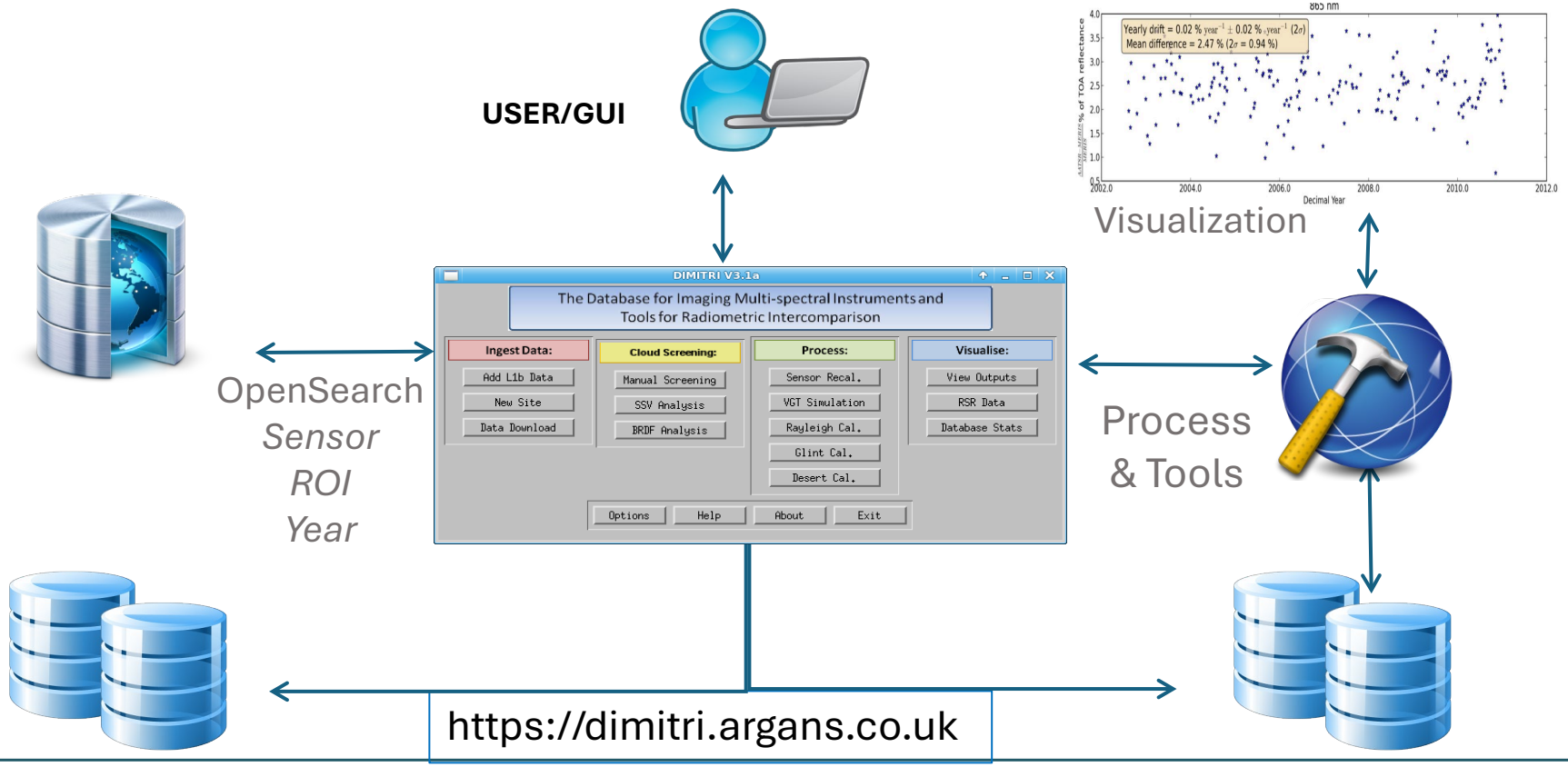
DIMITRI

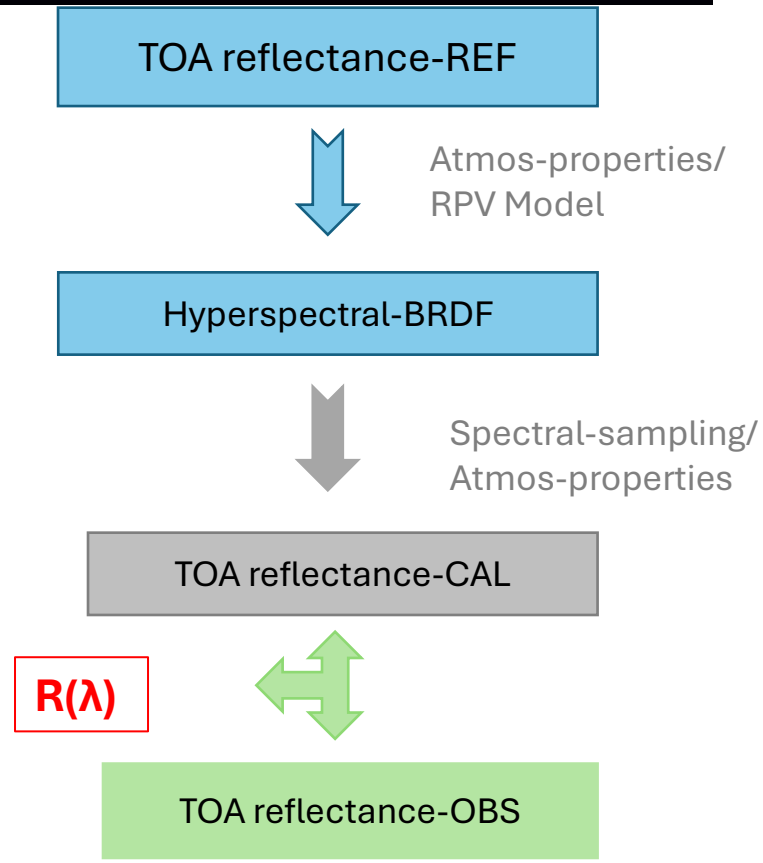
Database for Imaging Multi-spectral Instruments and Tools for Radiometric Intercomparison



