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7th Sentinel-3 Validation Team Meeting
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Validation of the SLSTR & OLCI Sentinel-3 calibration/radiometry using natural targets

7th S3VT – 18 October 2022

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sentinel-3

Validation of the Sentinel-3 radiometric calibration

- Activity to validate the **calibration**, and more generally validate the **radiometry** of optical sensors
- S 3 A&B Level-1 data are extracted and evaluated through **many different calibration methods**
  - different approaches using very different targets (spectral, radiance level)
- If every method tries to evaluate the same instrumental calibration, each method is also sensitive to different instrumental radiometric behavior
  - e.g. variation within the field-of-view, variation with time, spectral consistency, linearity behavior, polarization, straylight, spectral knowledge, saturation…
- At the end, a **good consistency** = a **validation of the whole radiometric behavior** (instrument + processing), including of course the absolute calibration

S3 Operational Environment = S3ETRAC + SADE + MUSCLE

Inputs : Level-1 data

S3ETRAC = Extraction and Selection of Measurements = PREPROCESSING

- Reading of S3 images, selection of relevant data, extraction of data
- Developed by ACRI-ST and operated within MPC-S3

SADE = Measurement & Calibration Data Repository = DATABASE

- Easy data management & traceability : product identifier, calibration version, SADE identifier, acquisition conditions (dates, geometries), meteorological data, tool version, processing date and parameters…

MUSCLE = Multiple Method Calibration tools (Front-end Graphic) = CALIBRATION

- Common calibration tools for all sensors

S3 Operational Environment = S3ETRAC + SADE + MUSCLE

Inputs : Level-1 data through S3ETRAC data

Data used for following results :

- OLCI-A : Reprocessing REP006 then operational processing
- OLCI-B : Reprocessing then operational processing
- SLSTR-A : Operational processing (data after 01/01/2017 -> SWIR-2 band update at the end of 2016)
- SLSTR-B : Reprocessing then operational processing

SADE/MUSCLE calibration methods : the arsenal :

Deserts

Sun Glint

Rayleigh

Clouds (DCC)

SADE/MUSCLE system : Common calibration tools for all sensors

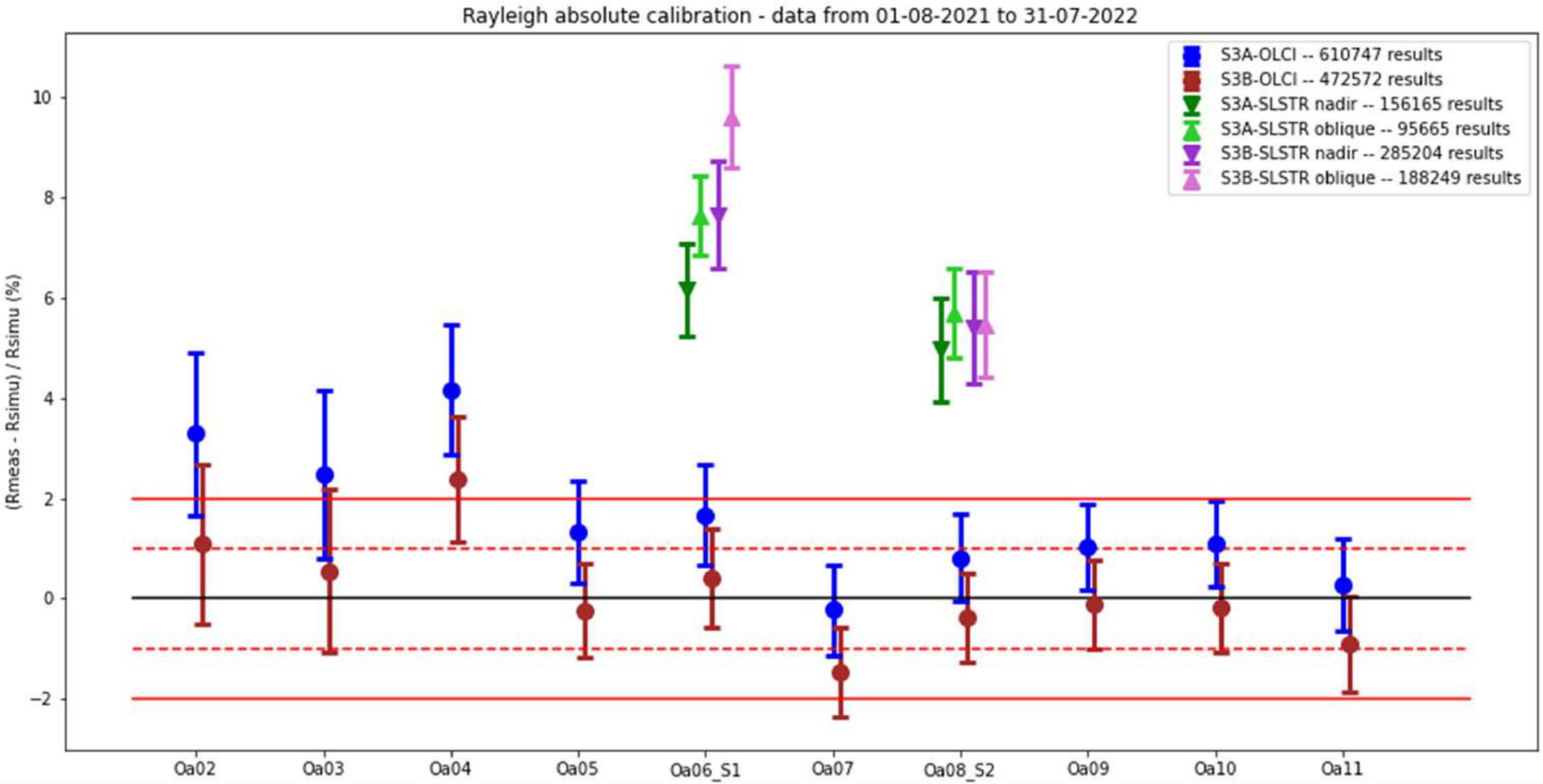
Absolute Calibration over Ocean : Method

What is Rayleigh calibration ?

- Vicarious **absolute** radiometric calibration method
- Statistical approach based on **molecular scattering** (Rayleigh)
- Observation of the atmosphere over a dark surface (ocean)
- Use Oceanic Oligotrophic Sites (very clear non-turbid scenes)
- Strict selection of measurements : very clear + non-turbid situations for atmosphere + surface
- Reference = **Rayleigh scattering** (**~90% of TOA signal after selection** - predictable)
- Absolute calibration over a wide range of the fov (exc. sunglint) for VISIBLE range
- Calibration from blue to red spectral bands (440nm to 750nm)

[Hagolle et al., 1999, Fougnie et al., 2010]

Absolute Calibration over Ocean : Results



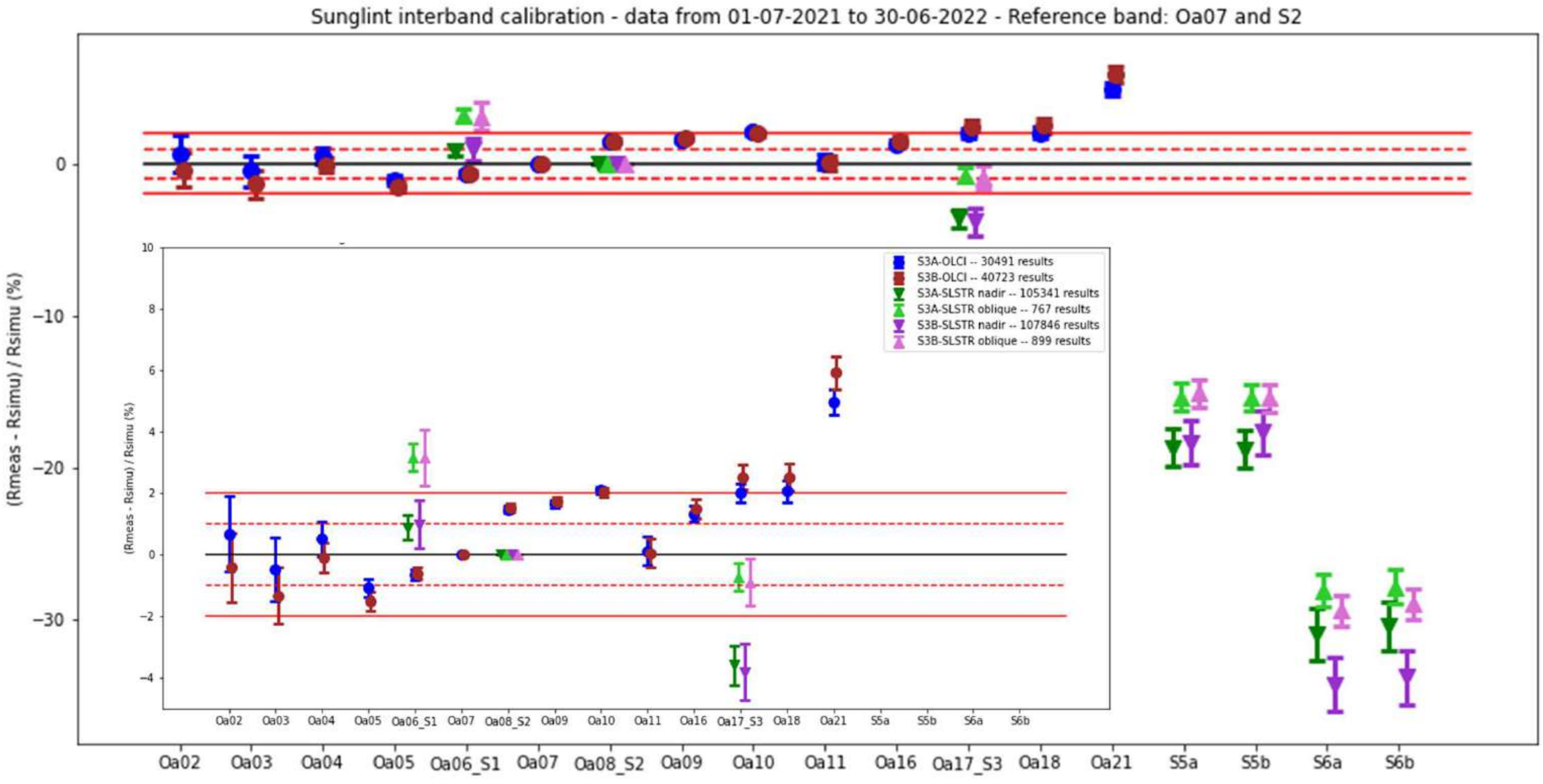
Inter-band Calibration over Sunglint : Method

Principle of the method

- Observation of the "white" **reflection of the sun over the ocean surface**
- Inter-calibration of blue to SWIR bands with a **reference band** :
  - red band (~620-660nm) usually adopted as reference
- Accurate computation of the **2 main contributors** :
  - **Rayleigh scattering**
  - **Sunglint** contribution strongly depend to the **wind speed** is characterized using the reference band
- Use Oceanic Oligotrophic Sites (very clear non-turbid scenes)
- Strict selection of measurements : very clear + non-turbid situations for atmosphere + surface
- Interband for all **reflective** bands wrt the reference band

[Hagolle et al., 2004; Fougnie 2016]

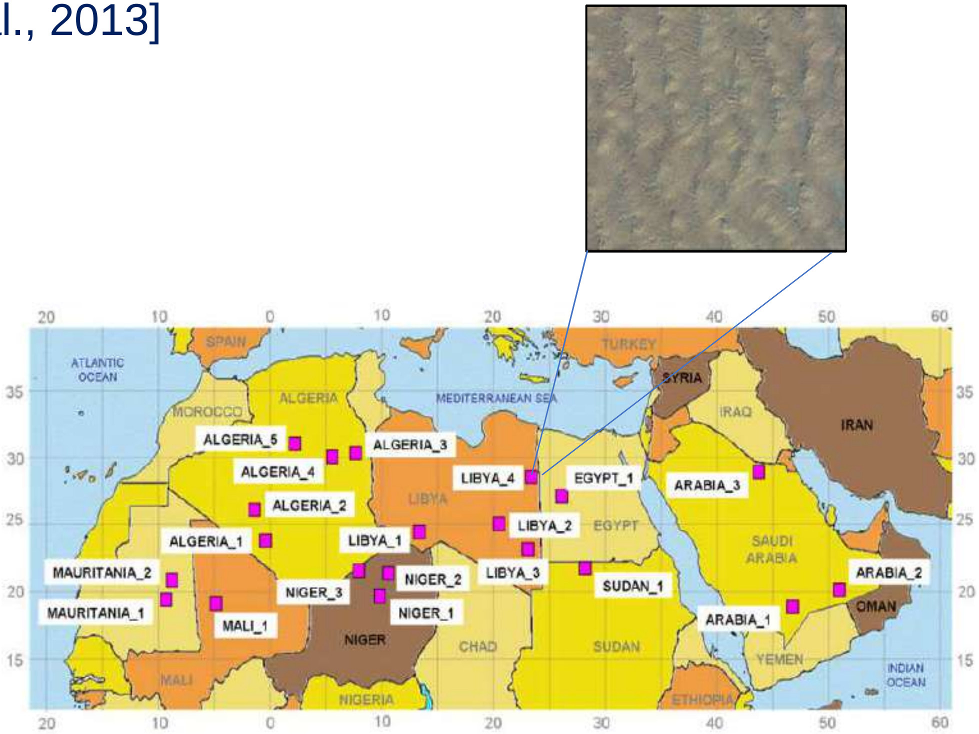
Inter-band Calibration over Sunglint : Results



