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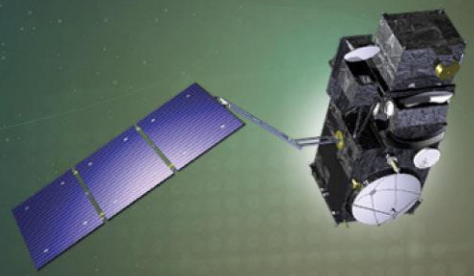

# 7th Sentinel-3 Validation Team Meeting 2022

18-20 October 2022 | ESA-ESRIN | Frascati (Rm), Italy

# Copernicus Sentinel-3 OLCI Calibration status

*Author, co-authors and their affiliations provided next slide*

# COPERNICUS Sentinel-3
# Ocean and Land Colour Instrument (OLCI) calibration

**This work has been performed for ESA by the OPT-MPC OLCI-SYN Level 1 Expert Support Lab**


- **Coordination and integration:** L. Bourg, ACRI-ST, Fr
- **Radiometric Calibration:** L. Bourg, L. Blanot, ACRI-ST, Fr
- **Radiometric Validation:** B. Alhammoud, ARGANS, UK, S. Adriaensen, S. Sterck, VITO, Be
- **Spectral Calibration:** R. Preusker, SpectralEarth, Ge
- **Geometric Calibration:** S3-MPC Operators, ACRI-ST, Fr


**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.

# Overview

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| | |
|---|---|
| Geometric Calibration | → Georeferencing Performance |
| Spectral Calibration | → OLCI-A / OLCI-B Differences |
| Radiometric Calibration | → Validation using Natural Targets |

# GEOMETRIC CALIBRATION

# Geometric Calibration Performance Methodology

- A dedicated SW tool (GeoCal, developed by ESTEC) allows regular quantitative assessment of OLCI geolocation performance by correlation with Ground Control Points imagettes.

- Performance assessment gives access to global RMS error but also differentiated along-track and across-track biases at camera level.

- The same tool allows also geometric re-calibration from a significant time series (> 2 months).

# Geometric Calibration Performance
# RMS performance, compliance to RQT

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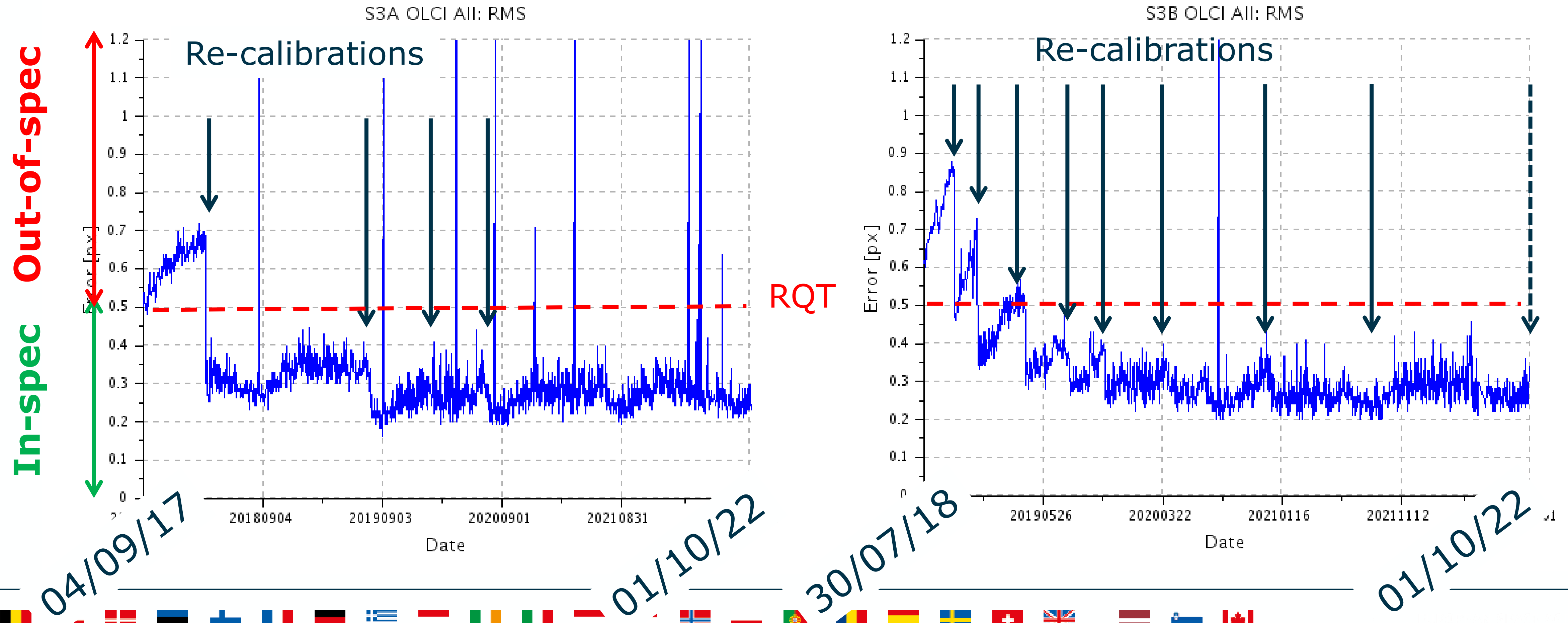
Regular assessment of OLCI-A and OLCI-B geometric performance using dedicated SW → **RMS georeferencing performance**