Dataset & Tools: Desert-PICS methodology

- 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:**

$R(\lambda)=\rho^{obs}/\rho^{sim}$; Uncertainty ±5% (excluding WV absorption bands)



More details in Bouvet (2014)

https://dimitri.argans.co.uk

Cross-mission Intercomparison: MSI-A vs MSI-B

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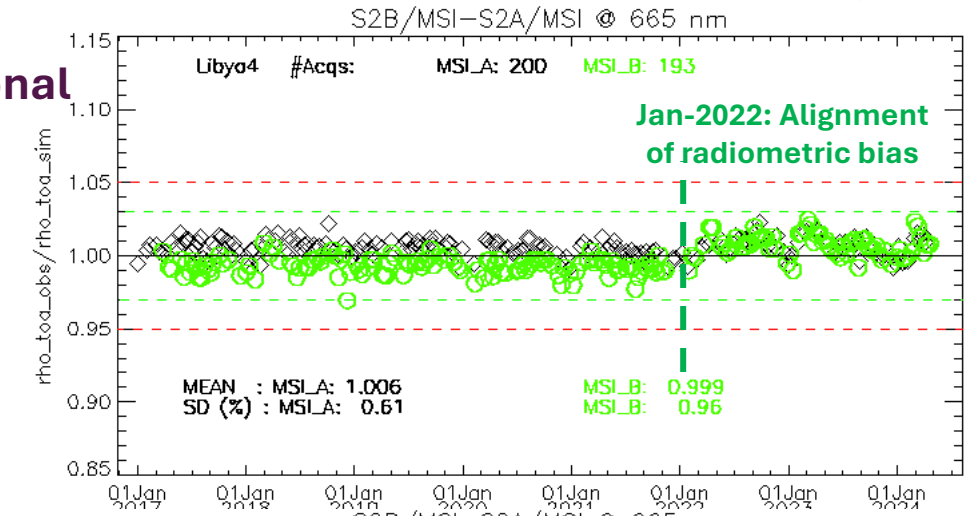
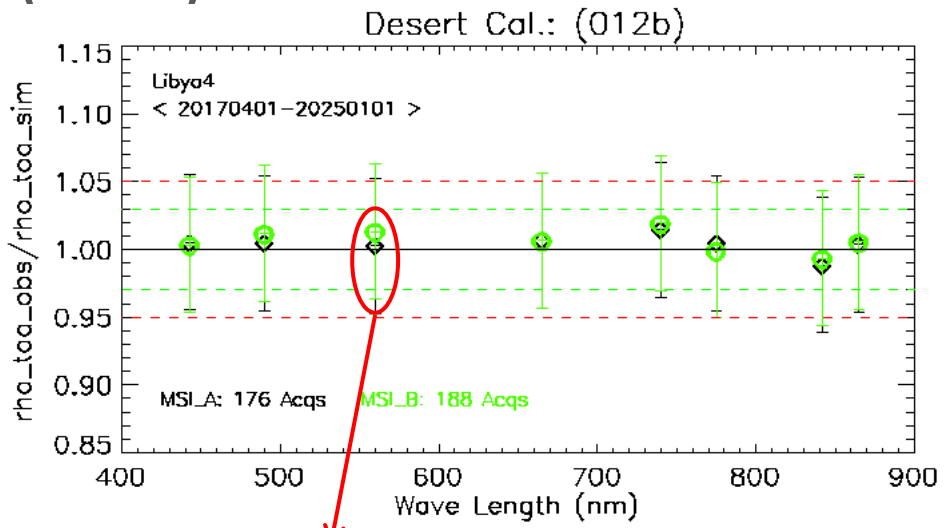
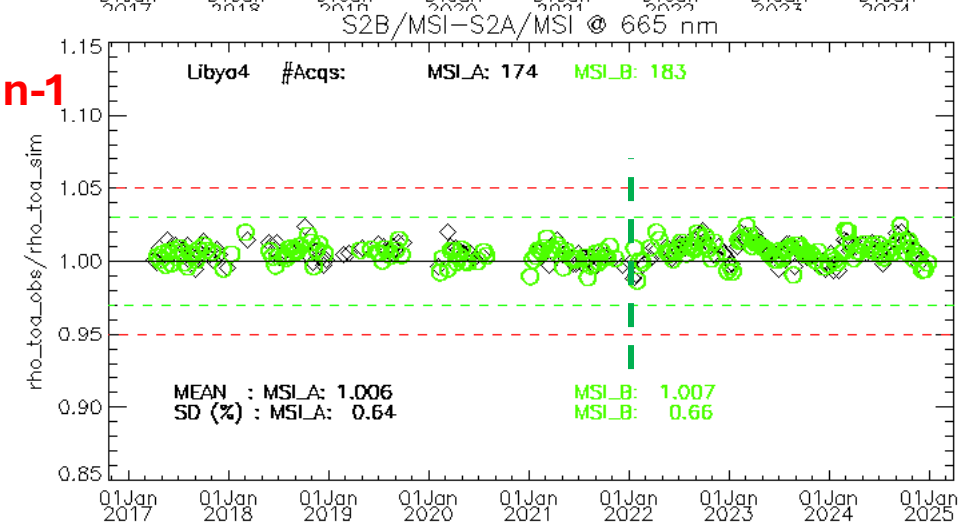
Desert-PICS Method : X-mission intercomparison (LIBYA4): MSI-A/MSI-B