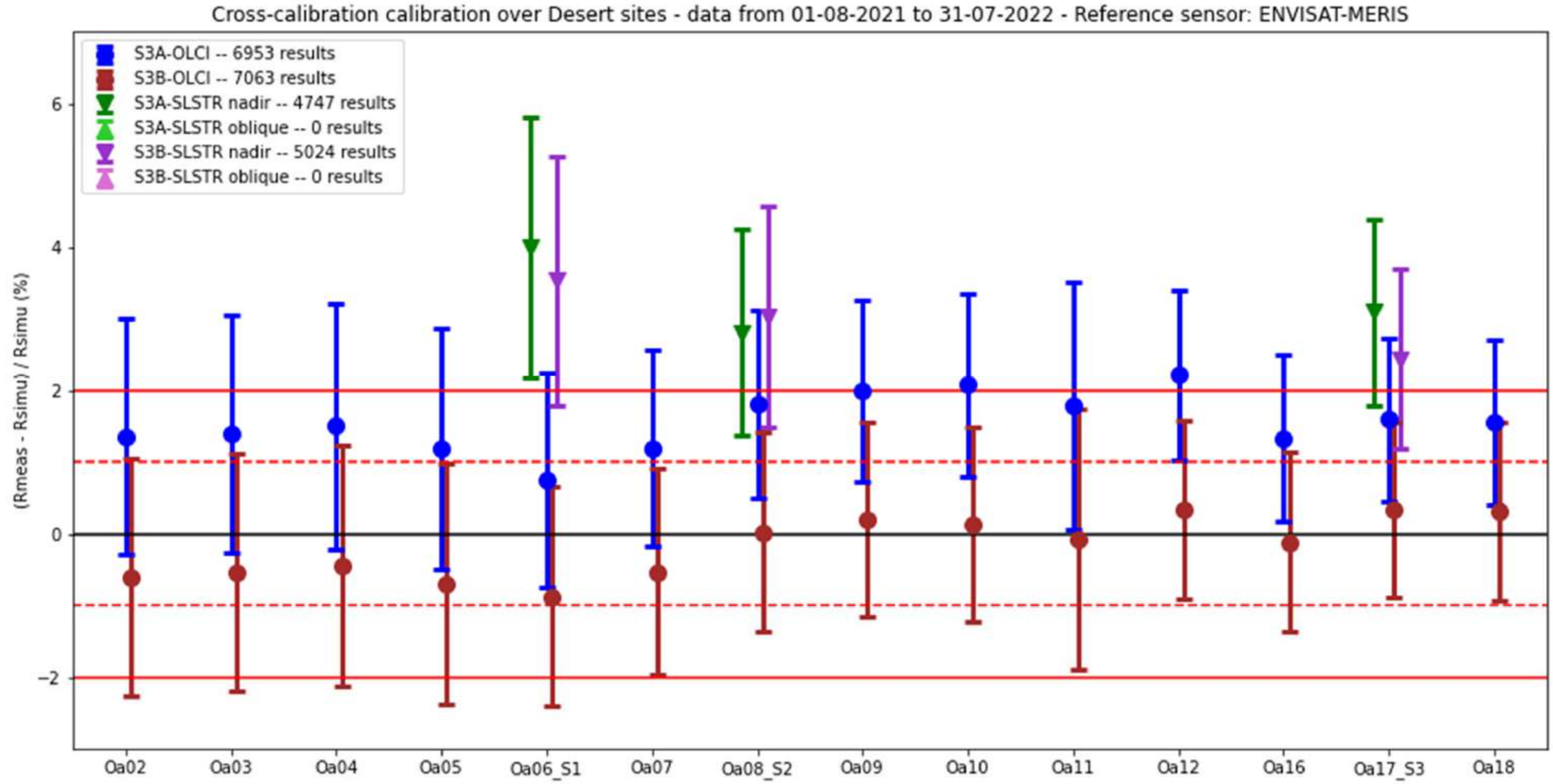
Cross-Calibration over Deserts : Method

Pseudo Invariant Calibration Sites (PICS) and Snow sites

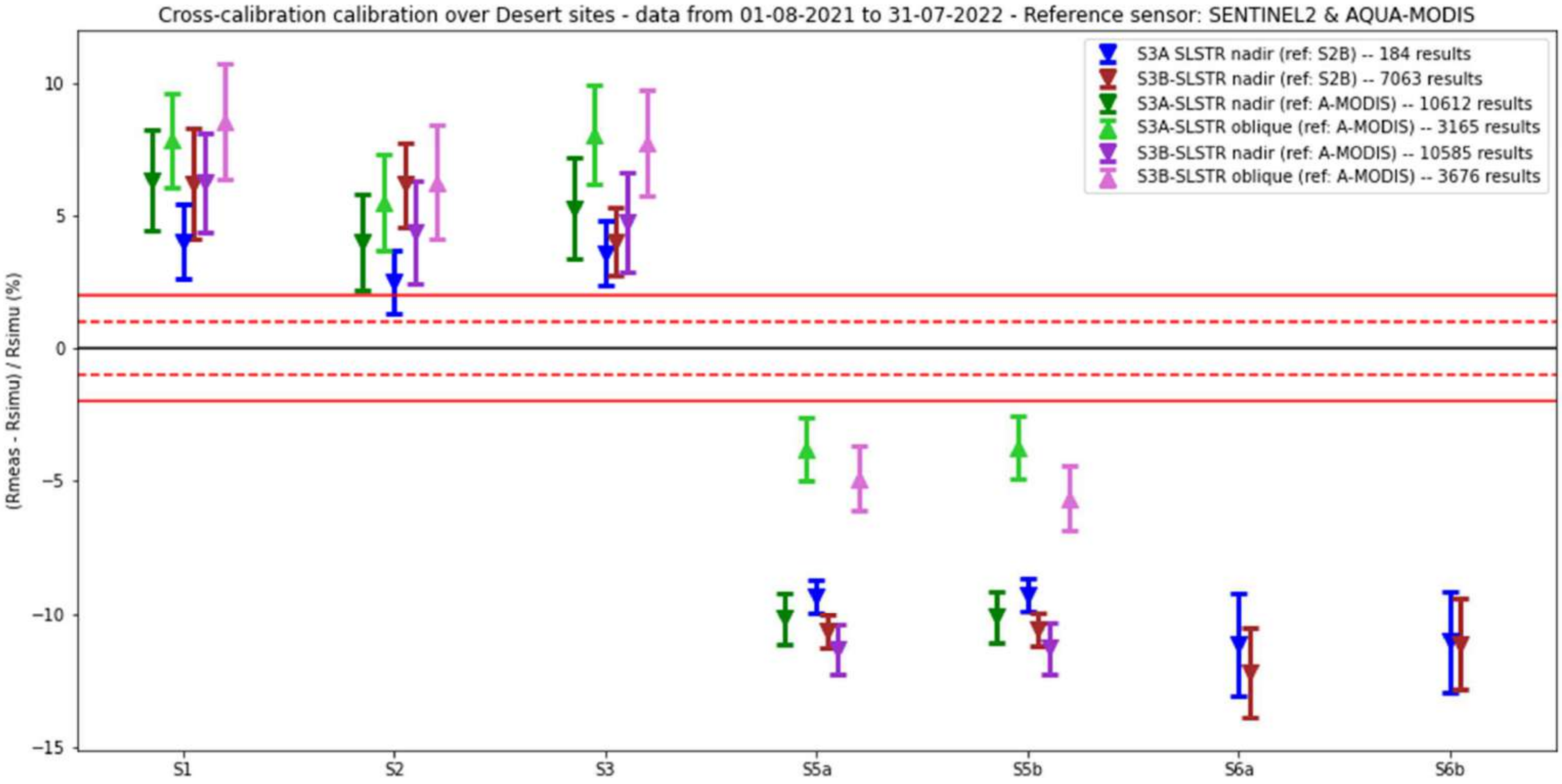
- Cross-calibration wrt. **reference sensor**
- use of 19 desert sites in Africa/Arabia [Lachérade et al., 2013]
  sites selected for their **stability**
- reference = one sensor or one date
- **geometrical matching** : viewing and solar angles
  => no simultaneity needed
- spectral interpolation [Lachérade et al., 2013]
- cross-calibration and temporal evolution
  for all **reflective** bands (exc. Absorbtion bands)



Cross-Calibration over Deserts : Results VNIR



Cross-Calibration over Deserts : Results SWIR



Inter-band Calibration over Clouds : Method

Principle of the method

- In certain conditions, deep clouds provide a stable radiance
- Reflectance of the clouds difficult to assess → no absolute calibration
- Reflexion of sun light on a dense cloud is « white » in VNIR → **inter-band calibration**
- **Reference** = one spectral band (red band ~620-660nm)

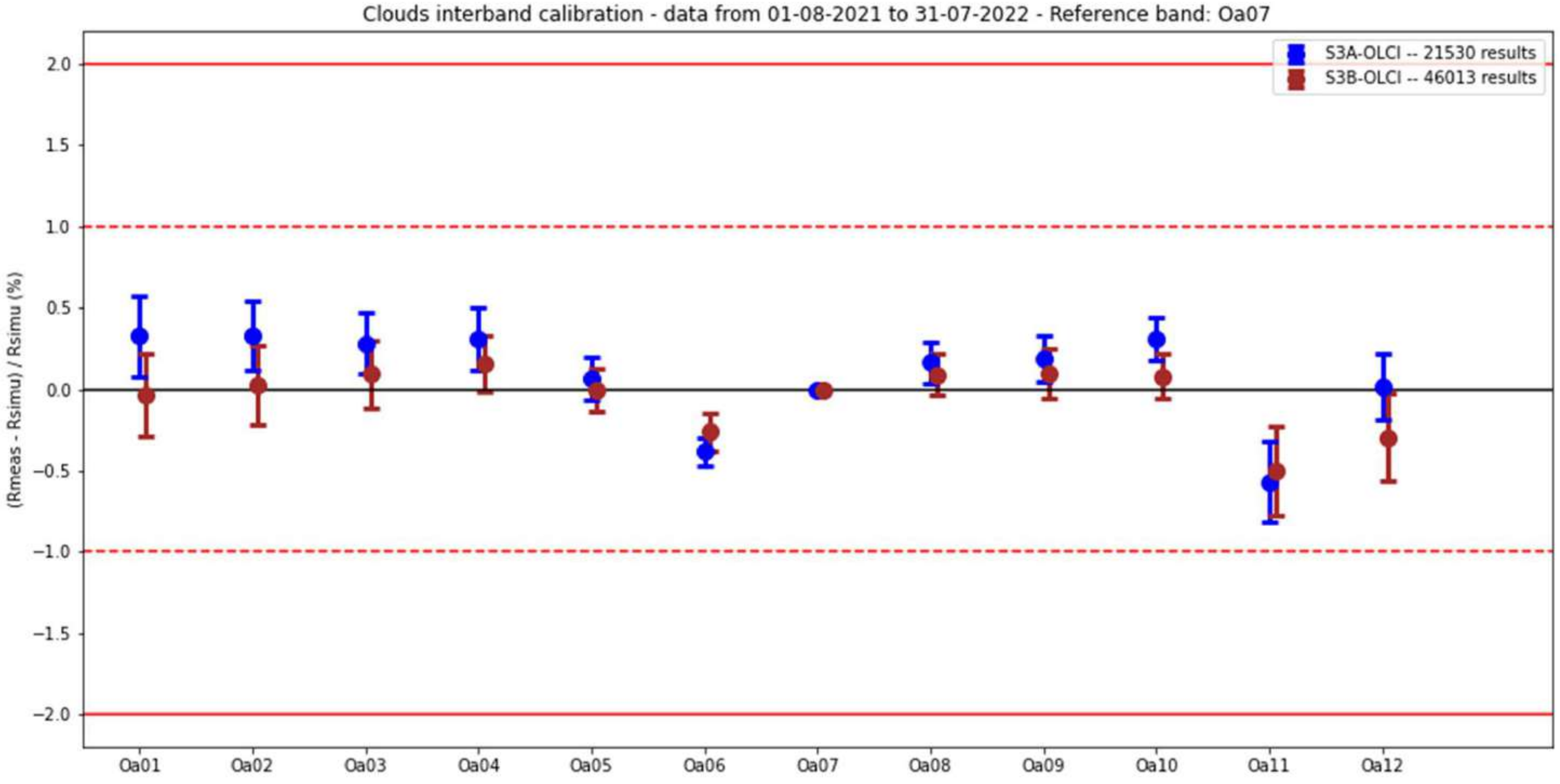
Use of « white » clouds in VNIR

- In sub-tropical convective systems, above the ocean
- High altitude clouds, very thick and large
- No contamination by tropospheric aerosols, surfaces, cirrus or non-cloudy neighbourhood