# Detailed OLCI-A Camera biases

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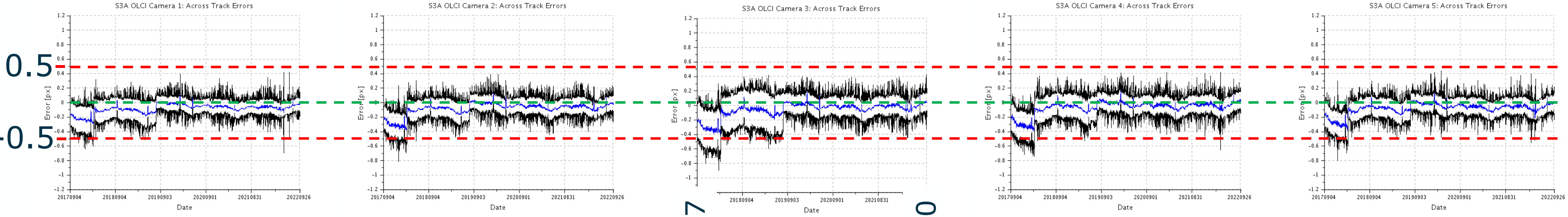
## Across-track biases

Camera 1 Camera 2 Camera 3 Camera 4 Camera 5

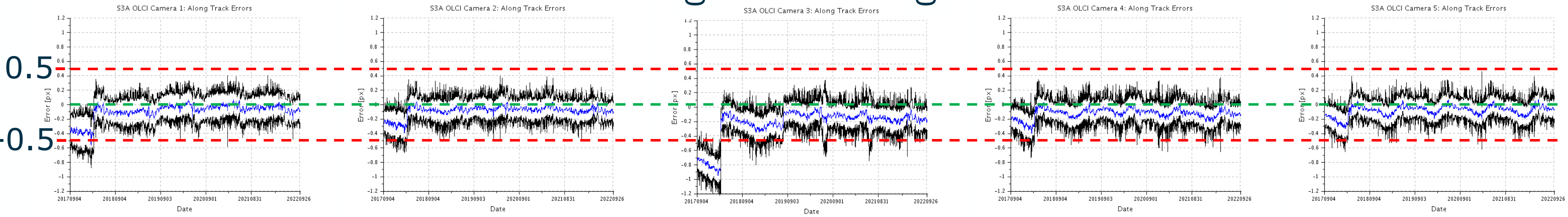



## Along-track biases

04/09/17

04/12/20

Camera 1 Camera 2 Camera 3 Camera 4 Camera 5

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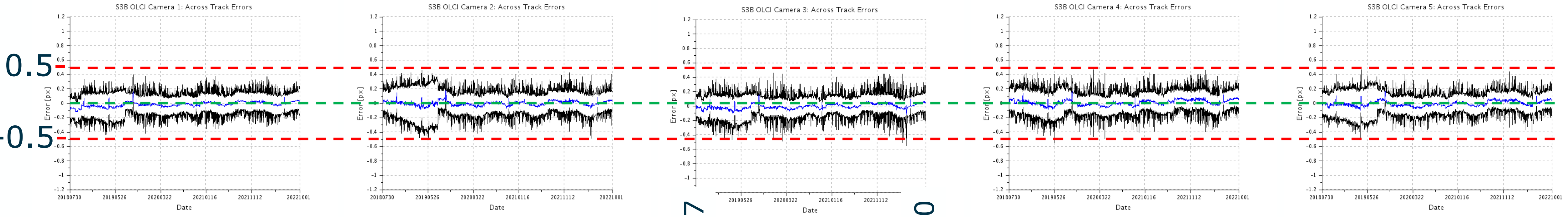
## Across-track biases

Camera 1 | Camera 2 | Camera 3 | Camera 4 | Camera 5

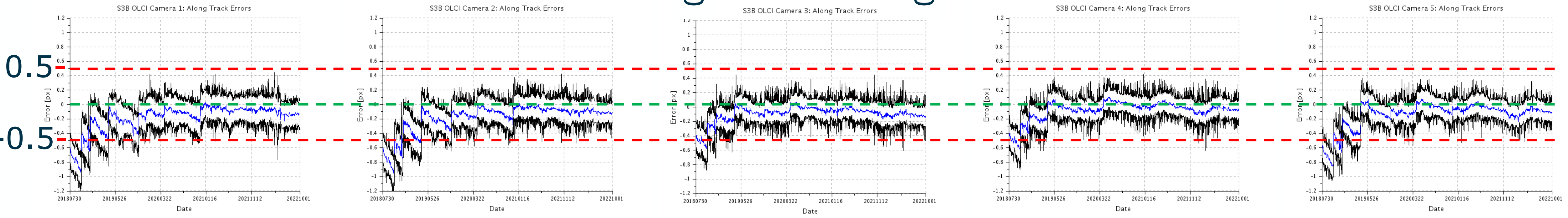



04/09/17

04/12/20

## Along-track biases

Camera 1 | Camera 2 | Camera 3 | Camera 4 | Camera 5

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# SPECTRAL CALIBRATION

# In-flight Spectral calibration: Means



OLCI channels are programmable. OLCI can be configured to transmit 46 single row µ-bands, instead of 21 nominal bands.

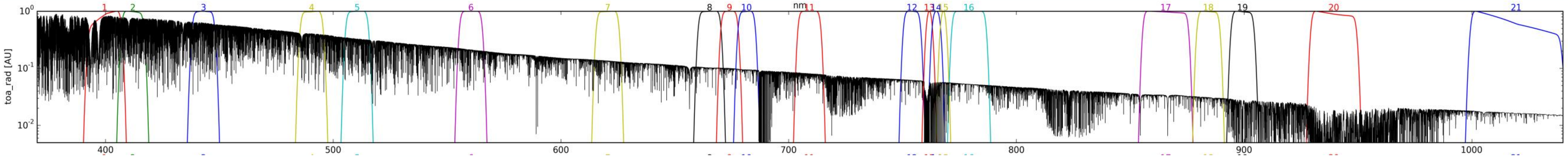
4 settings are used to observe:

- 8 solar Fraunhofer lines on **Solar Diffuser or Earth View**
- Oxygen A line absorption on **Earth View**
- 3 rare earth absorption lines on a dedicated **Spectral Diffuser**