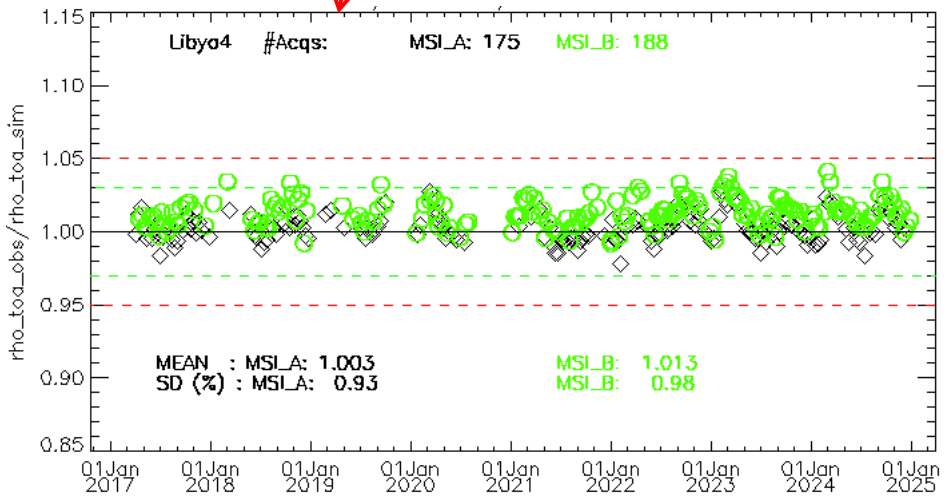
Operational





Collection-1





MSI_A vs MSI_B:

VNIR discrepancy <1% (B03: 1.1%)

