OLCI Calibration Status: Performances and recent progress

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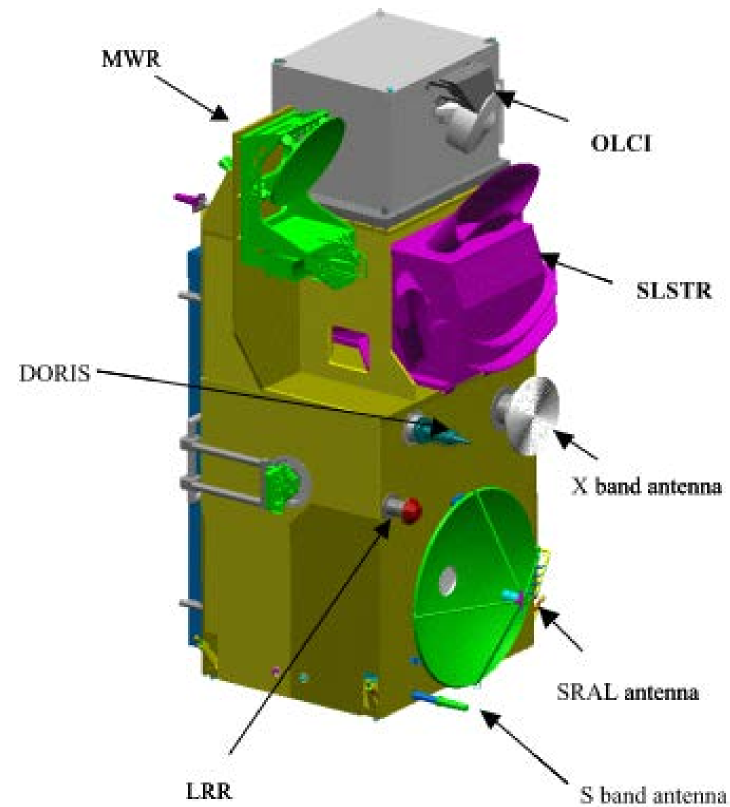
& the S3-MPC L1 ESL team



esa EUMETSAT

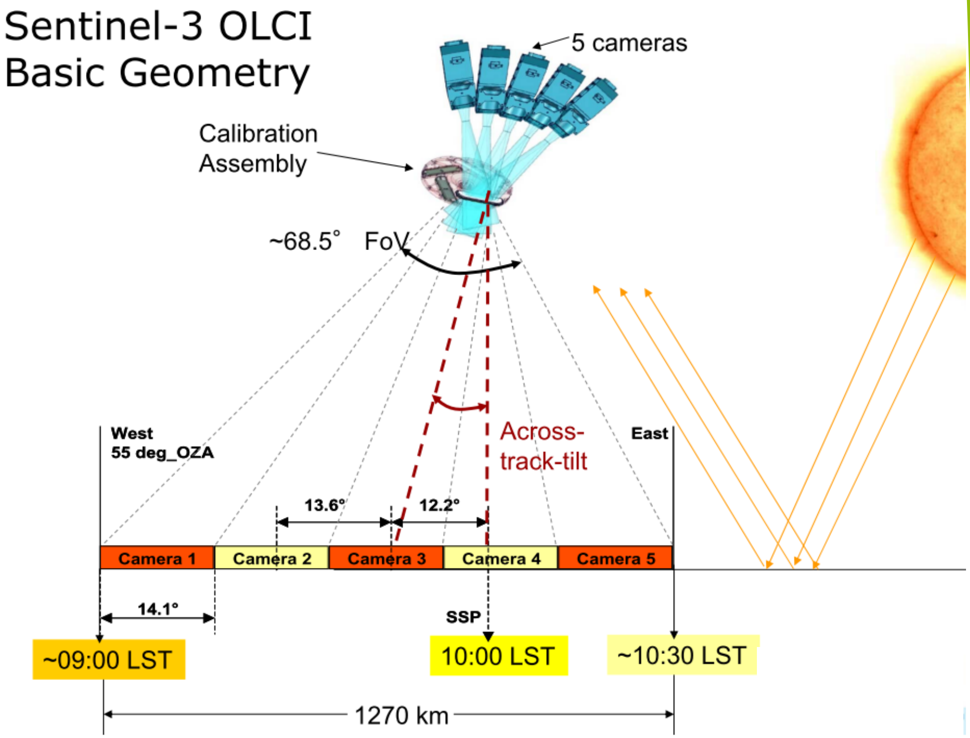
Overview

- **Performance status**
  - Geometric
  - Spectral
  - Radiometric
    - SNR
    - Dynamic range
    - Stability
- **Recent Progress**
  - Diffuser BRDF model revision
  - Instrument long-term drift

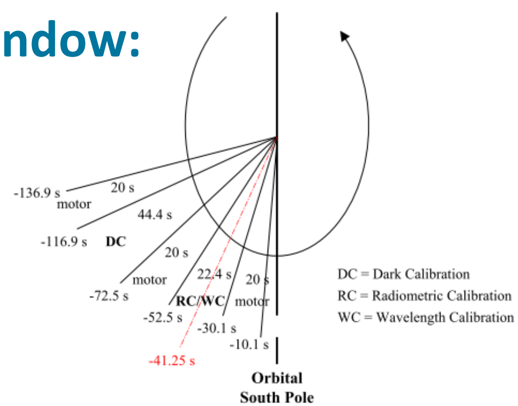
OLCI, successor to MERIS

- Push-broom imaging spectrometer, 5 fan-arranged cameras
- Radiometric calibration based on on-board diffuser(s)
- Spectral calibration using dedicated on-board diffuser

+ 12 degrees westward tilt to minimize Sun glint and increase swath to 1250km
+ number of bands increased to 21
+ technological improvements…



Radiometric calibration outside EO observation window:

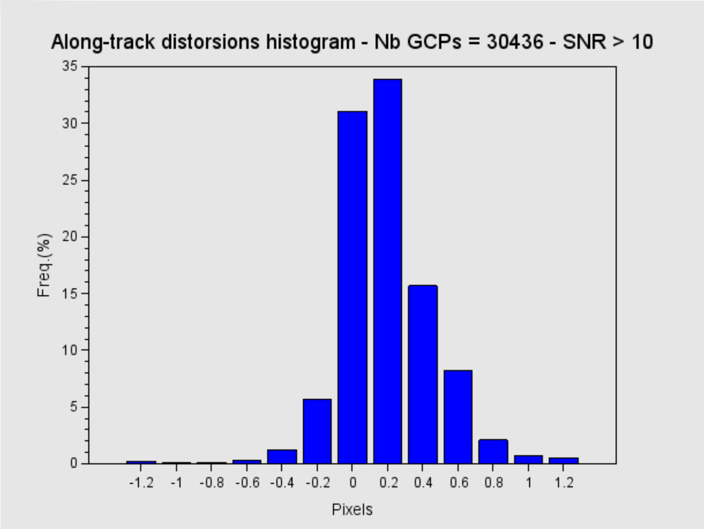


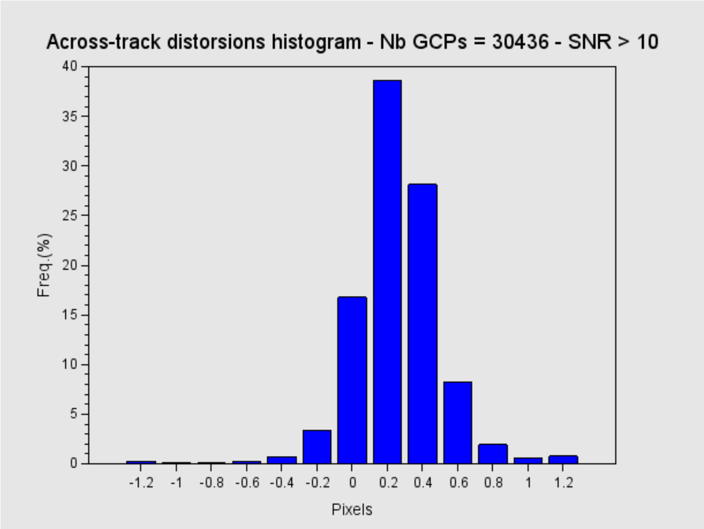
Geometric Calibration Overview

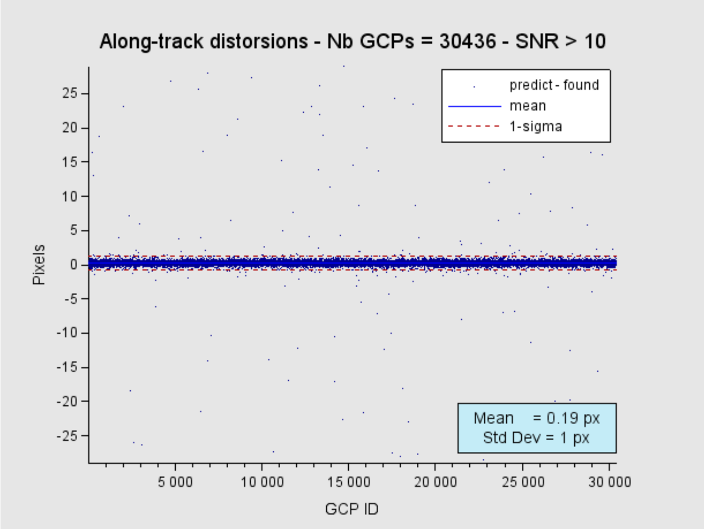
- **Geometric in-flight calibration of the instrument took place during Commissioning Phase**
  - Dedicated GeoCal tool: correlation with GCPs imagettes
  - Update of the pointing vectors (per pixel) and Geometric Models i.e. platform to instrument alignment, including thermo-elastic effect at short (along-orbit) and long (seasonal) terms (per camera)
  - Performance is met (<0.5 pixel RMS) after calibration

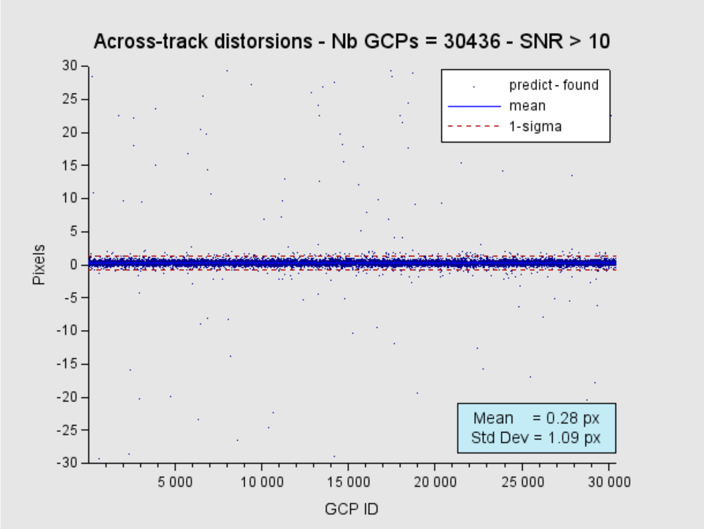
- **Same tool allows validation against GCPs, and regular monitoring.**
  - Performance is met since then without any detectable trend: 0.19 AC, 0.28 AL.