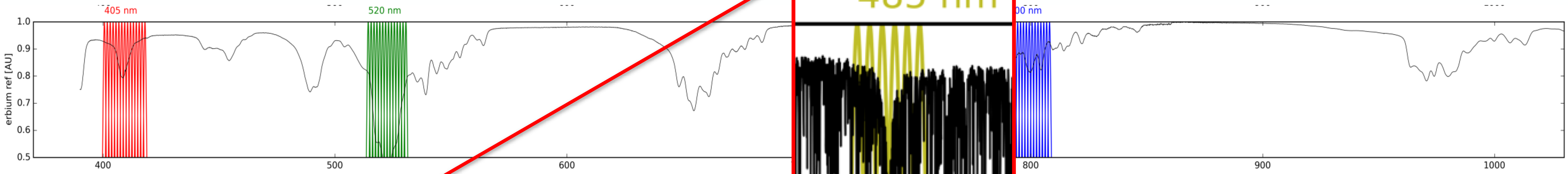
Allows to **complement Ground Characterisation at full spatial resolution** to derive **a comprehensive Instrument Spectral Model**

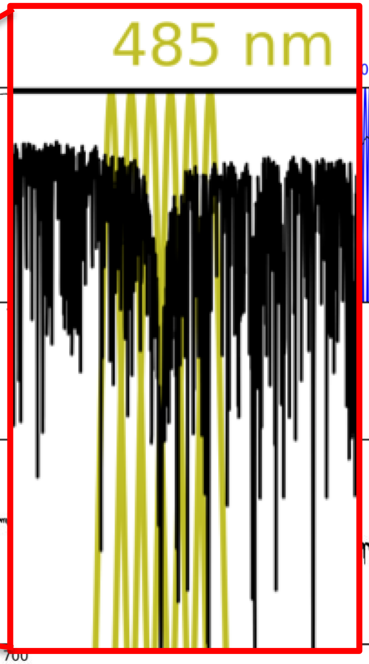
# OLCI spectral programming capability!