Cross-mission Intercomparison: MSI vs OLI

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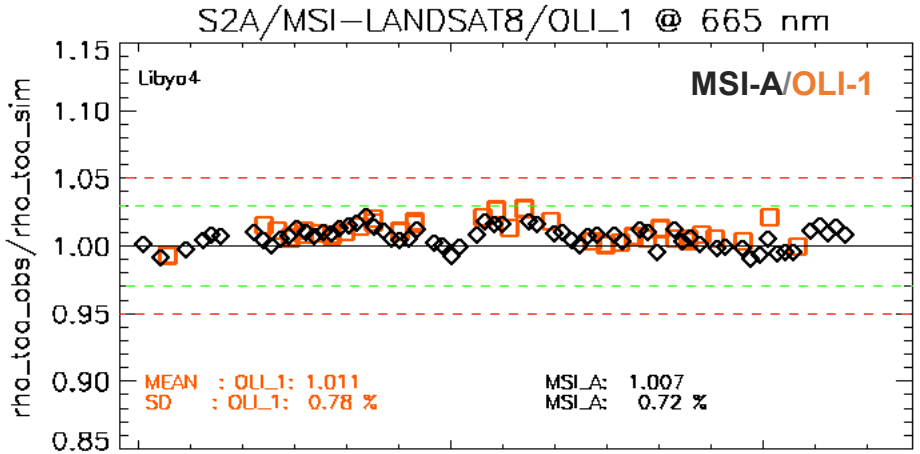
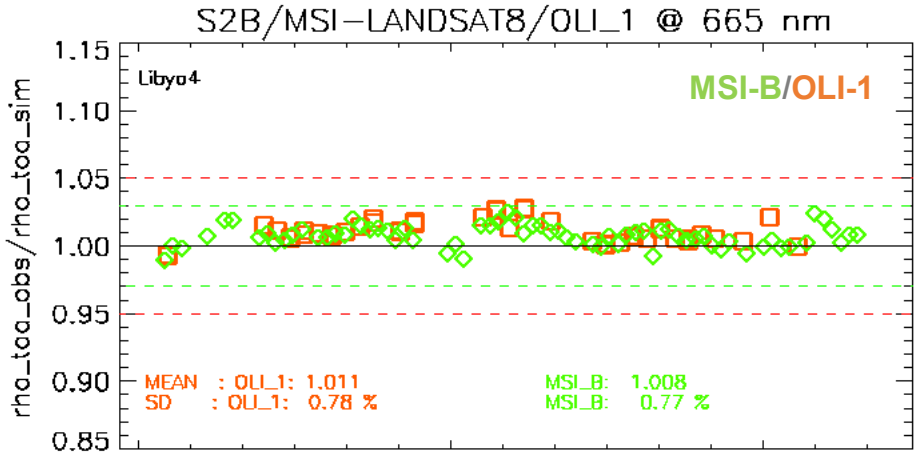
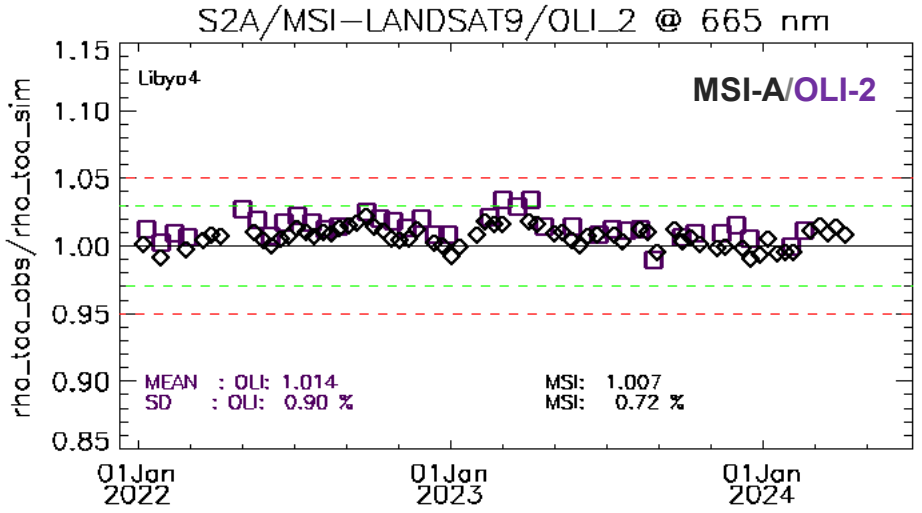
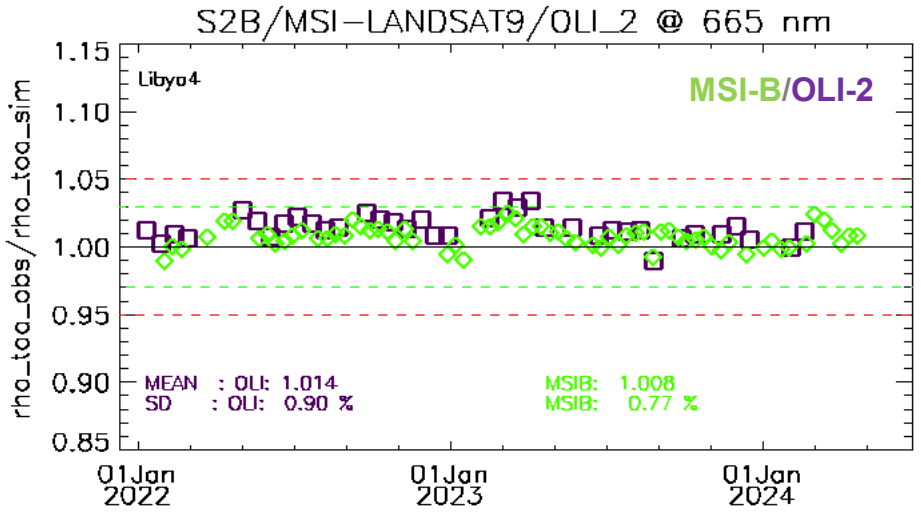
Desert-PICS Method : X-mission intercomparison (LIBYA4): MSI-A/MSI-B/OLI_1/OLI_2









MSI_A:

VNIR discrepancy

OLI_1 & OLI_2:

<1% (B01: 1.5%)

MSI_B:

VNIR discrepancy

OLI_1 & OLI_2:

<1% (B01: 1.4%)