Geometric Calibration: results for April 2017







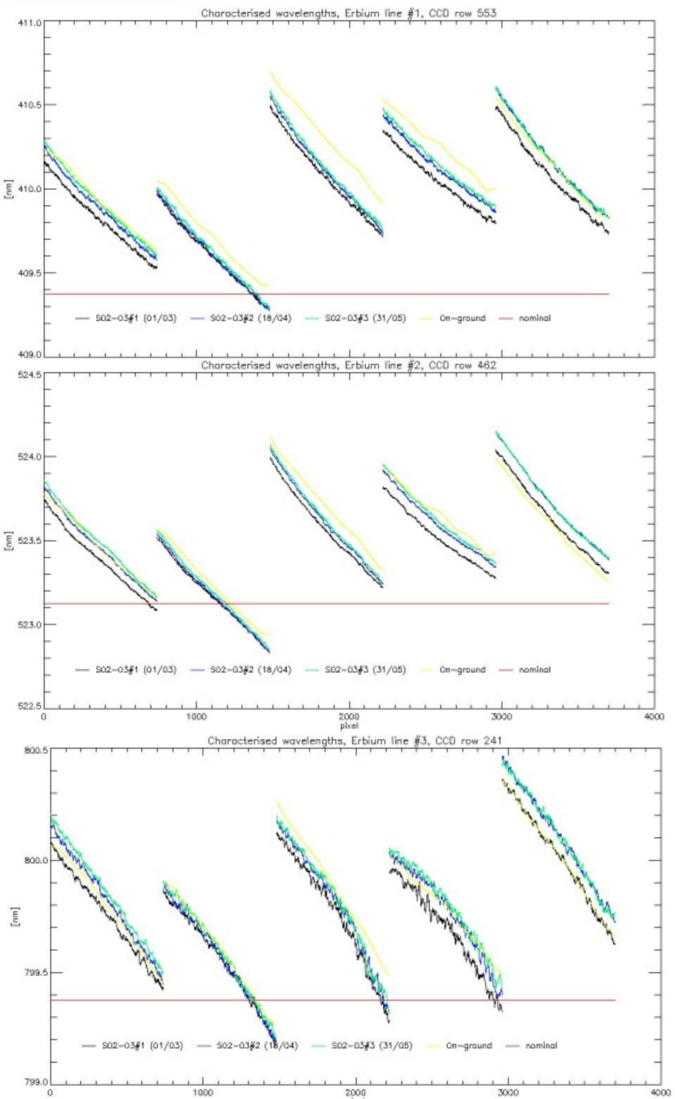


Spectral Calibration Overview

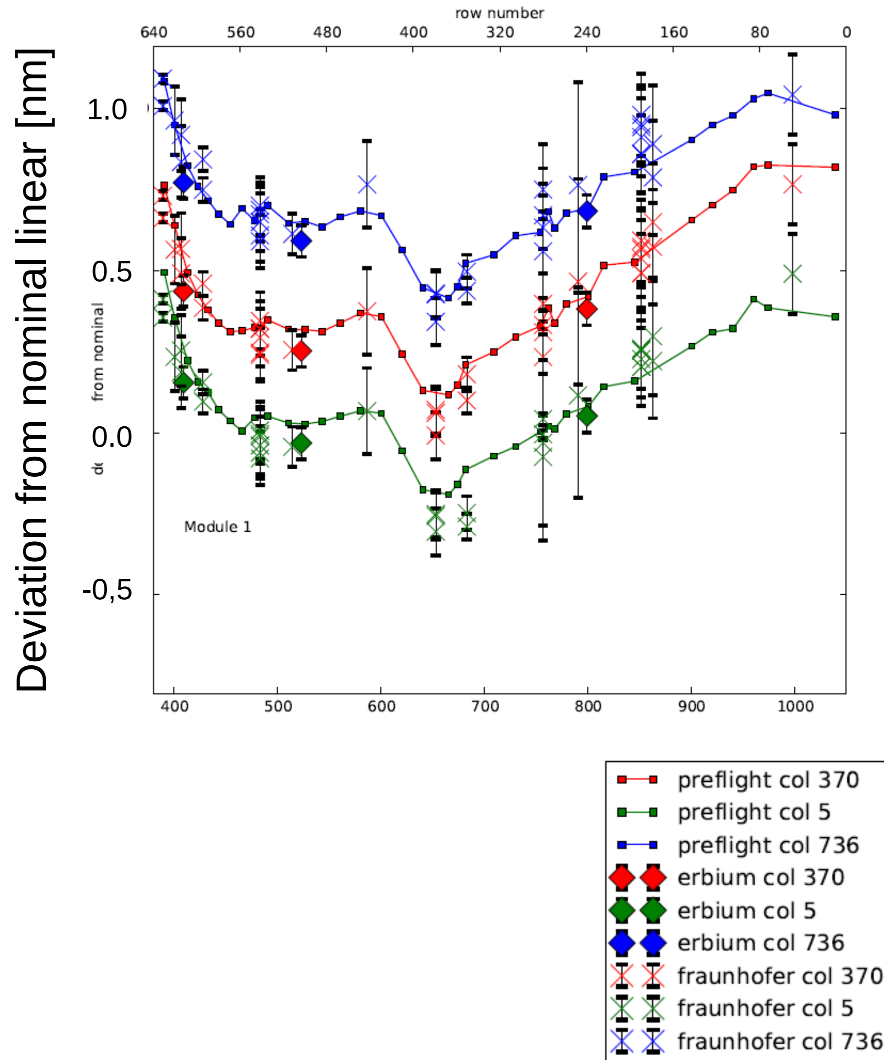
- **In-flight spectral calibration thanks to programmable channels: 45 µchannels in CAL mode, 1.9 nm resolution (step 1.25nm)**
  - Dedicated doped-diffuser with absorption lines around 408, 520 & 800 nm
  - Fraunhofer lines on diffuser and Earth
  - O2-A and O2-B lines on Earth
- **Results show:**
  - Very good pre-flight characterization (<0.25 nm from in-flight)
  - Very good stability with time
  - Confirms pre-flight cross-track variation within each camera (<0.8nm)
- **The spectral model has been updated using in-flight data**
  - No long-term trend included (not significant)
  - Median values used