## OLCI 21 bands:

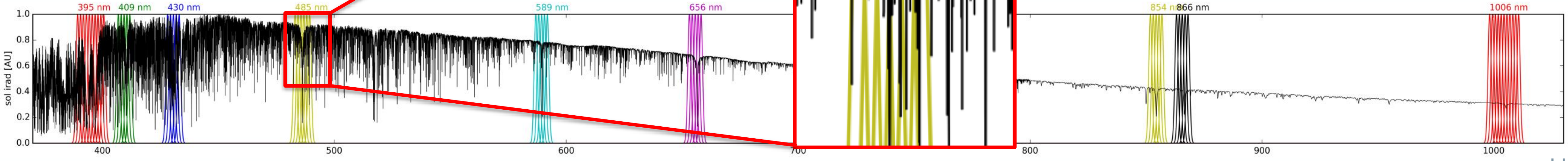



## Spectral diffuser groups of micro-channels



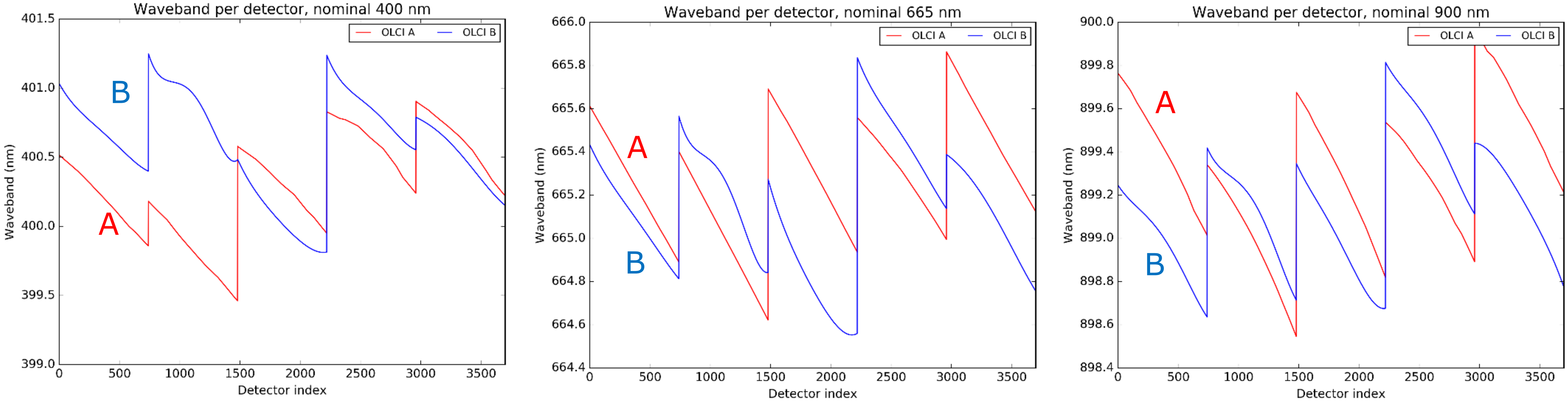

## Fraunhofer lines groups of micro-channels



# In-flight Spectral Calibration: Example