Cross-mission Intercomparison: MSI-A vs MSI-B

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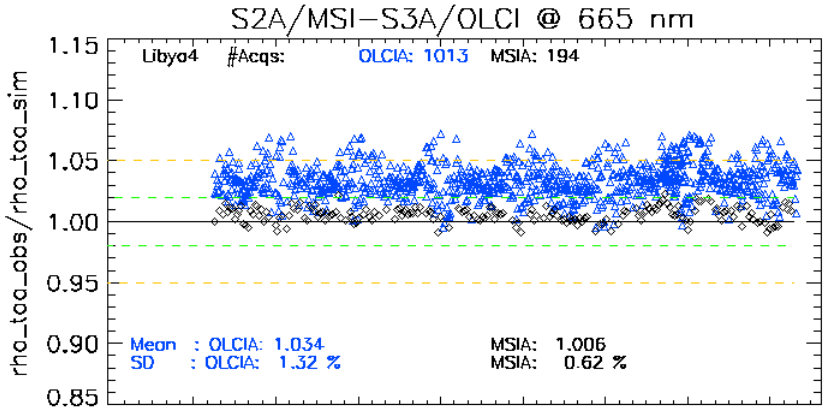
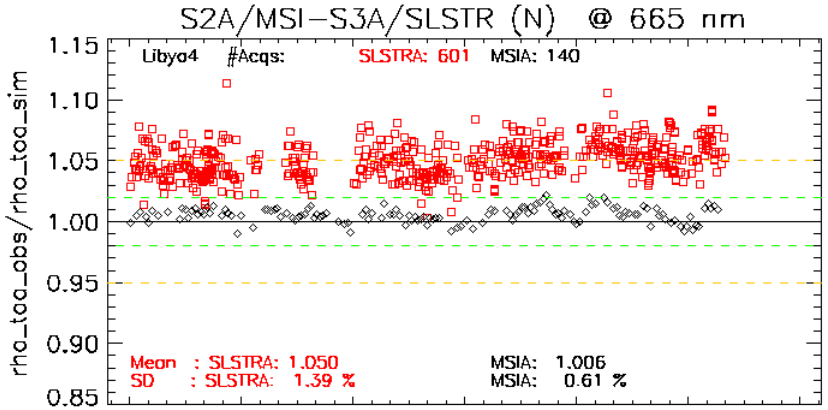
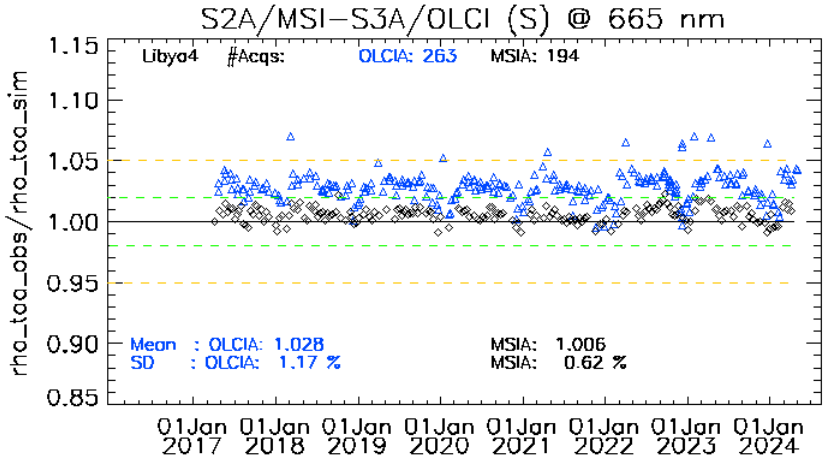
Desert-PICS Method : X-mission intercomparison (LIBYA4): MSI-A/OLCI_A/SLSTR_A