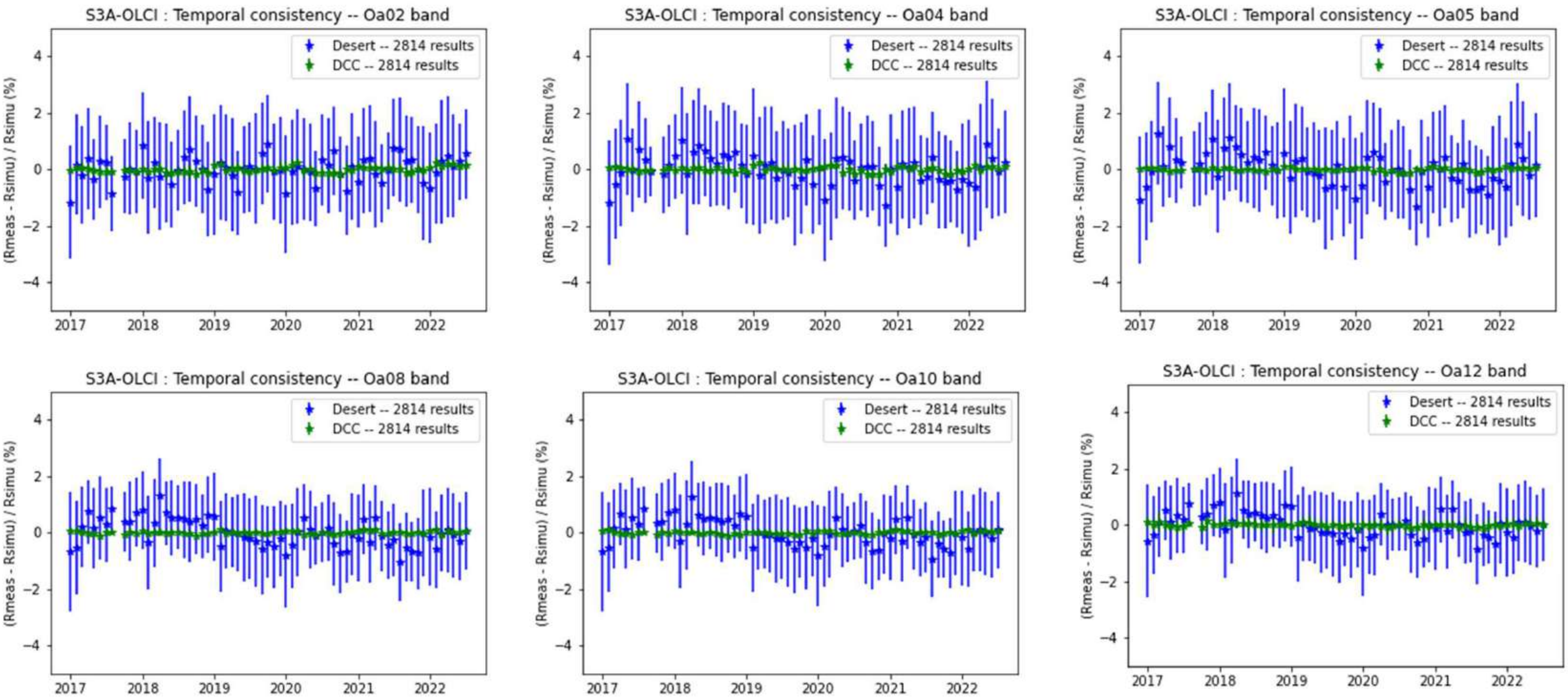
→ **Strict selection** of DCC [Fougnie and Bach, 2009; Fougnie 2016]

Inter-band Calibration over Clouds : Results

Spectral consistency : S3A&B OLCI : < 0.5%

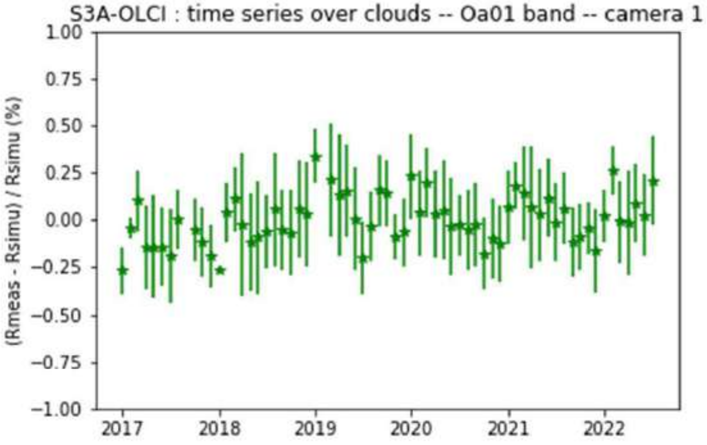


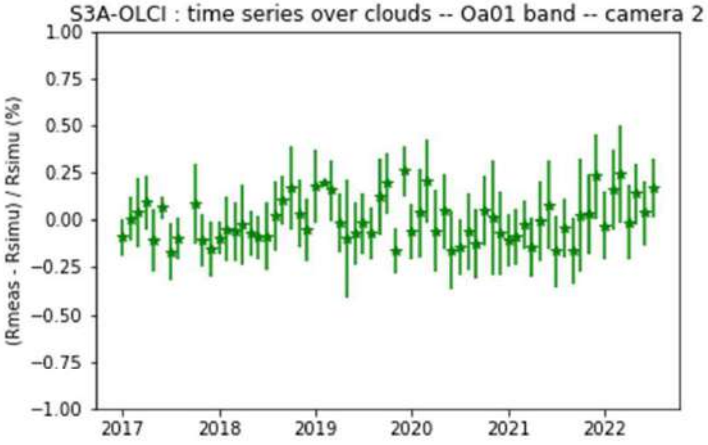
Temporal consistency : S3A OLCI

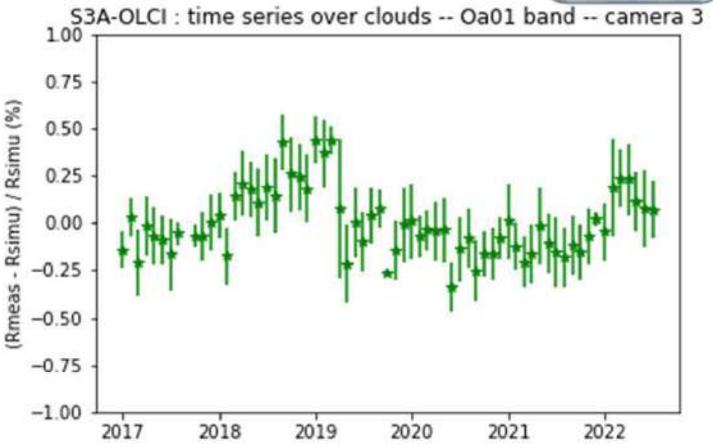


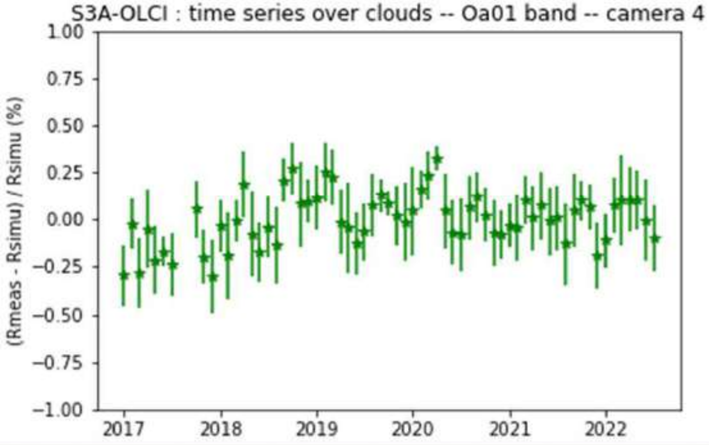
Temporal consistency : S3A OLCI

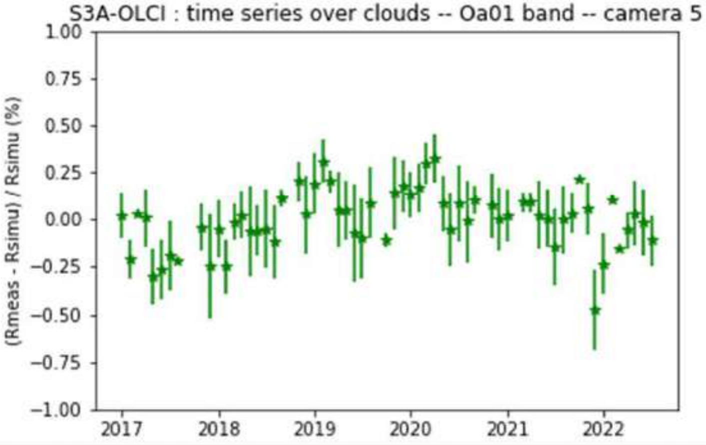
Temporal drift of S3A-OLCI Oa1-400nm : Time series for each camera over DCC







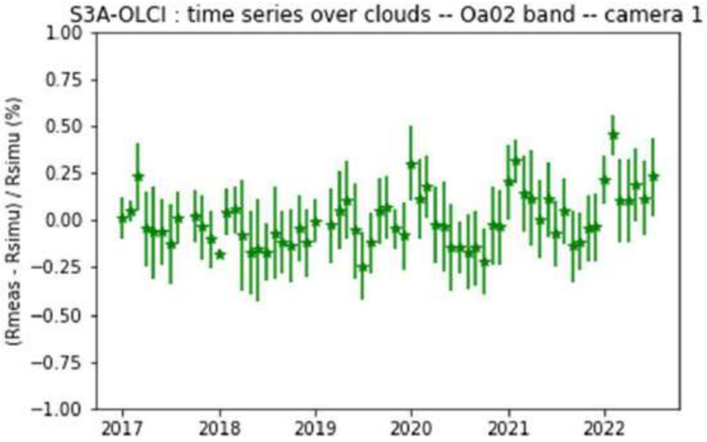


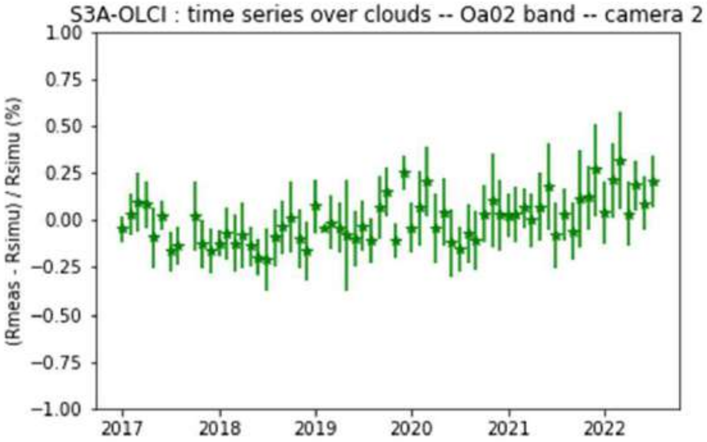


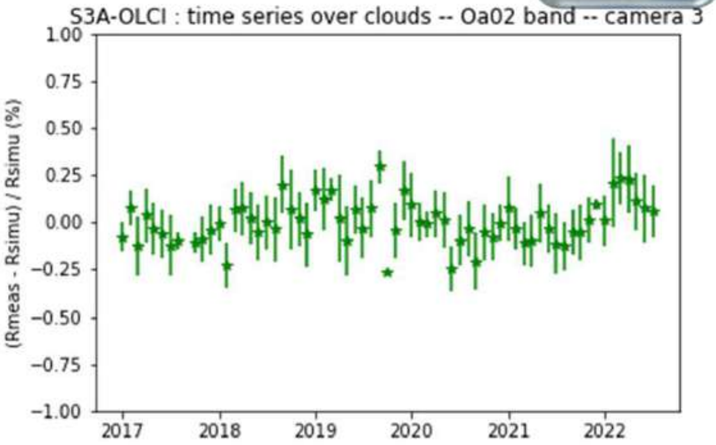
- Very small trending (~ 0.5%)
- Small gap for cam 3

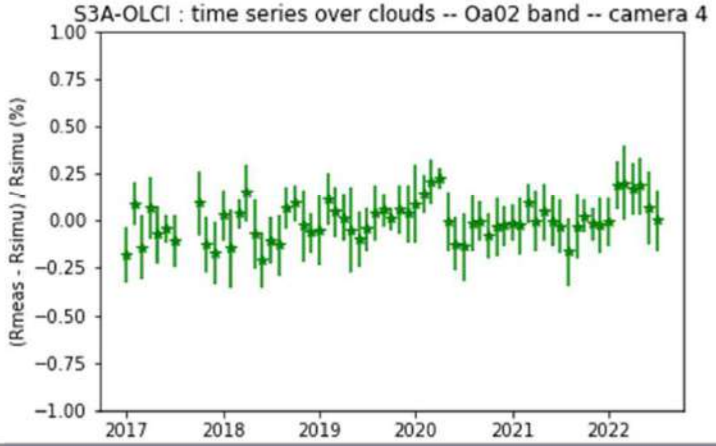
Temporal consistency : S3A OLCI

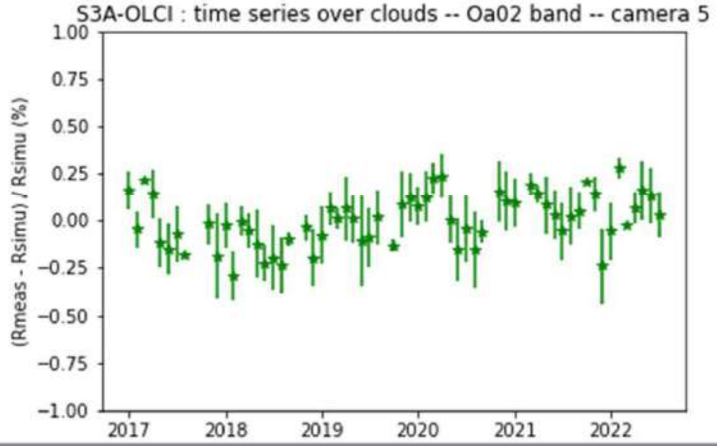
Temporal drift of S3A-OLCI Oa2-412nm : Time series for each camera over DCC