results

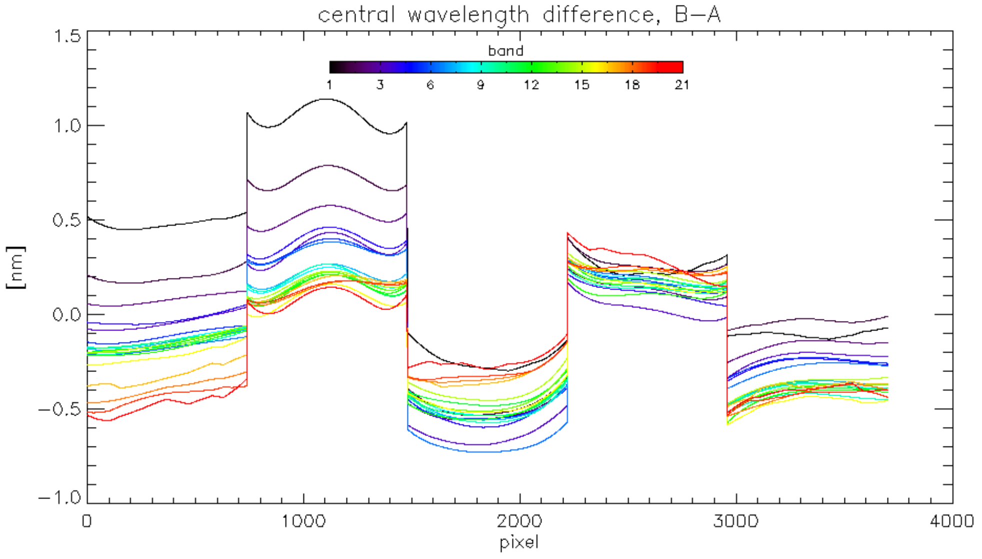
## Central wavelength for each pixel at various bands

| 400 nm | 665 nm | 900 nm |
|---|---|---|



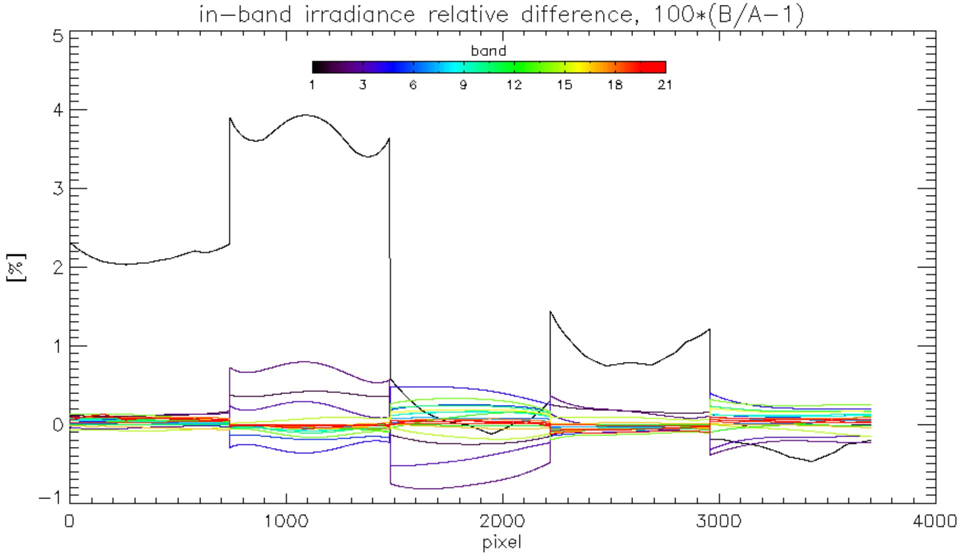
# In-flight Spectral Calibration: OLCI-B vs. OLCI-A