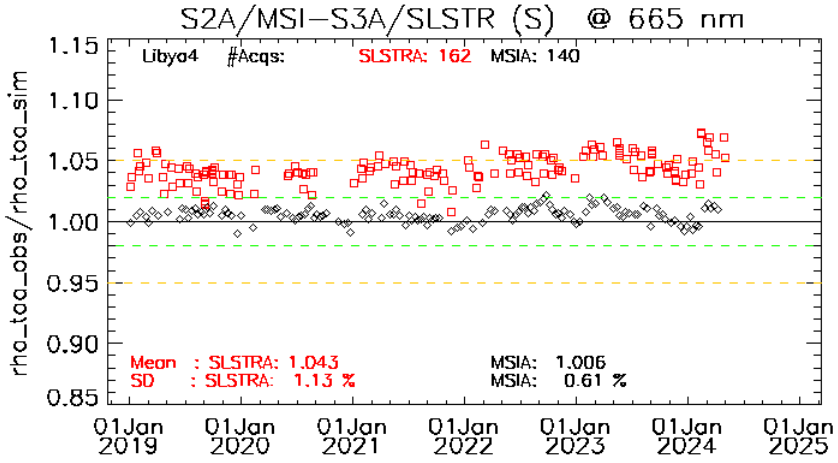
VZA : < 55°

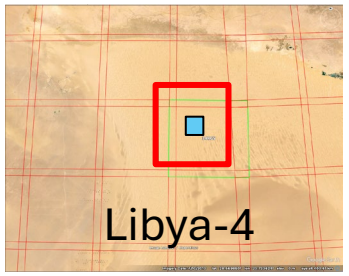




VZA < 10°







VNIR discrepancy

OLCI-A : 1-3%

SLSTR-A : 2-4%

Cross-mission Intercomparison: OLCI vs SLSTR

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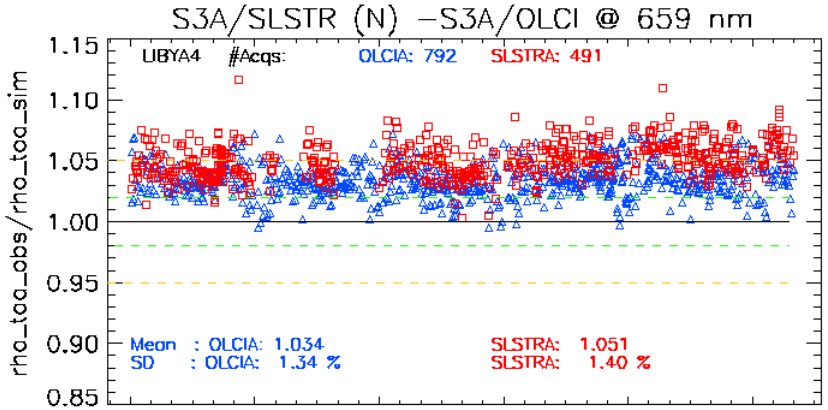
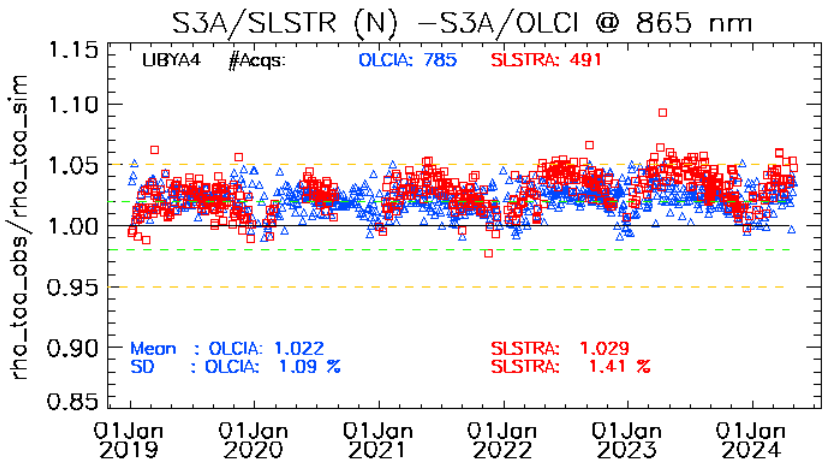
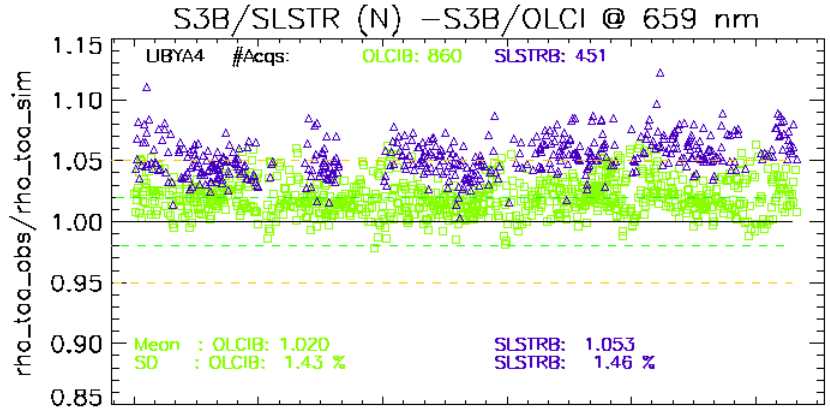
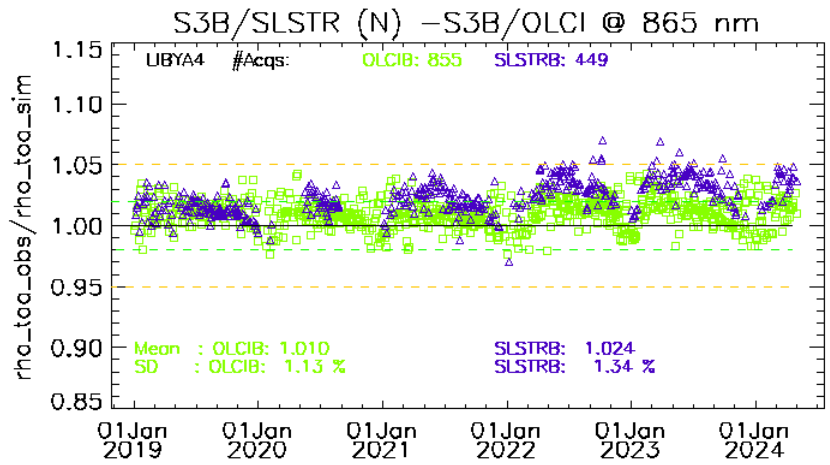
Desert-PICS Method : X-mission intercomparison (LIBYA4): OLCI-A/OLCI-B/SLSTR-A/SLSTR-B;









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Cross-mission Intercomparison: OLCI vs SLSTR