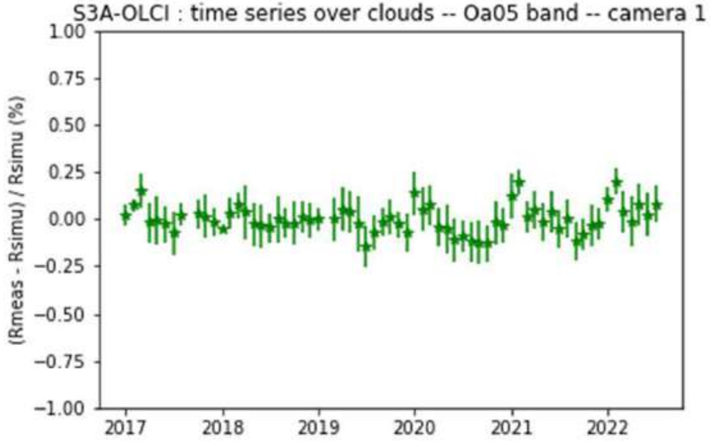


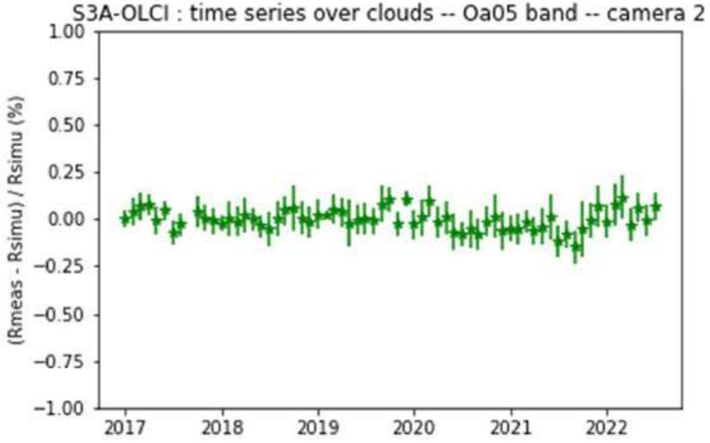


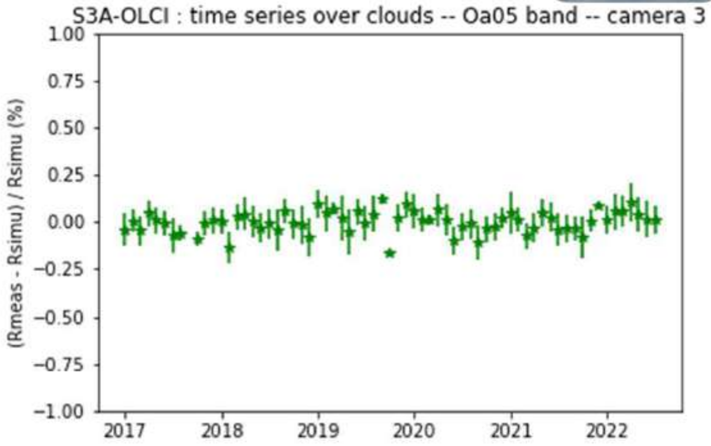
- Very small trending (< 0.5%)
- Very small gap (~0,25 %)
- To be confirmed with more data

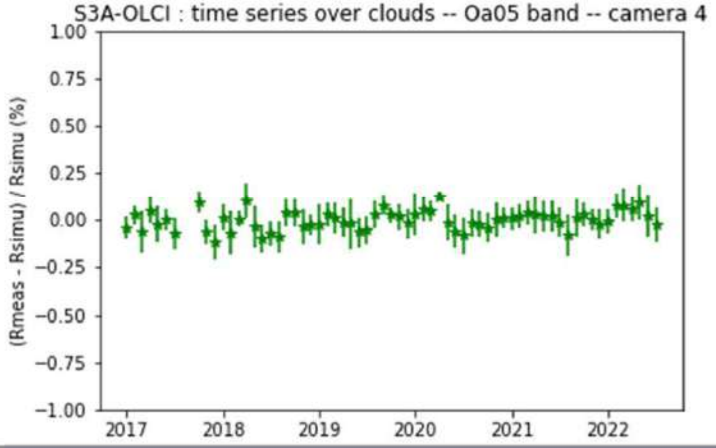
Temporal consistency : S3A OLCI

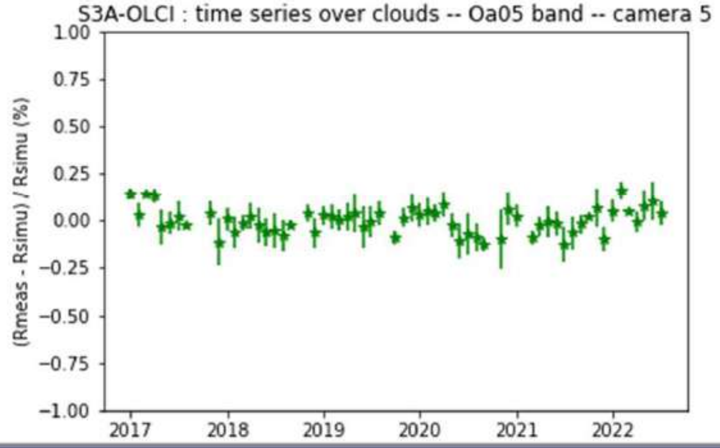
Temporal drift of S3A-OLCI Oa5-510nm : Time series for each camera over DCC







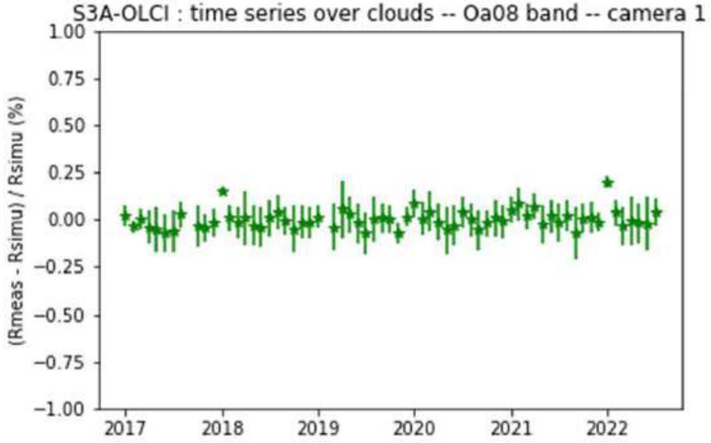


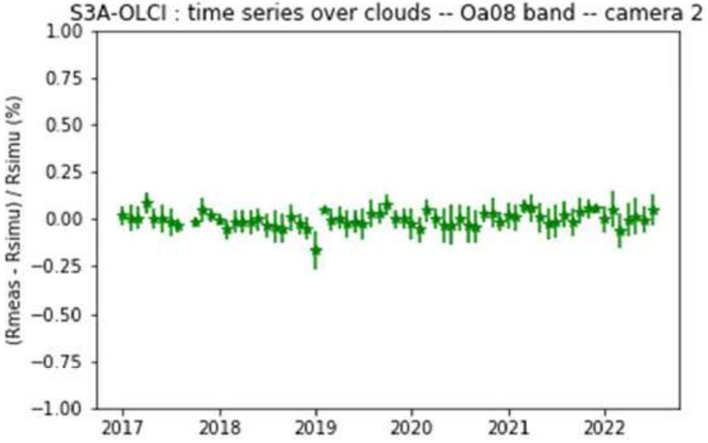


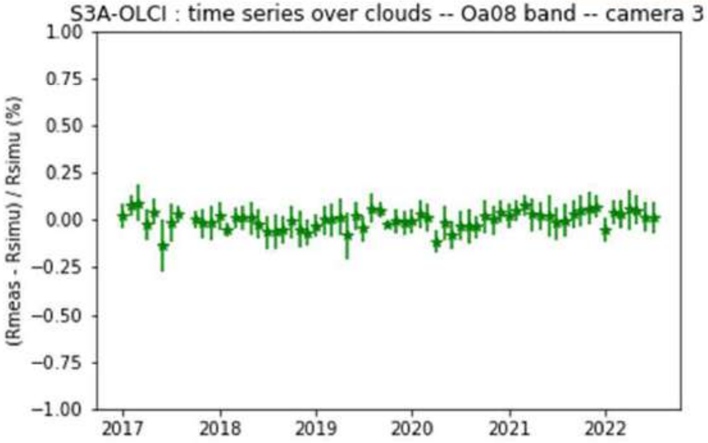
- No trending detected

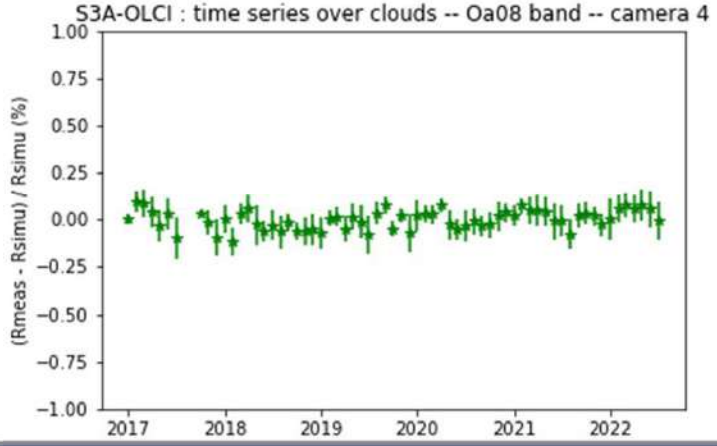
Temporal consistency : S3A OLCI

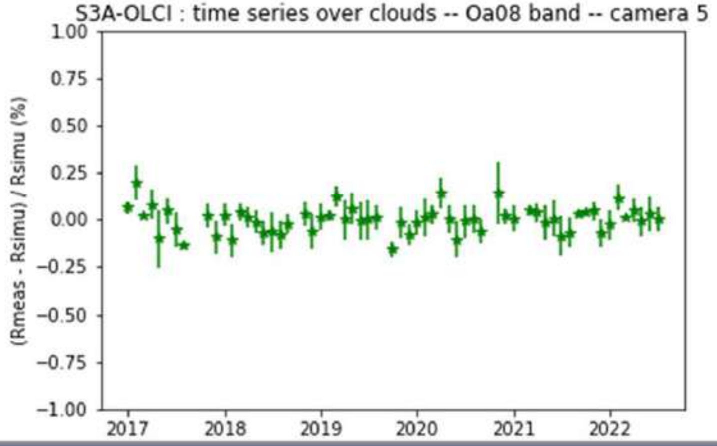
Temporal drift of S3A-OLCI Oa8-665 nm : Time series for each camera over DCC