Spectral Calibration
Absolute results

Doped diffuser results

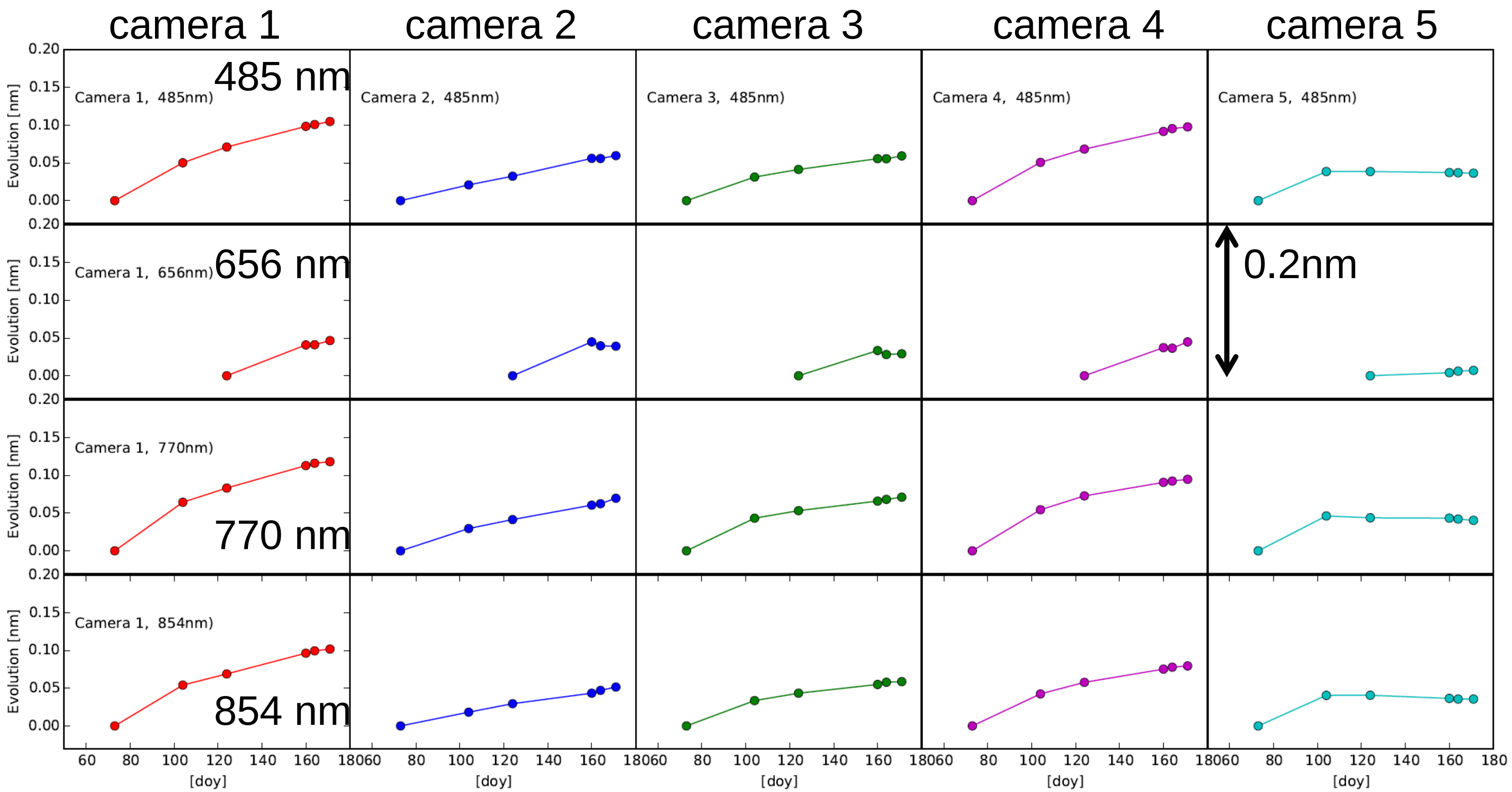


Comparison with pre-flight



Spectral Calibration
Time stability

- < 0.15 nm over 3 months, decreasing drift rate
- No measurable spectral dependence

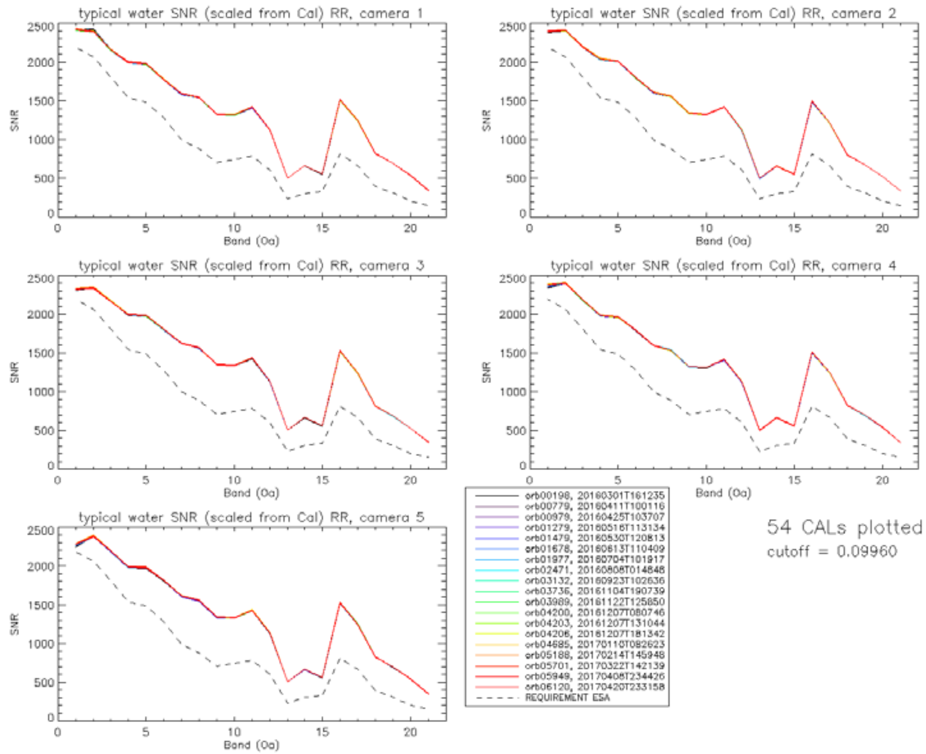


Radiometric Calibration Overview

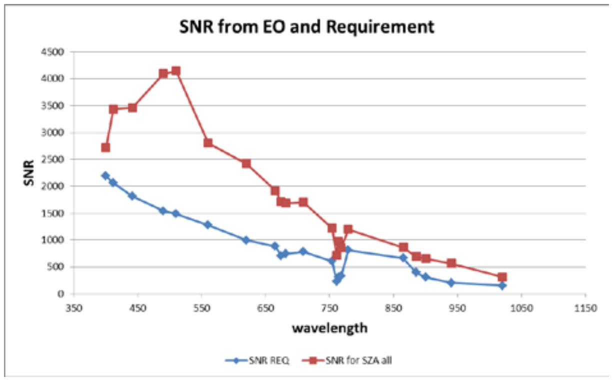
- **In-flight calibration thanks to nominal & reference diffusers**
  - Nominal used about every 2 weeks → absolute radiometric gains, evolution
  - Reference used about every 3 months → ageing of nominal diffuser
  - Diffuser as secondary standard via ground characterization → transfer to orbit relies on ability to compute diffuser BRDF at flight conditions, **need a model**
  - Ground BRDF model has residual Sun geometry dependency, need to be accounted for
- **In-flight results:**
  - Confirms ground BRDF model residual dependency with Sun geometry (~±0.5%) → need upgraded model (see next presentations)
  - Very good repeatability under same geometry (<0.1%),
  - significant sensitivity evolution (up to 3% over 14 months), wavelength & camera dependent, decreasing rate
  - Radiometric validation shows 2-3% excess of radiance

Radiometric: SNR

From calibration data, downscaled to ocean (one plot per camera)
Dashed line is RQT