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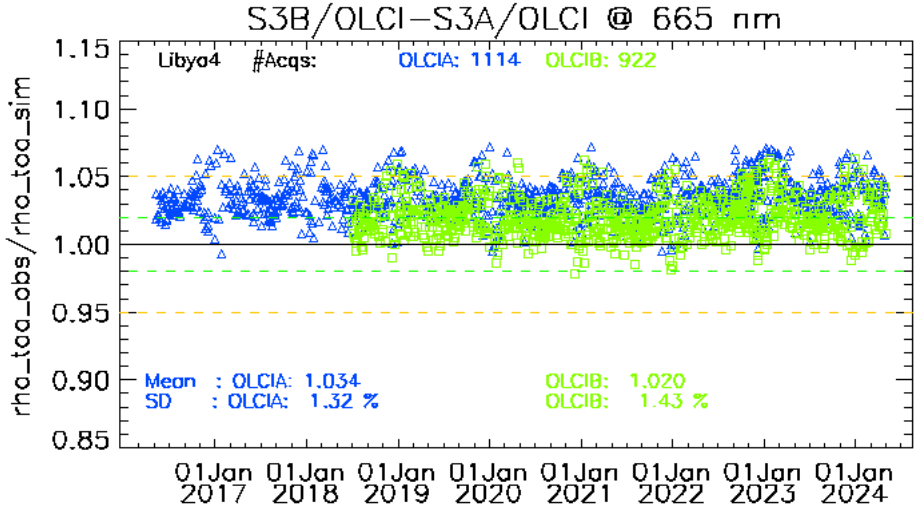
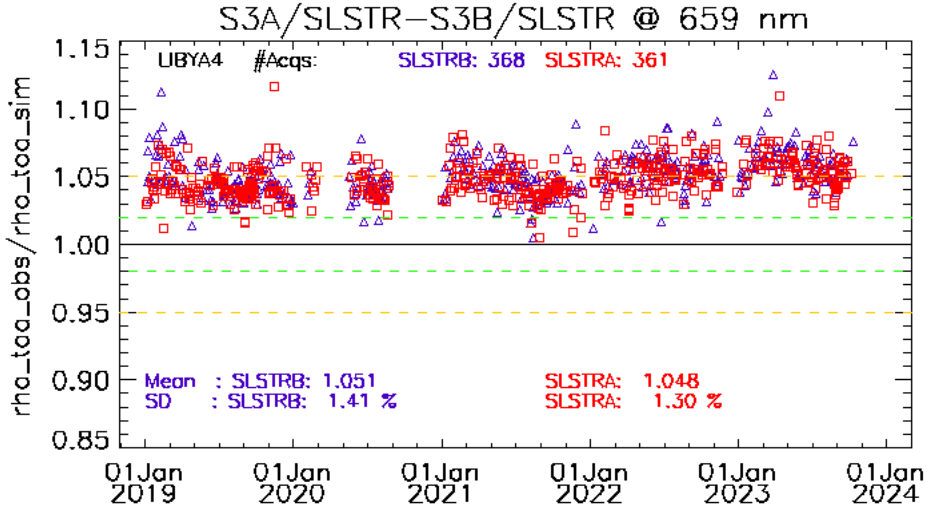
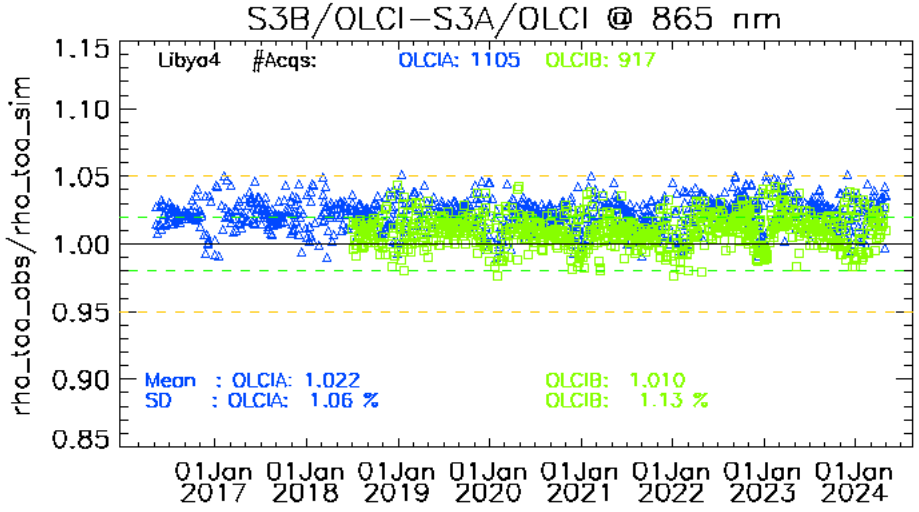
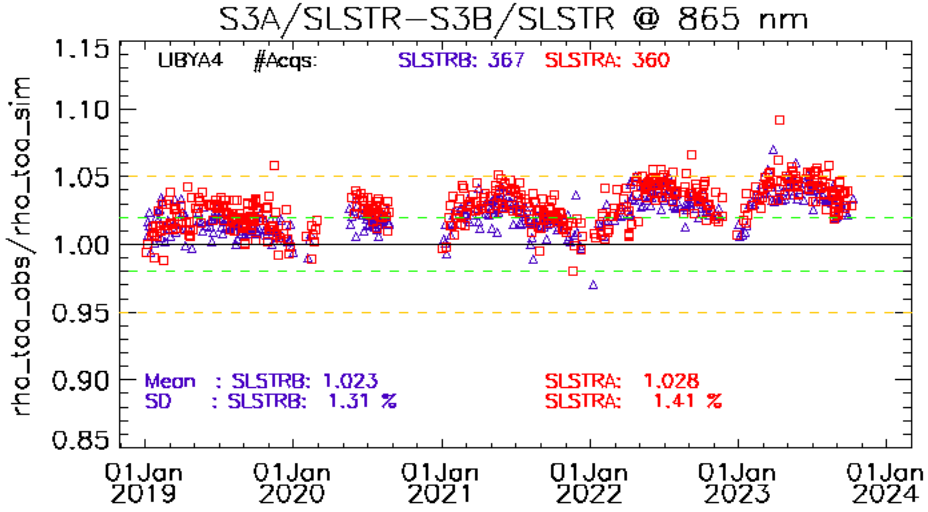
Desert-PICS Method : X-mission intercomparison (LIBYA4): OLCI-A/OLCI-B/SLSTR-A/SLSTR-B;