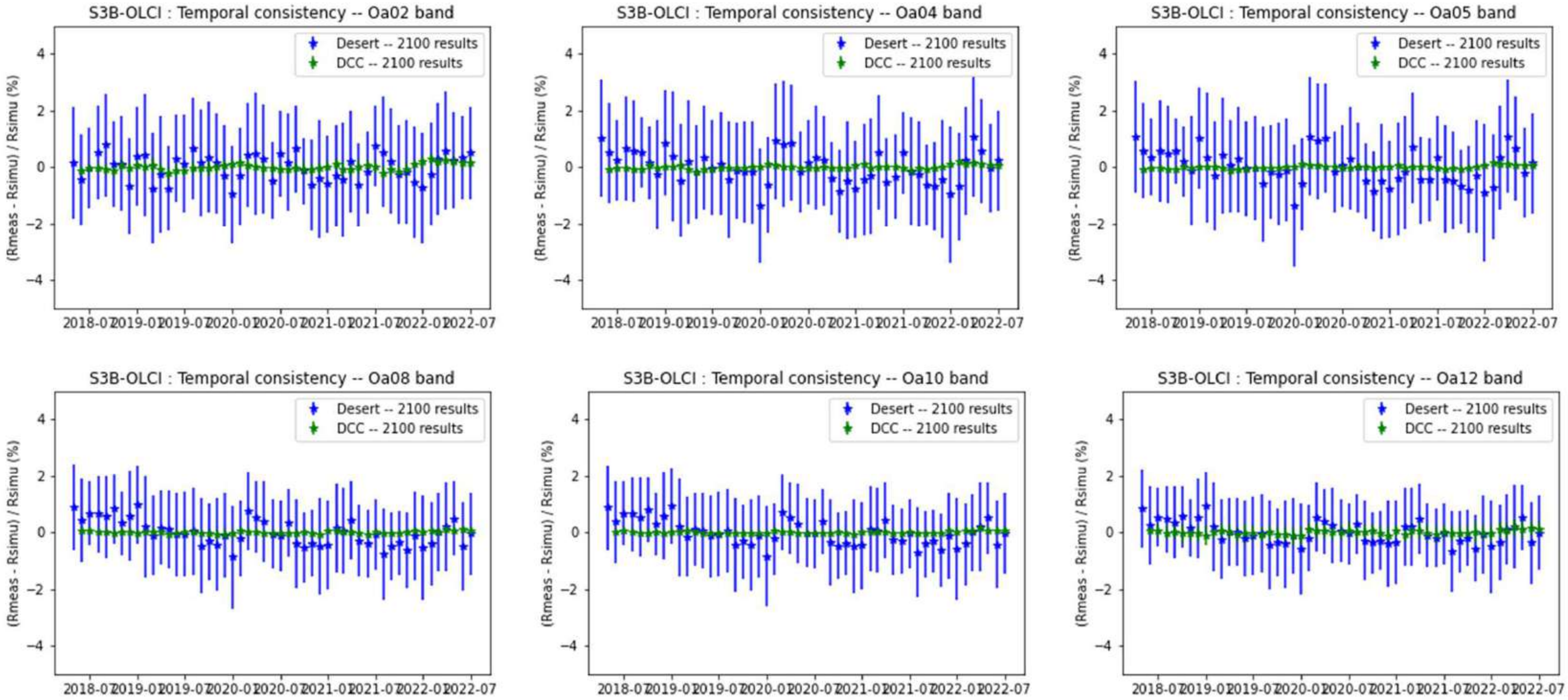






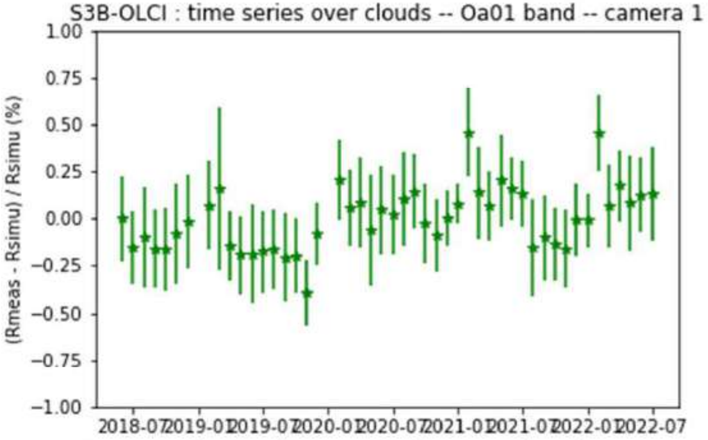
- No trending detected

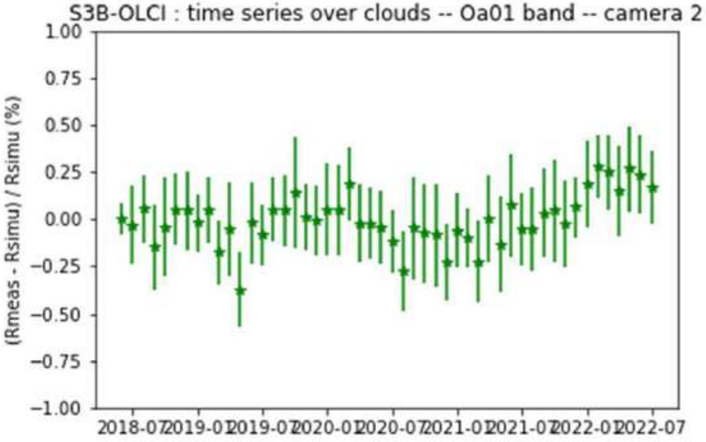
Temporal consistency : S3B OLCI

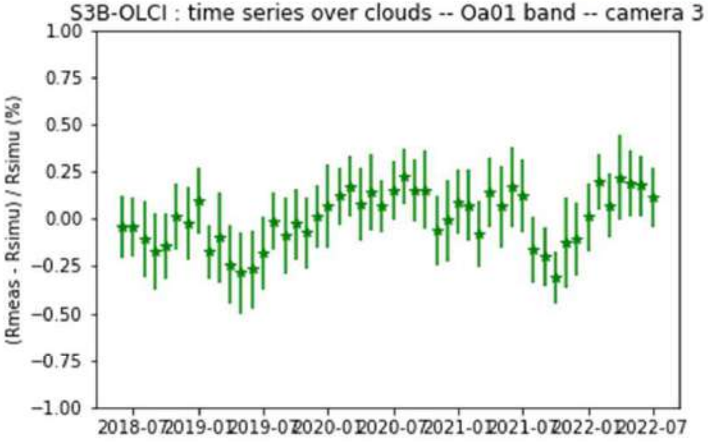


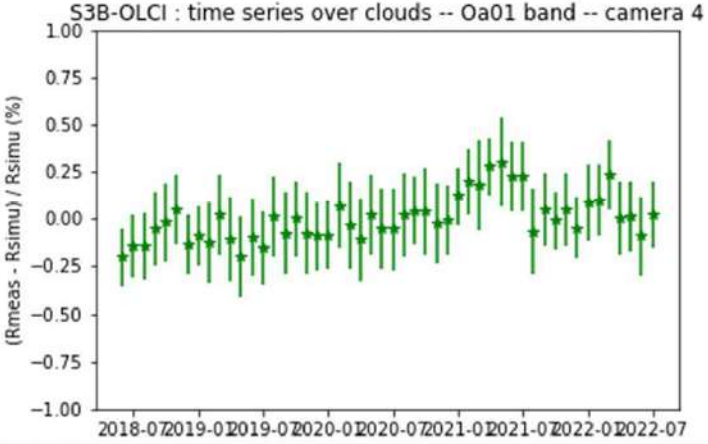
Temporal consistency : S3B OLCI

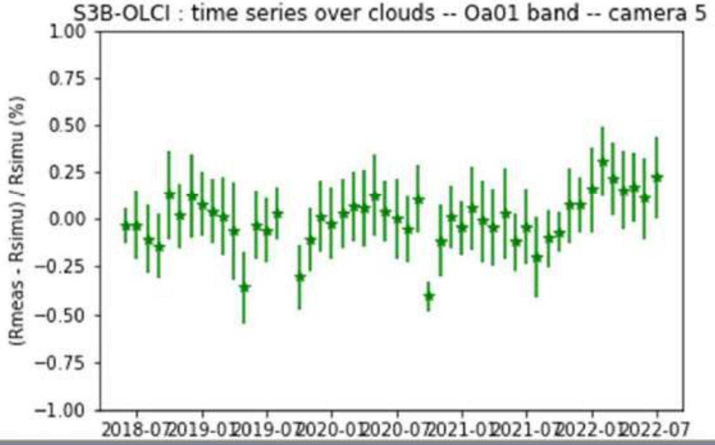
Temporal drift of S3B-OLCI Oa1-400nm : Time series for each camera over DCC







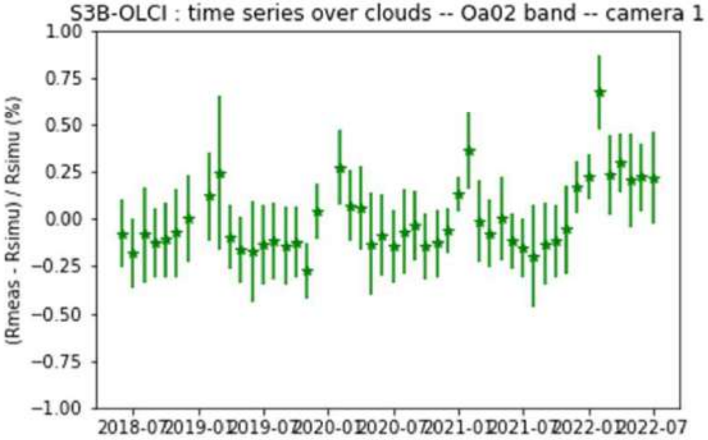


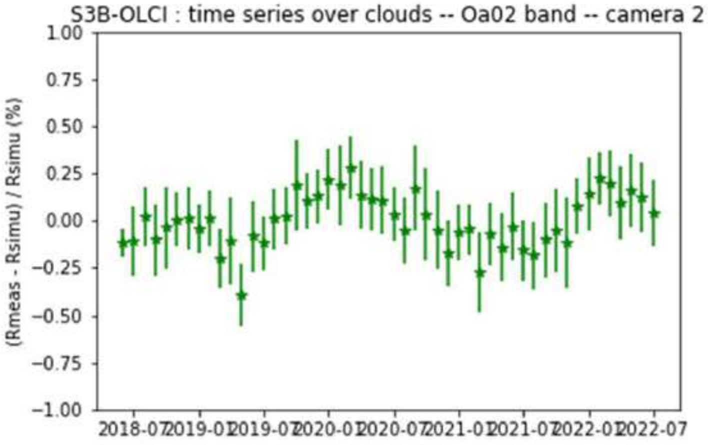


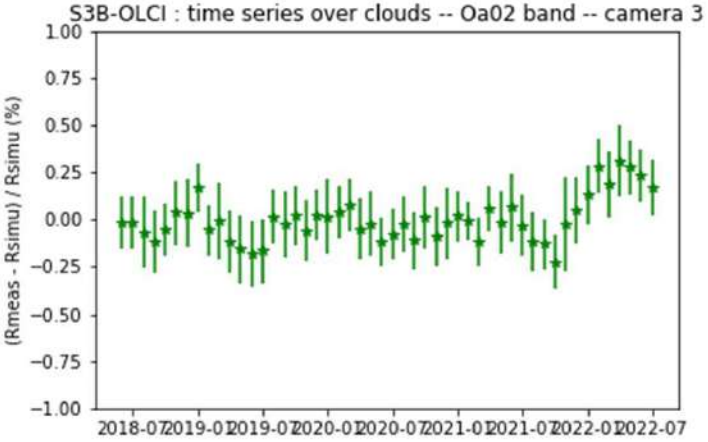
- Very small trending (~ 0.5%)
- Small gap

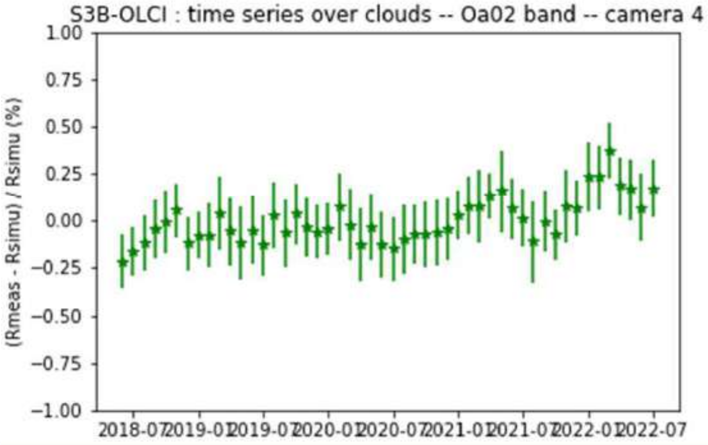
Temporal consistency : S3B OLCI

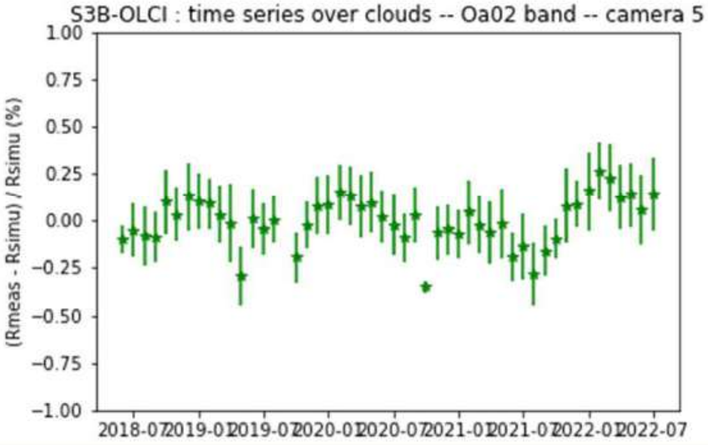
Temporal drift of S3B-OLCI Oa2-412nm : Time series for each camera over DCC







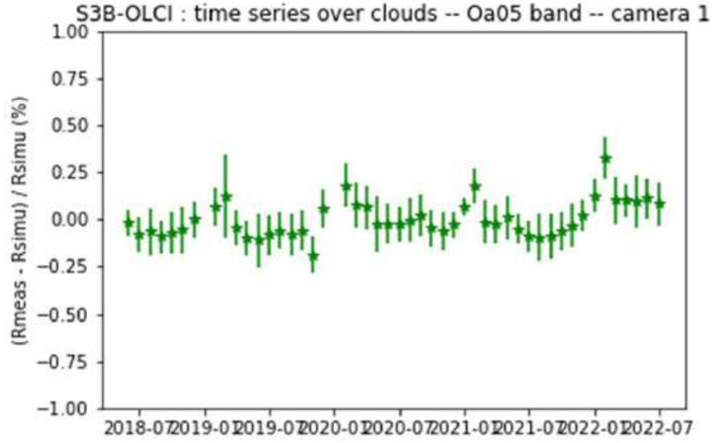


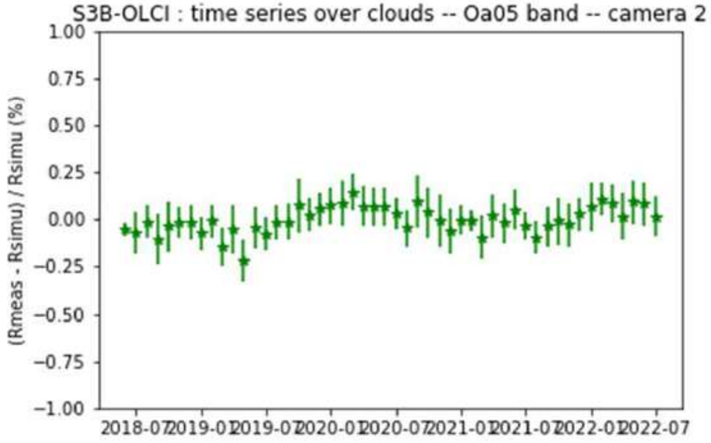


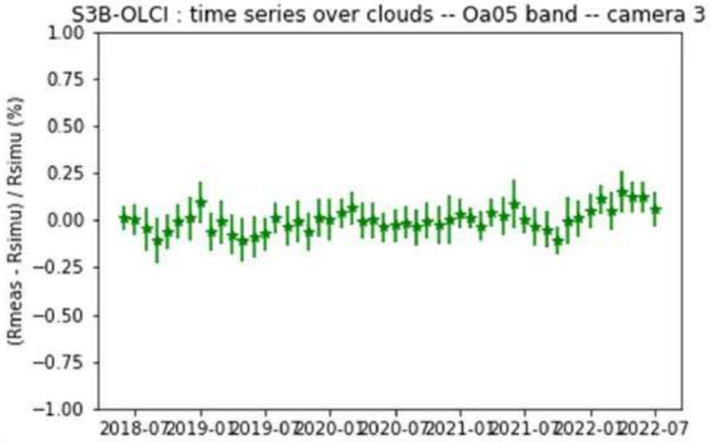
- Small trending (< 0.5%)