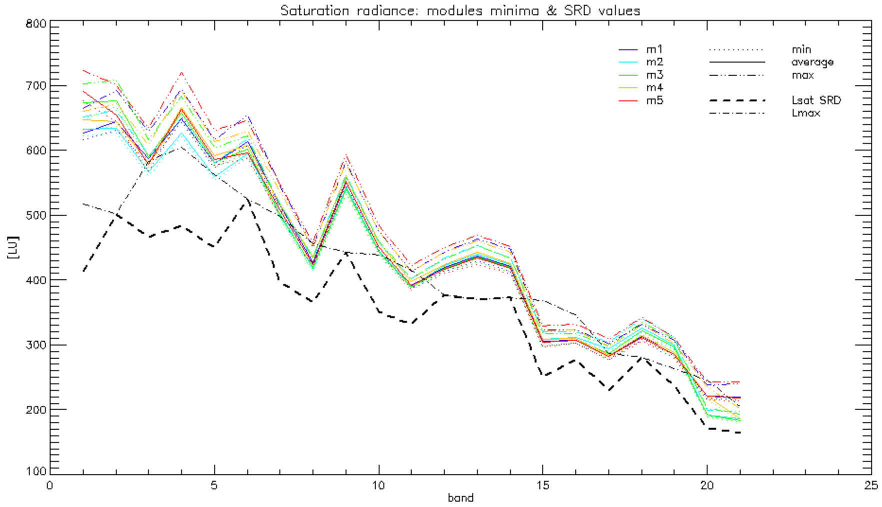


From EO data,
(Hu et al., 2012)
Blue line is RQT

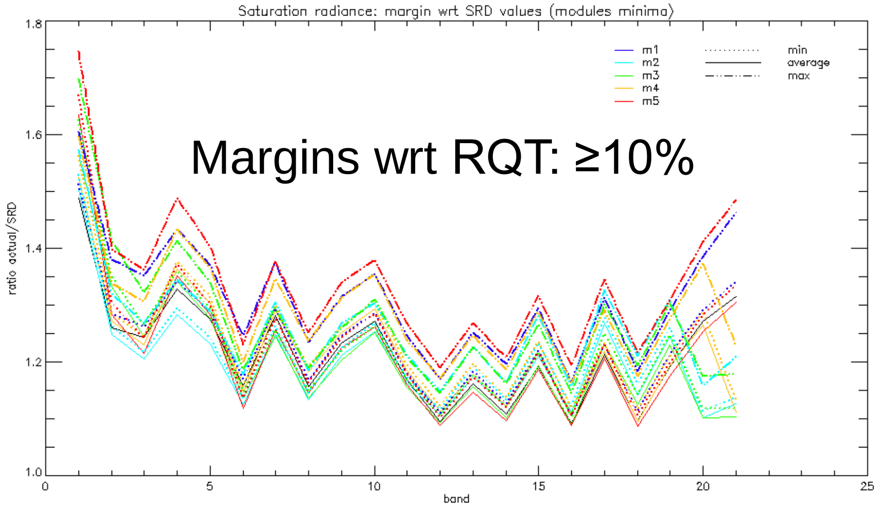


Both methods show compliance to RQT

Saturation radiance determined from Cal radiance & counts by extrapolating the calibration line



Measured and RQT
(Thick dashed line is RQT)