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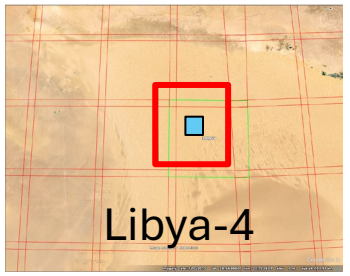
Cross-mission Intercomparison: Summary

Desert-PICS Method : X-mission intercomparison (LIBYA4)

GREEN	MSI_A	MSI_B	OLI	OLI_2	OLCI_A	OLCI_B	SLSTR_A	SLSTR_B
MSI_A	1.000	1.011	1.005	1.002	1.014	1.001	1.046	1.048
MSI_B		1.000	0.994	0.991	1.004	0.990	1.035	1.037

RED	MSI_A	MSI_B	OLI	OLI_2	OLCI_A	OLCI_B	SLSTR_A	SLSTR_B
MSI_A	1.000	1.001	1.004	1.007	1.029	1.015	1.050	1.053
MSI_B		1.000	1.003	1.007	1.028	1.014	1.049	1.052

NIR	MSI_A	MSI_B	OLI	OLI_2	OLCI_A	OLCI_B	SLSTR_A	SLSTR_B
MSI_A	1.000	1.002	0.995	0.996	1.020	1.008	1.033	1.031
MSI_B		1.000	0.993	0.994	1.018	1.006	1.031	1.028



(Alhammoud et al. 2025; submitted)

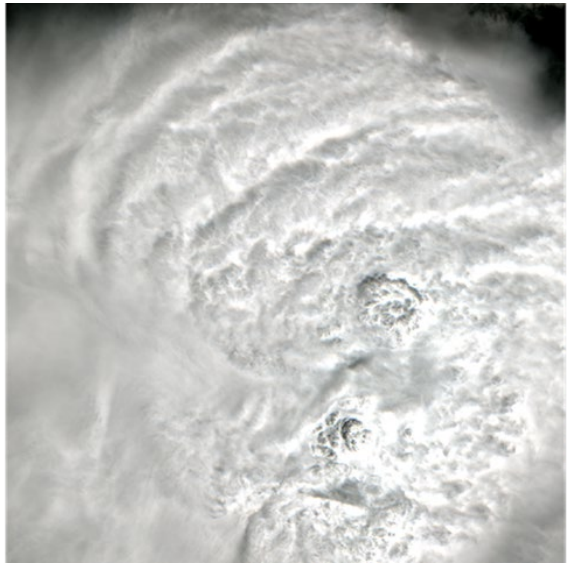
Cross-mission Intercomparison: Summary

DCC Method : X-mission intercomparison

GREEN	MSI_A	MSI_B	OLI	OLI_2
MSI_A	1.000	1.005	0.999	0.997
MSI_B		1.000	0.994	0.992

RED	MSI_A	MSI_B	OLI	OLI_2
MSI_A	1.000	1.004	0.987	0.988
MSI_B		1.000	0.983	0.984

NIR	MSI_A	MSI_B	OLI	OLI_2
MSI_A	1.000	1.002	0.985	0.986
MSI_B		1.000	0.983	0.984

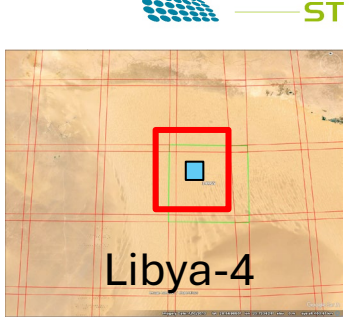


DCC extending over a complete S2 tile (~100x100 km²)

(Alhammoud et al. 2025; submitted)

Conclusions

- **Cross-mission intercomparison:**
  - ✓ **S2A/MSI & S2B/MSI show a good alignment ⇔ Successful intercalibration and correction of the bias S2B/S2A**
  - ✓ **MSI, OLI and OLCI show no significant temporal variability over VNIR bands;**
  - ✓ **OLCI-A shows slightly (1-2%) brighter TOA-reflectance wrt. OLCI-B and MSI-A/B, but nearly similar to SLSTR-A/B over PICS over the VNIR spectral range**
  - ✓ **SLSTR shows slight positive trend over PICS/Glint for the VNIR/SWIR bands;**
  - ✓ **Good consistency with similar missions (better <2%)**



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THANK YOU FOR YOUR ATTENTION

Thanks to OPT-MPC team and DIMITRI-team for their support

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Backup slides