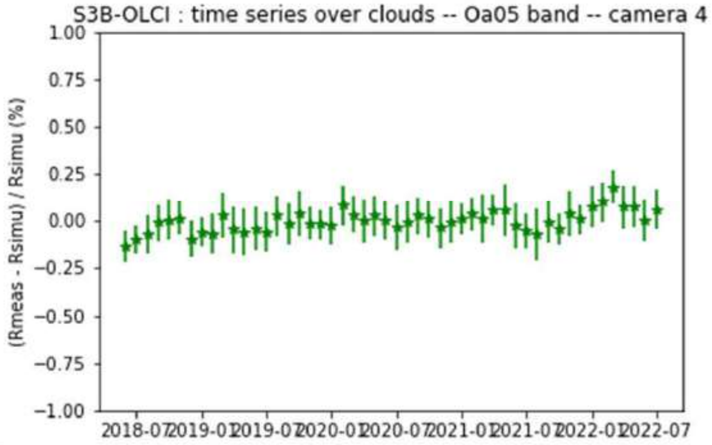
Temporal consistency : S3B OLCI

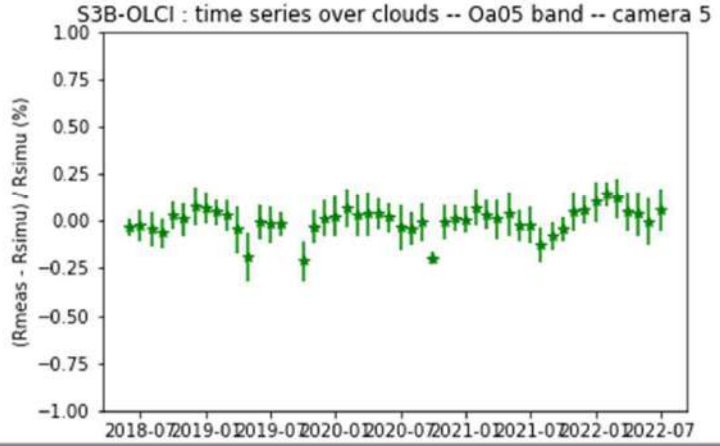
Temporal drift of S3B-OLCI Oa5-510nm : Time series for each camera over DCC







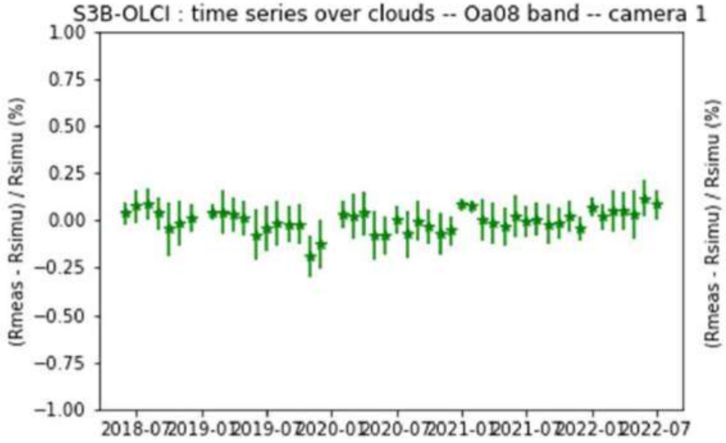


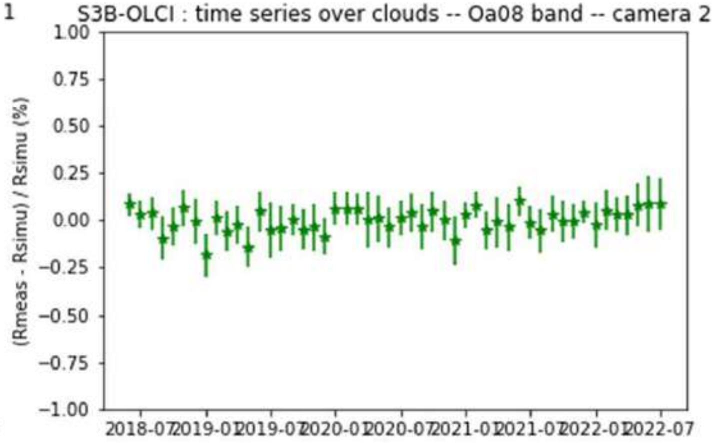


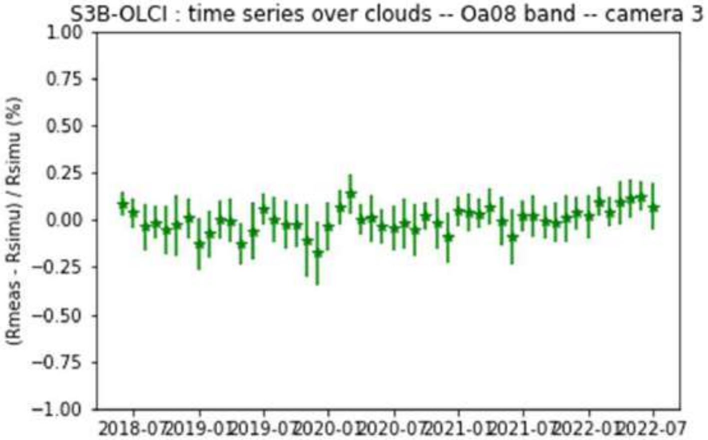
- No trending detected

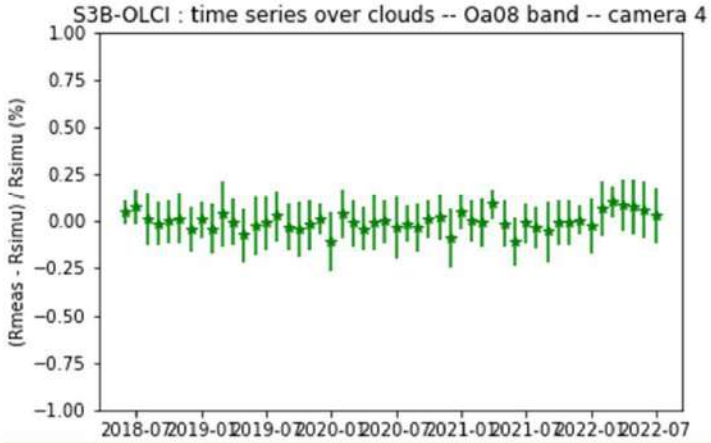
Temporal consistency : S3B OLCI

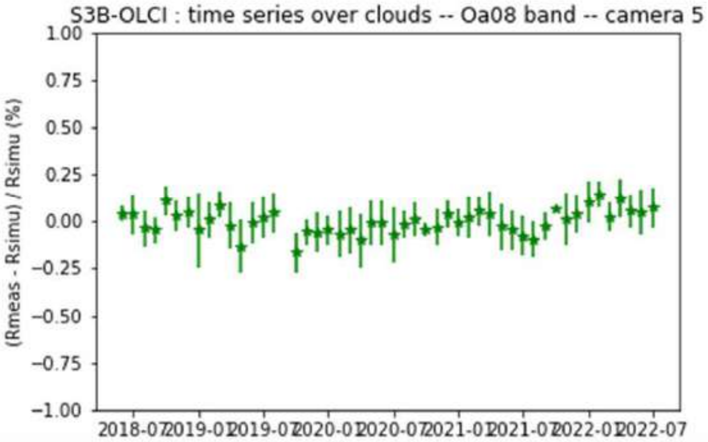
Temporal drift of S3B-OLCI Oa8-665 nm : Time series for each camera over DCC







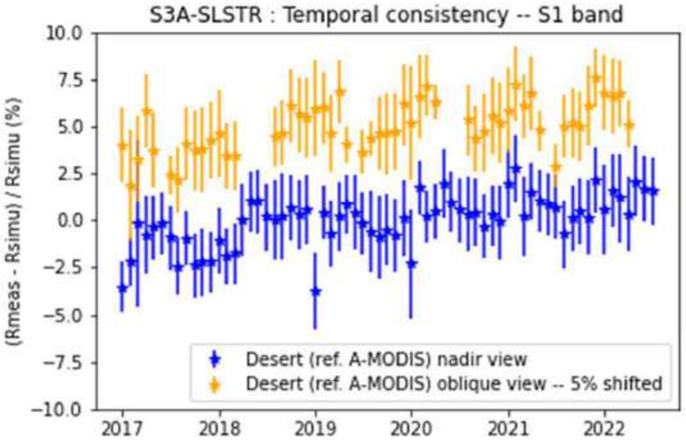


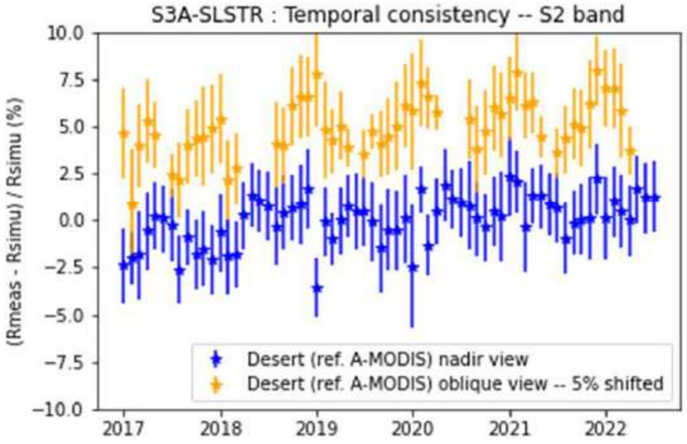


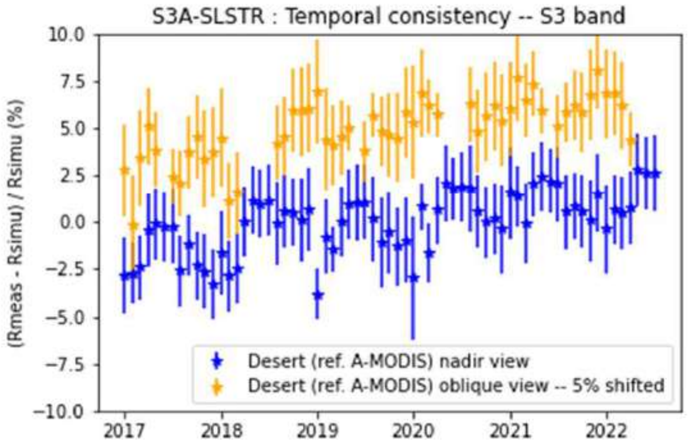
- No trending detected

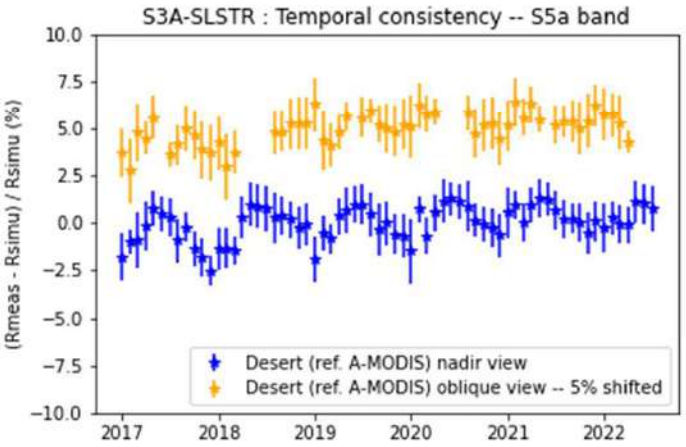
Temporal consistency : S3A SLSTR

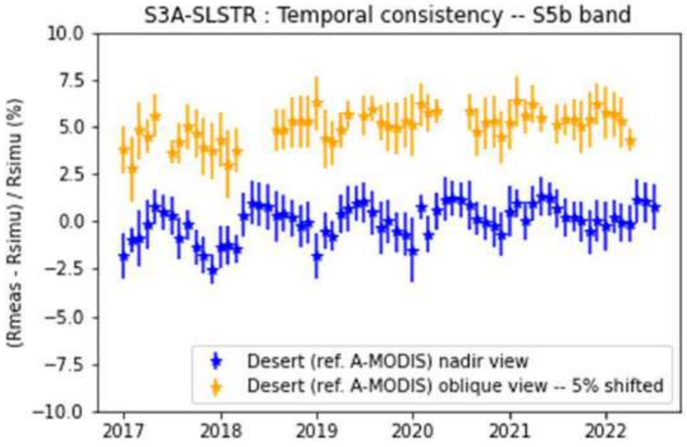
- Temporal drift detected on S3A-SLSTR for nadir & oblique views