Central wavelengths: B-A [nm]




Up to 1 nm in the blue
→ up to 1% on Rayleigh reflectance

in-band irradiance: 100·(B/A-1) [%]

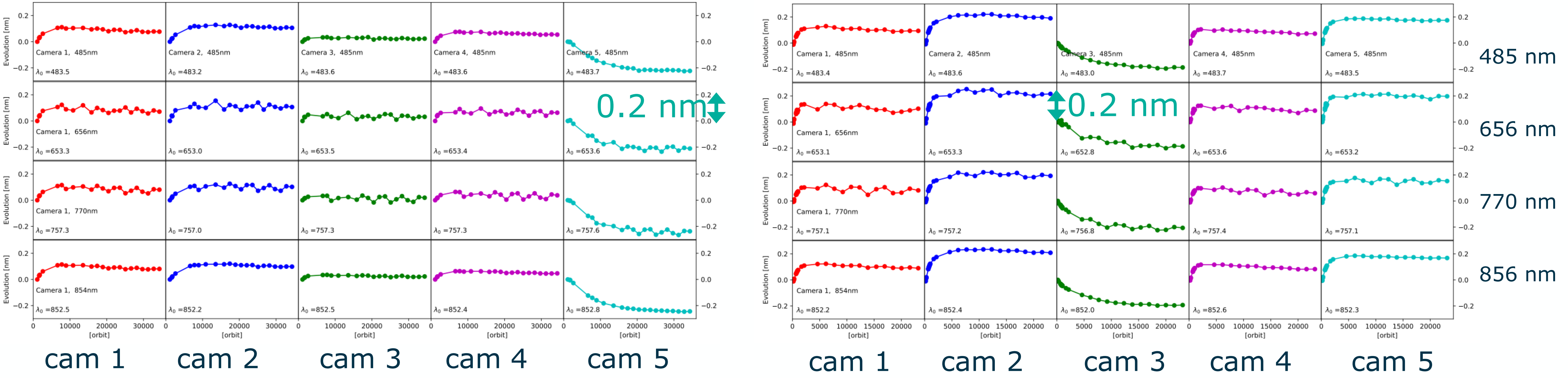



Up to 4% in the blue
→ **TOA radiance not directly comparable**

**To Level 1 users:**
**Please consider spectral effects before any comparison!**

# In-flight Spectral Calibration: temporal stability

## OLCI-A and OLCI-B




**$\Delta\lambda(t)$ < ~0.25 nm → $\Delta E_0$ (hence $\Delta L$) in general negligible → no update in processing**

But **$\Delta E_0$** can reach 0.4% (400nm), 0.2% (443nm), impacting radiance

**Spectral drift can induce small error in L, but negligible in r (or $L/E_0$), hence at L2!**

However, a drift model is under study as required for better use of $O_2$ absorption bands