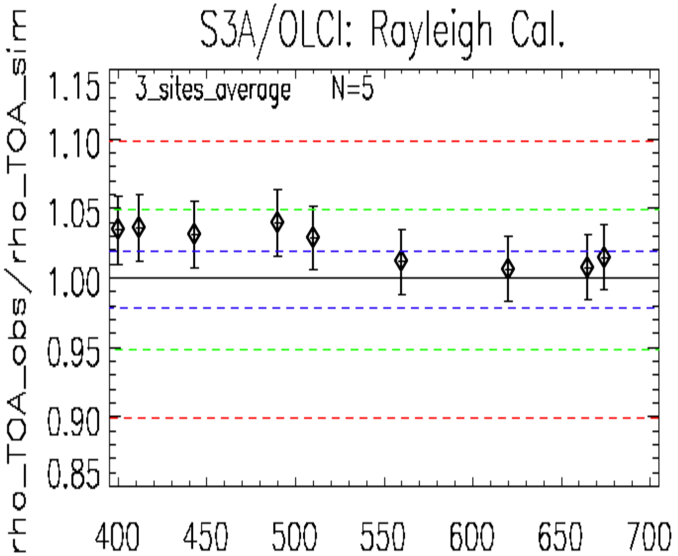


Measured over RQT

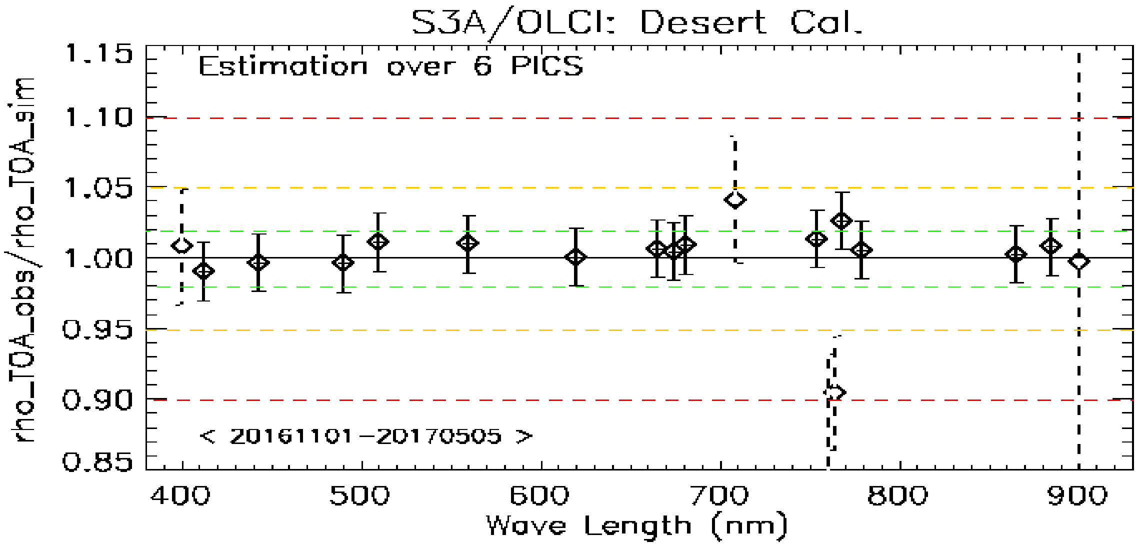
OLCI is compliant to RQT

Radiometric: absolute accuracy validation over 11/2016-04/2017

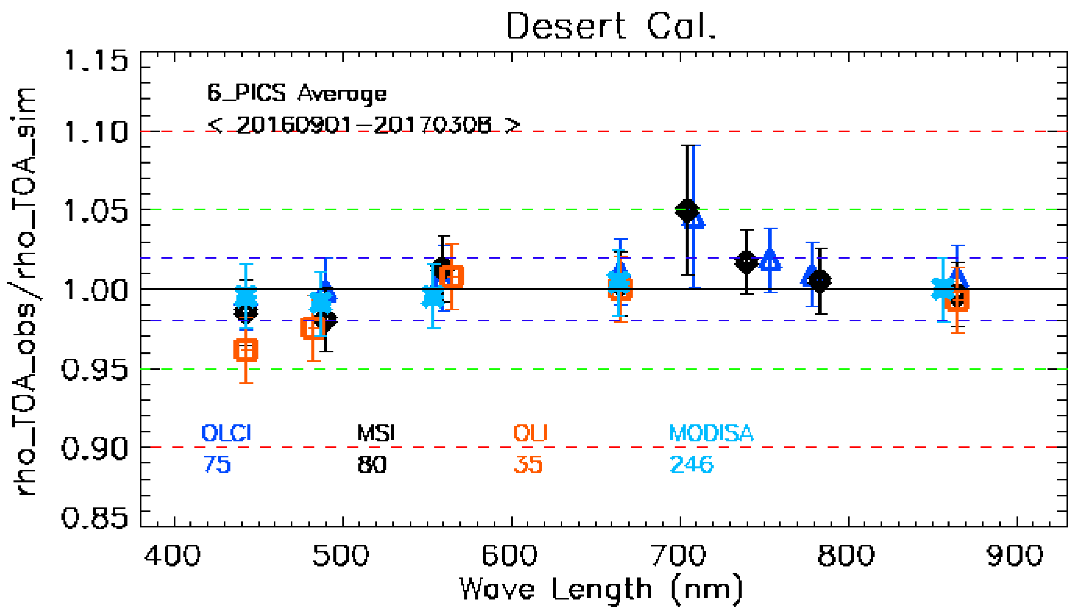
Rayleigh method
→ Not compliant



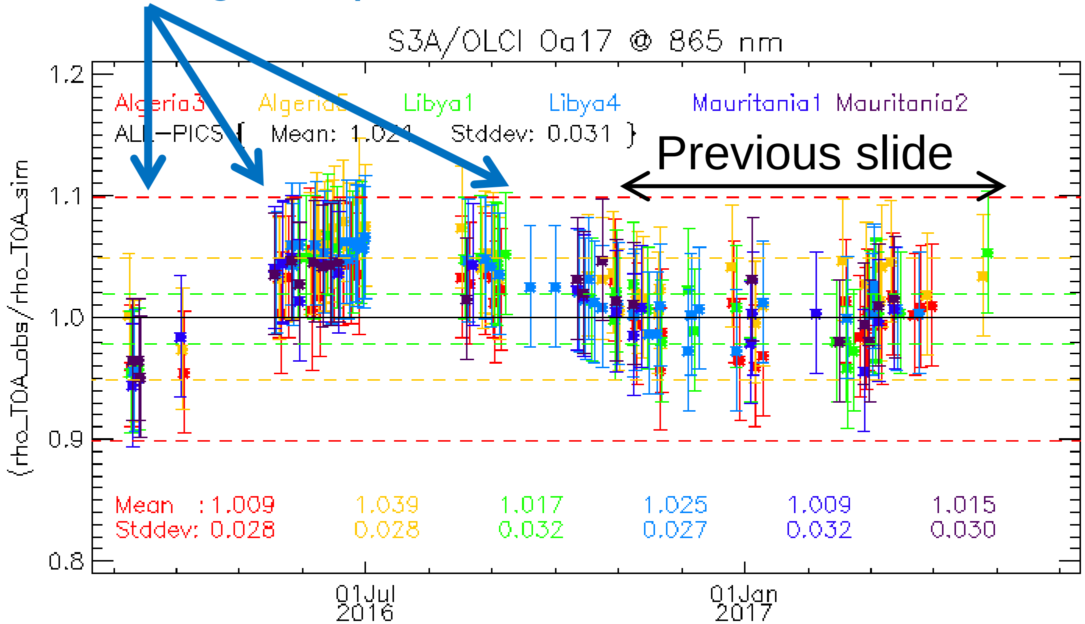
PICS method
→ Compliant



Radiometric validation



Several gain updates



Radiometric Validation needs consolidation:
Evolution + gain update or methodology issue ?

Radiometric stability

Assessment using radiometric calibration data:

- **Gain ratios time series**
- **Need to assess diffuser stability first**
- **Need to control / correct potential dependency with illumination geometry**

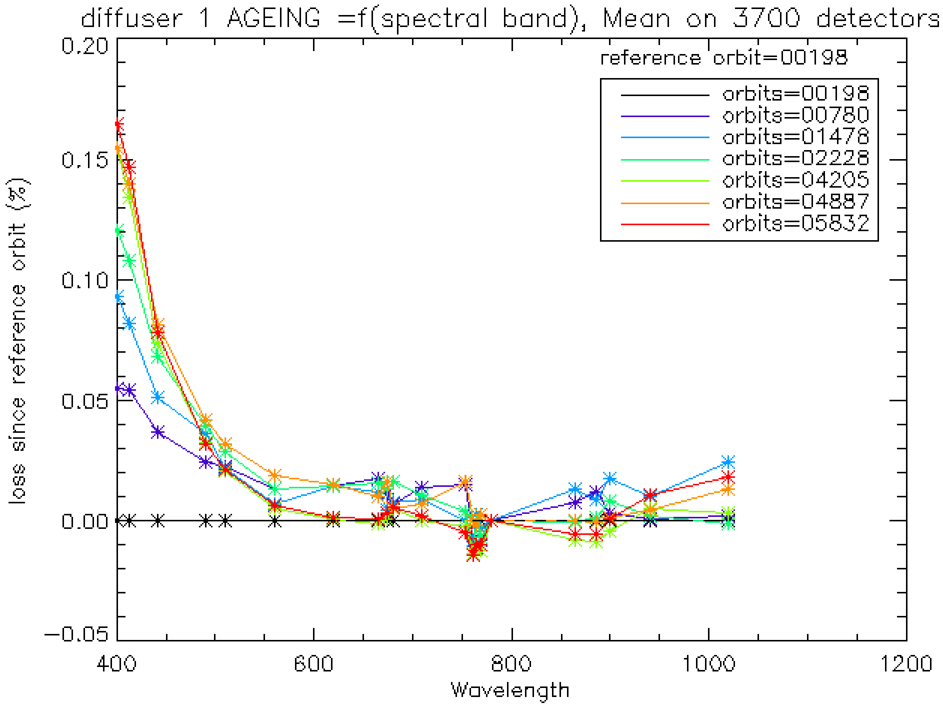
Radiometric stability
pre-requisite: quantify diffuser ageing