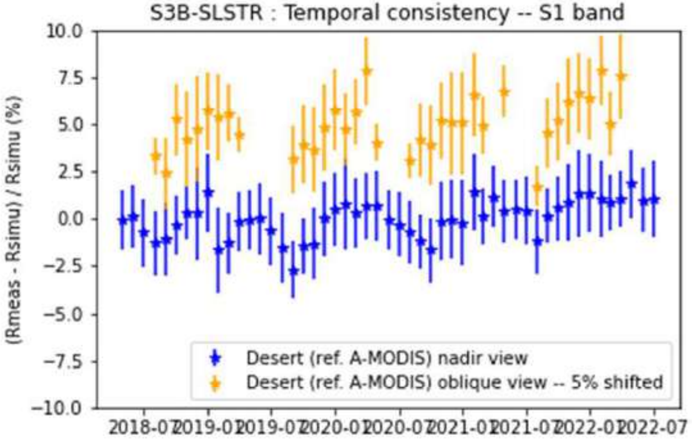


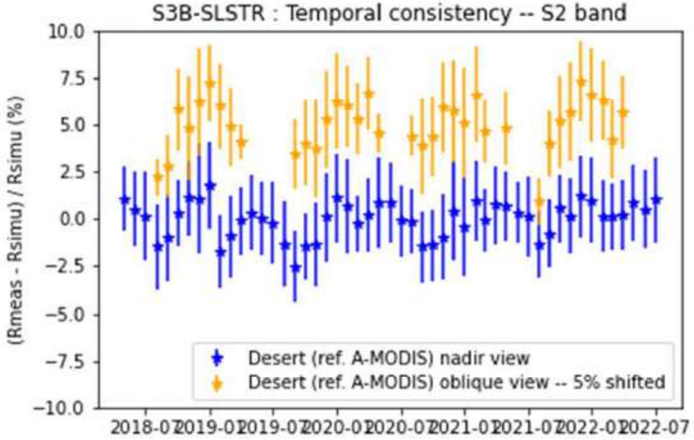


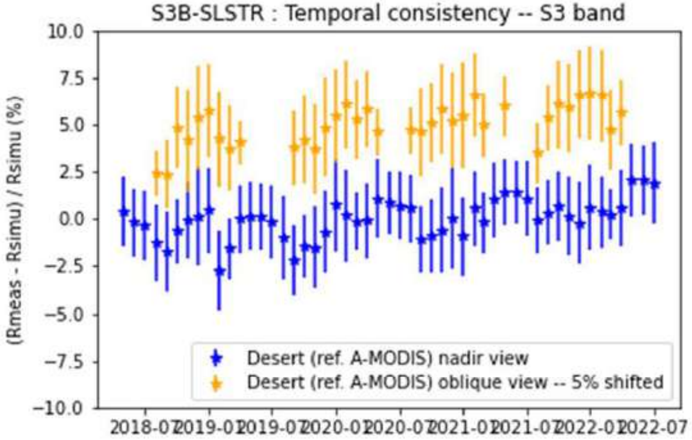


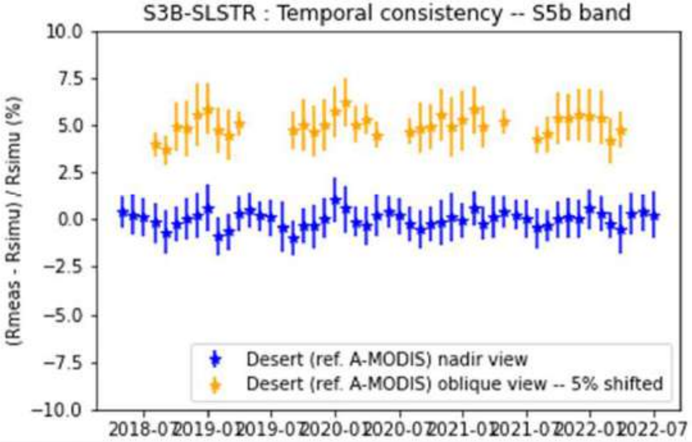
Temporal consistency : S3B SLSTR

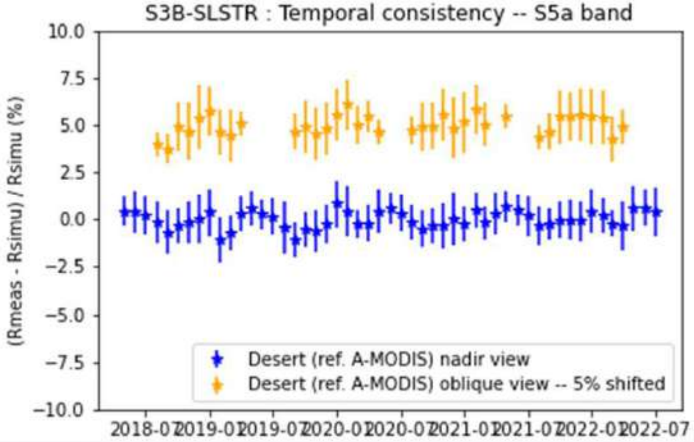
- Small drift observed for S1 & S3 bands – to be confirmed with more data





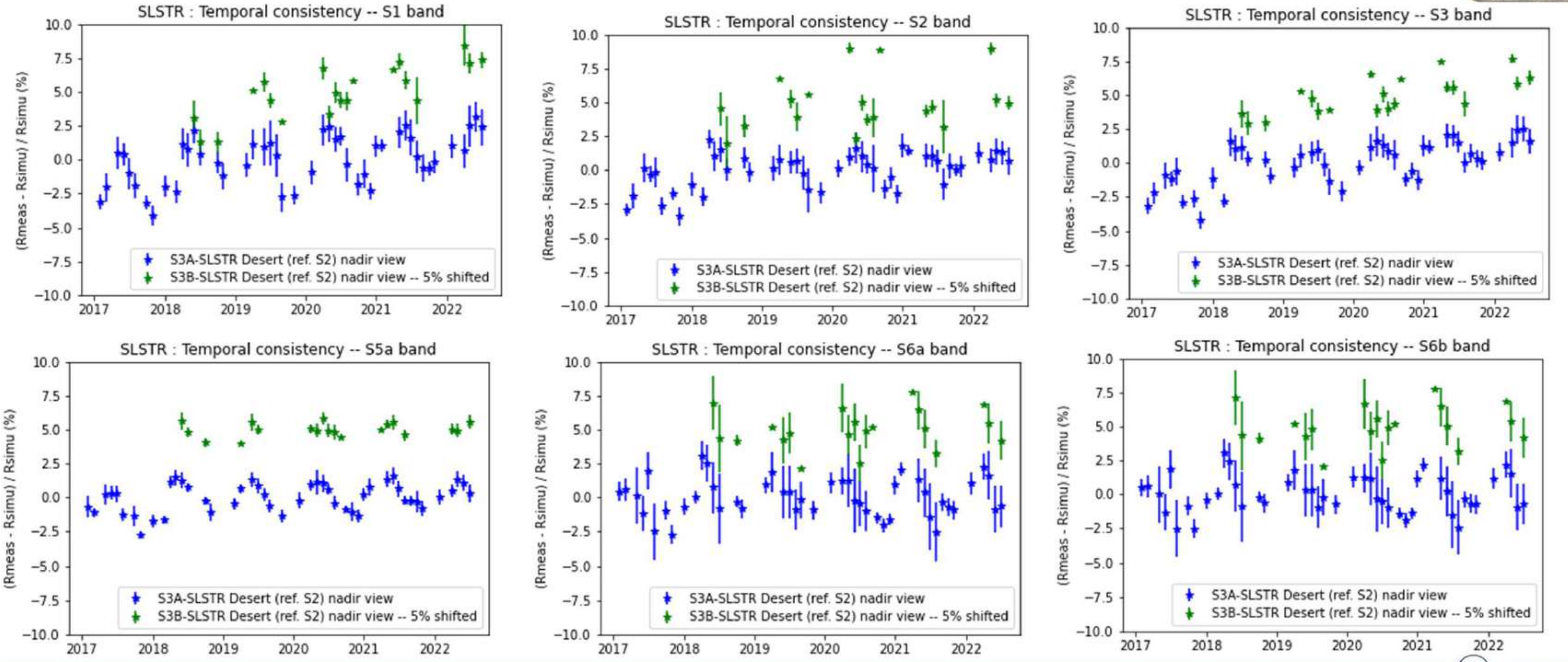




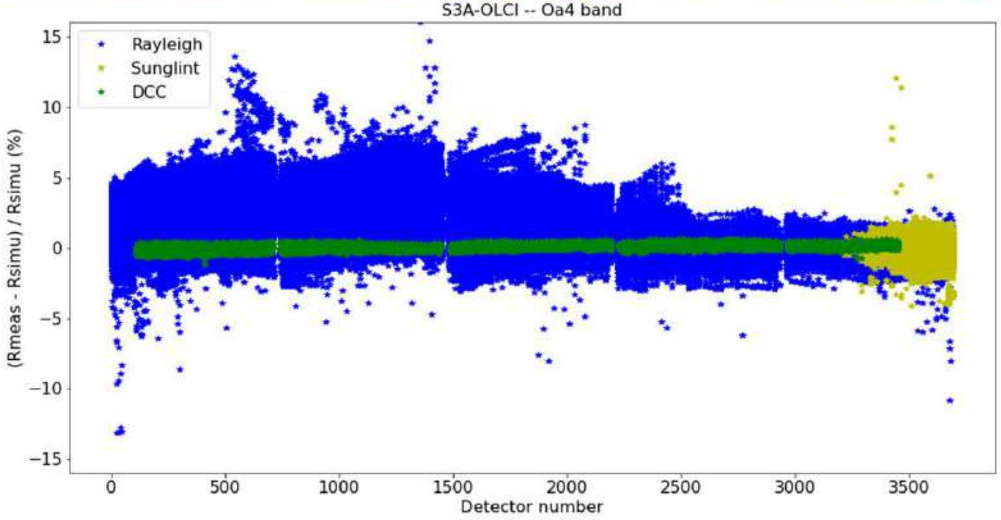


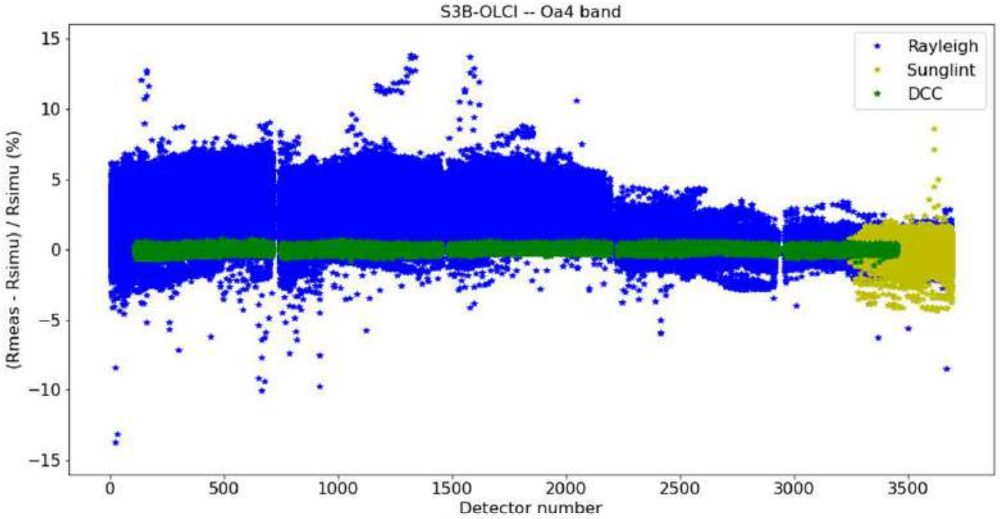
Temporal consistency : S3A&B SLSTR nadir view

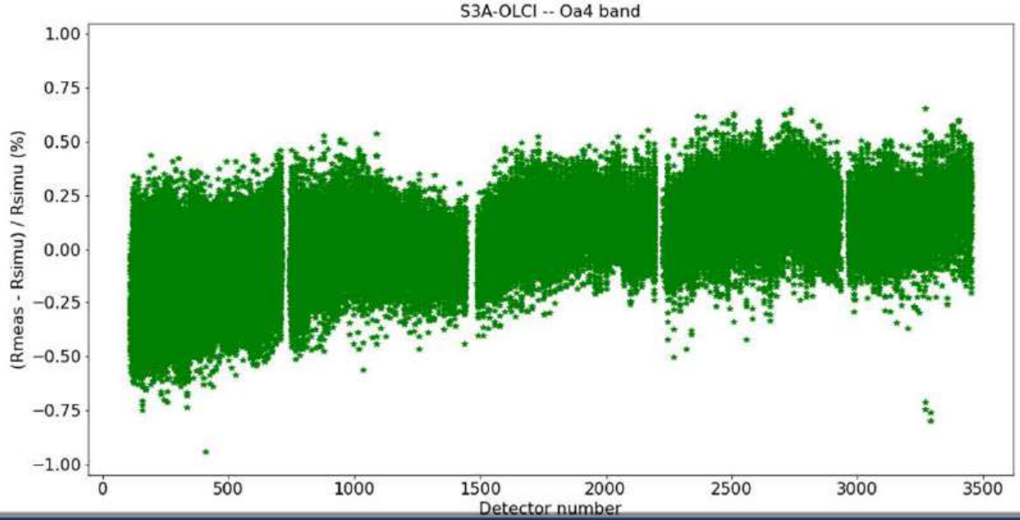
- Temporal drift confirmed with S2 as reference sensor