# Radiometric validation

# Radiometric Validation over Natural Targets

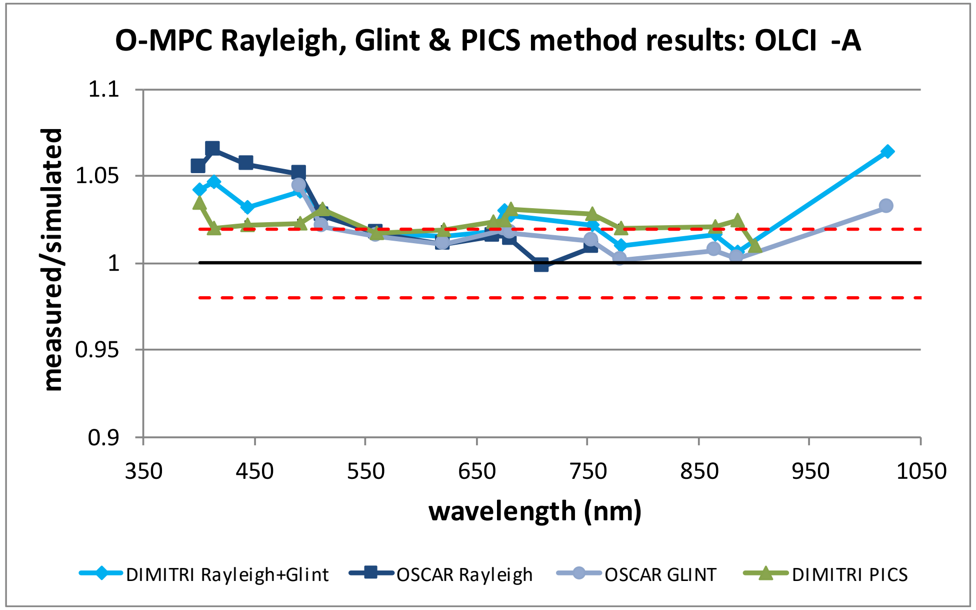
## Three Methods:

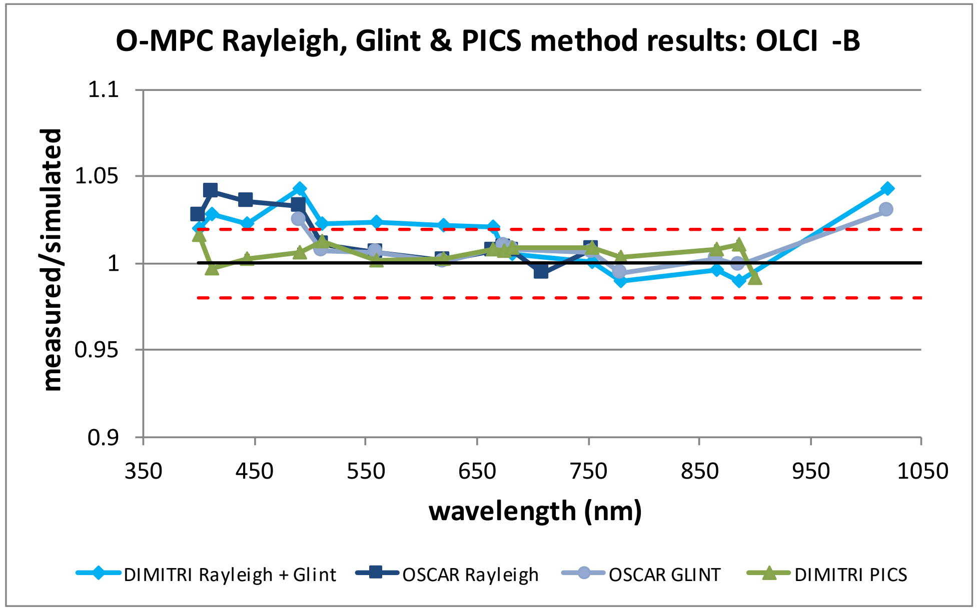
1. Pseudo-Invariant Calibration Sites (PICS): bright deserts, using reference sensor or model and climatological atmosphere correction. Cross-mission, temporal, $\lambda \in [400, 900]$ nm

2. Rayleigh: oligotrophic oceanic areas off-glint and with very low aerosol load, using Chl or reflectance climatology, semi-absolute (aerosol estimate obtained from one NIR band “as is”). Two implementations: DIMITRI (ARGANS) and OSCAR (VITO), $\lambda \leq 665$ nm

3. Glint: specular reflection of the Sun over oligotrophic ocean, inter-band, two implementations: DIMITRI (ARGANS) and OSCAR (VITO), $\lambda \geq 560$ nm