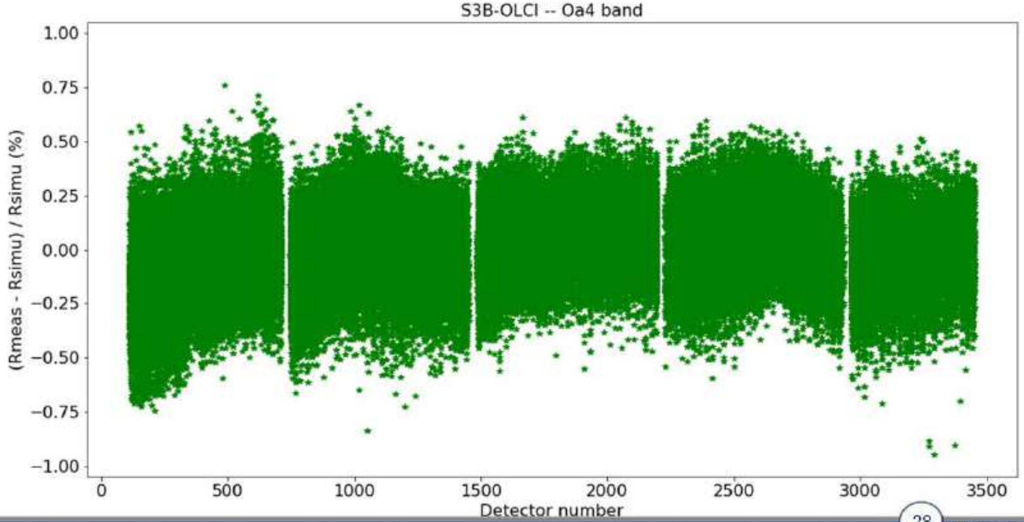


Variation within field-of-view: OLCI

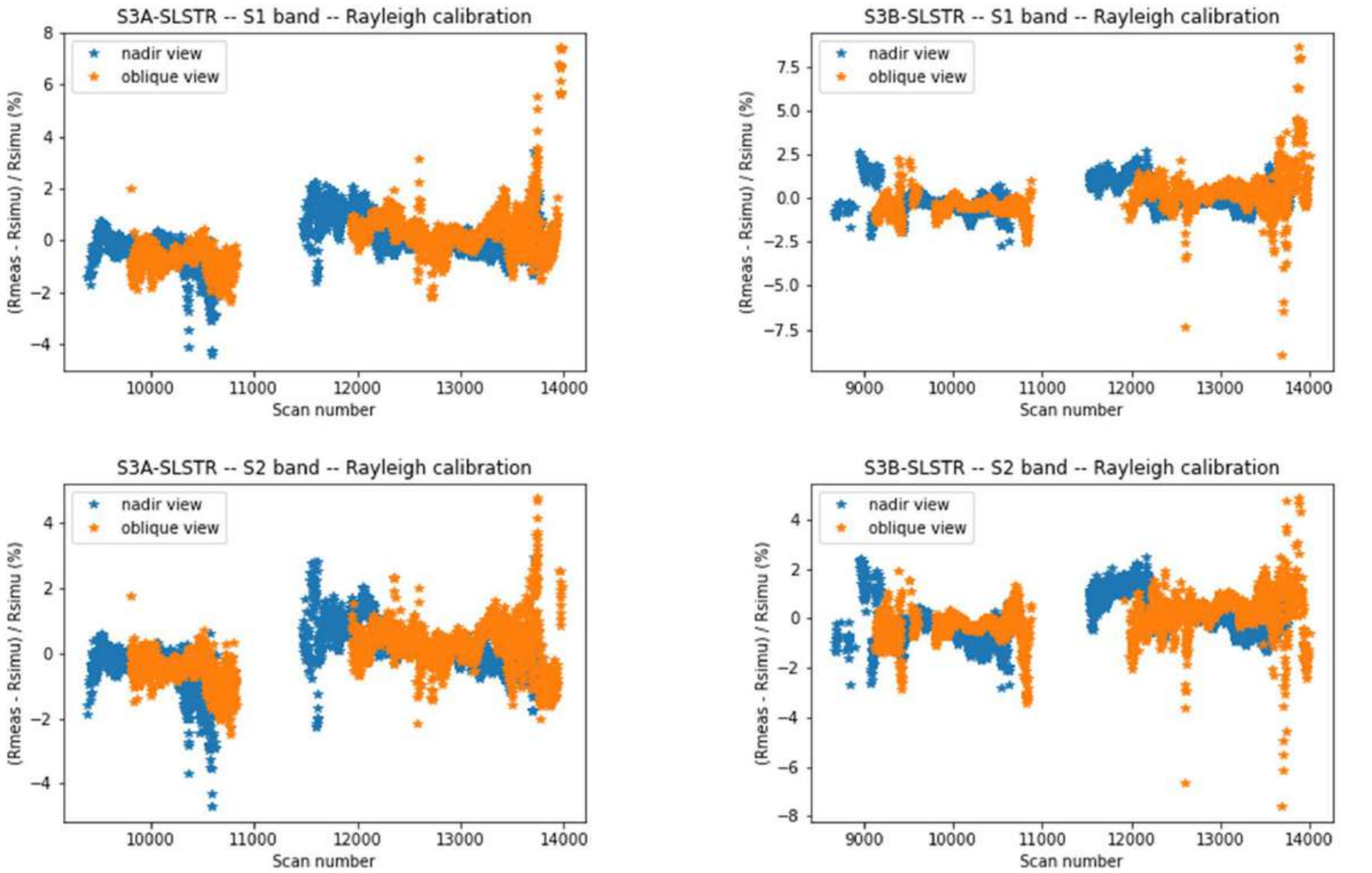






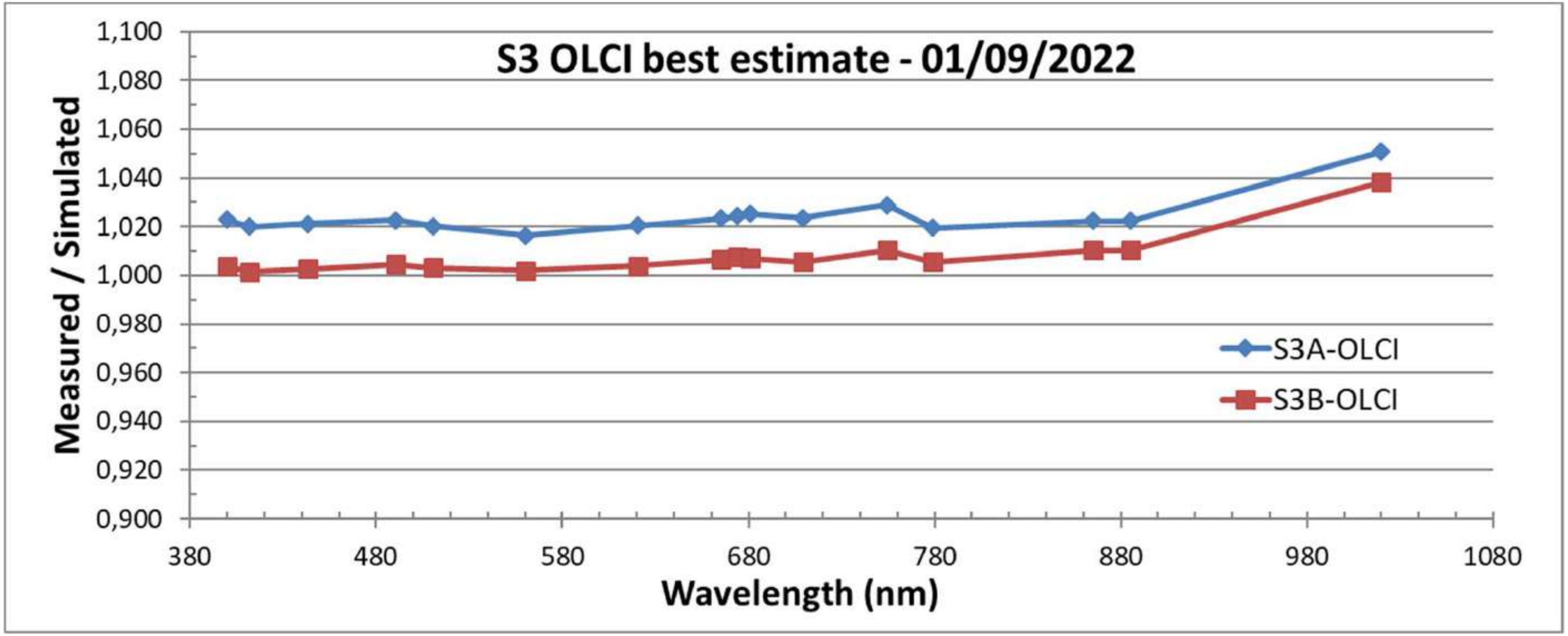


Variation within scan number: SLSTR



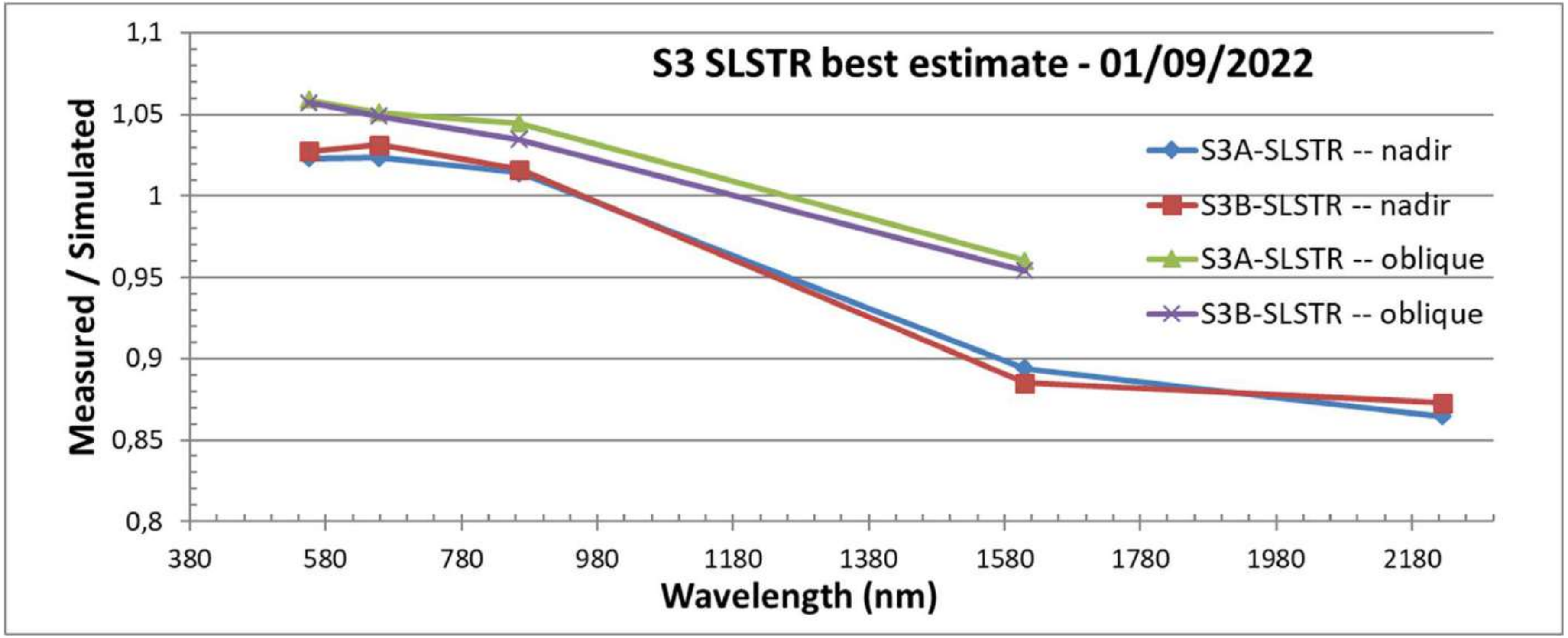
S3A&B OLCI best estimate of the radiometric calibration

- This best estimate is based on values for which various calibration methods are consistent or for which one calibration method is considered as more accurate than others



S3A&B SLSTR best estimate of the radiometric calibration

- This best estimate is based on values for which various calibration methods are consistent or for which one calibration method is considered as more accurate than others



No consolidated estimate available for S6 oblique view

Conclusion

OLCI :

- OLCI spectral consistency : < 0.5 % (except for 1020)
- A radiometric bias of about + 2 % is observed on the S3A OLCI absolute calibration (except for 1020)
  A radiometric bias of about + 0.5-1 % is observed on the S3B OLCI absolute calibration (except for 1020)
- The 1020 band on S3A seems to have a absolute bias of +5.5 % and a inter-band bias of +3 %
  The 1020 band on S3B seems to have a absolute bias of +4 % and a inter-band bias of +3.5 %
- No significant variation with time

SLSTR :

- A radiometric biais of about +2-3% for VISNIR, and -10-15 % biais on SWIR bands is observed on the S3A&B SLSTR absolute calibration for nadir view.
- SLSTR : Differences between oblique and nadir views are observed:
  2-4% for VISNIR bands and 7-8 % for S5
- Temporal drift observed