# Radiometric Validation: All direct results

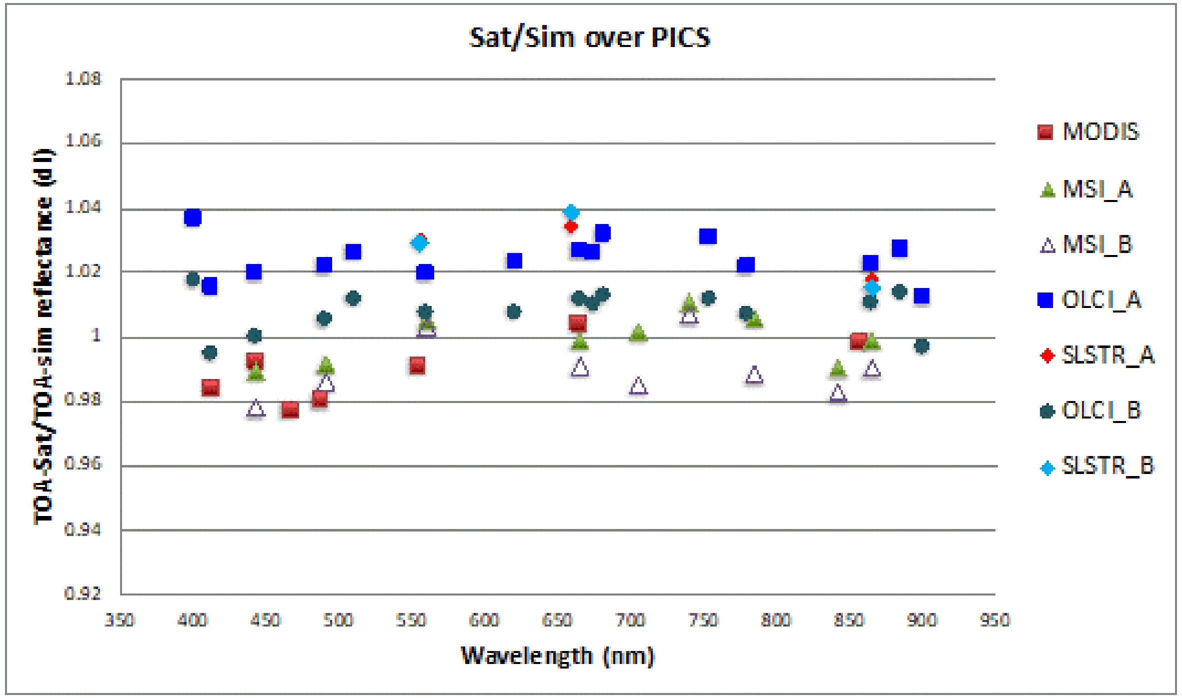



Rayleigh, Glint and PICS assessment.

**For A 2-3% bias in 510-900nm**.
**For B** similar shape but only **about 1-2% bias**.
**In the blue region, ambiguous results**: Rayleigh provides higher biases, but Rayleigh suspected to overestimate. The two Rayleigh implementation also significantly differ…
**For both instruments, time series do not show any significant temporal trends**

# Radiometric Validation: Cross-mission using PICS




Cross-mission comparisons using PICS confirms:

- Bright bias of about 2-3% for OLCI-A (**blue** squares)
- Much better consistency for OLCI-B (**green** circles)
- A/B cross-calibration significantly coloured (discrepancy ↘ with wavelength).

# Conclusion

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**1. Geometry:**

**OLCI-A complies to its georeferencing performance accuracy.**
**OLCI-B more complex with its along-track drifts but is compliant since 11/04/2019**

**2. Spectral:**

**OLCI-A and OLCI-B are accurately characterised with ground an flight measurements.**
**A & B spectrally differ by up to 1 nm, must be accounted by processing, merging or comparison.**
**Both show small temporal drifts <0.25 nm with no impact at L2, but limited one at L1 (λ<443nm)**

**3. Radiometry:**

**OLCI-A confirmed as too bright by ~2-3%; OLCI-B better (~1% bright bias)**
**Significant instrument response evolution (up to >2%), well corrected.**