7 ageing sequences so far

(RC with nominal diffuser followed by reference on next orbit)

→ 6 ageing assessments

- **Expected spectral behaviour: strong decrease with λ**
- **Expected magnitude: ≤ 0.2% over a year**
- **Intrinsic variability ~0.03%**

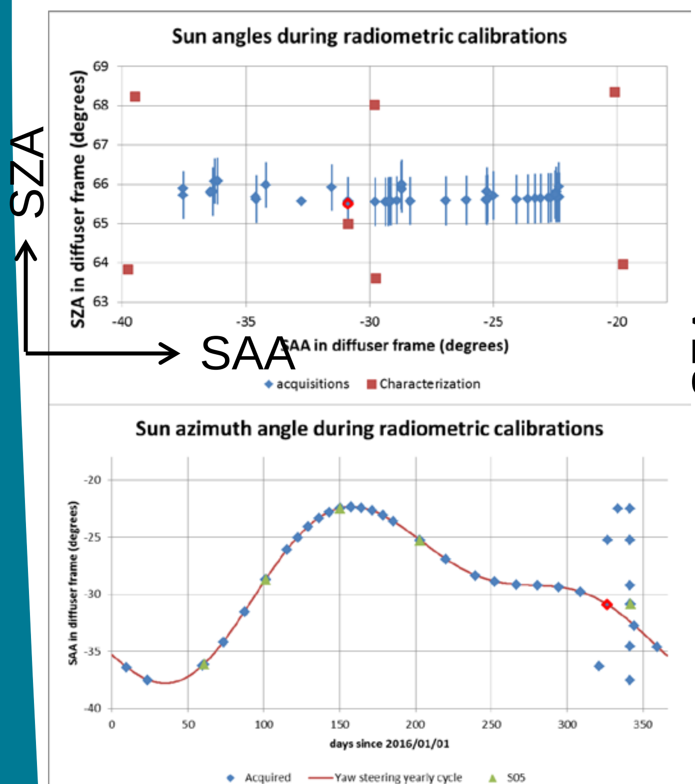


NOT corrected for in current evolution assessments (yet)

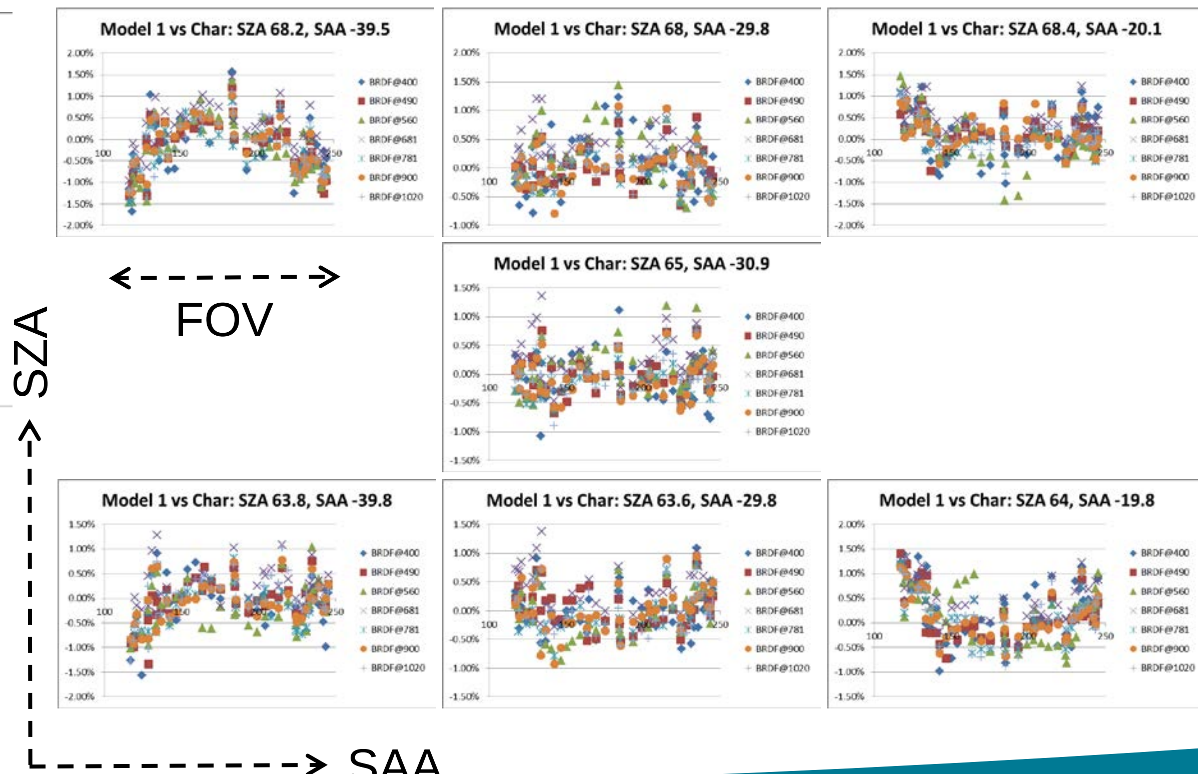
Radiometric stability dependency with illumination geometry

BDRF model (ground version) sensitive to Sun azimuth

Characterization and in-flight illumination conditions



Diffuser BRDF modelling residuals



Radiometric stability dependency with illumination geometry

Confirmed by in-flight data

400 nm:

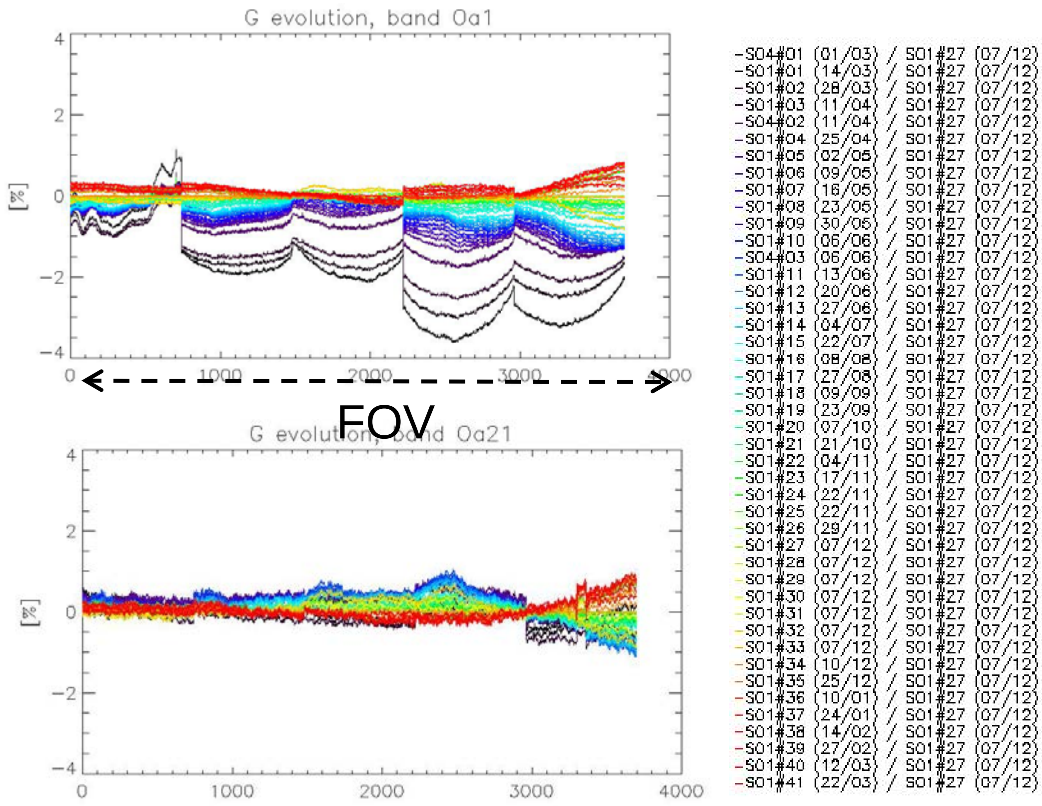
Large temporal evolutic (expected)

Unexpected spatial structures

1020 nm:

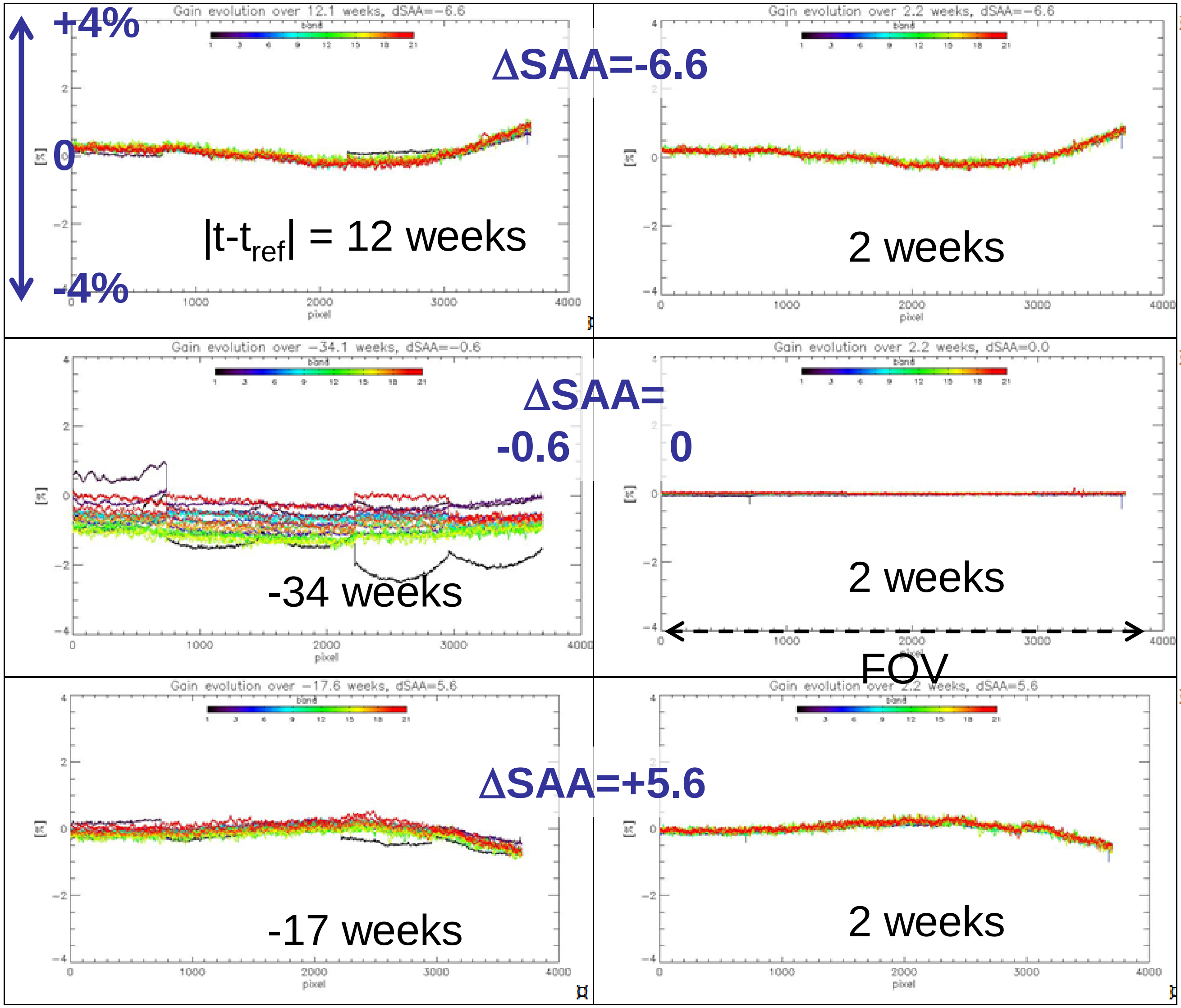
Small temporal evolutio (expected)

Unexpected spatial structures more visible



Gain ratios G(t,b)/G(tref,b) for band Oa1 (top) and Oa21 (bottom), all calibrations so far (~13 months of data), ref. 07/12/2016

Radiometric stability dependency with illumination geometry



100% correlated with SAA

$G(t,b)/G(t_{ref},b)$

Two types of variability:

- **One is roughly "white", correlated with Sun azimuth: likely BRDF model residual error**
- **The second is band and camera dependent: instrument evolution**

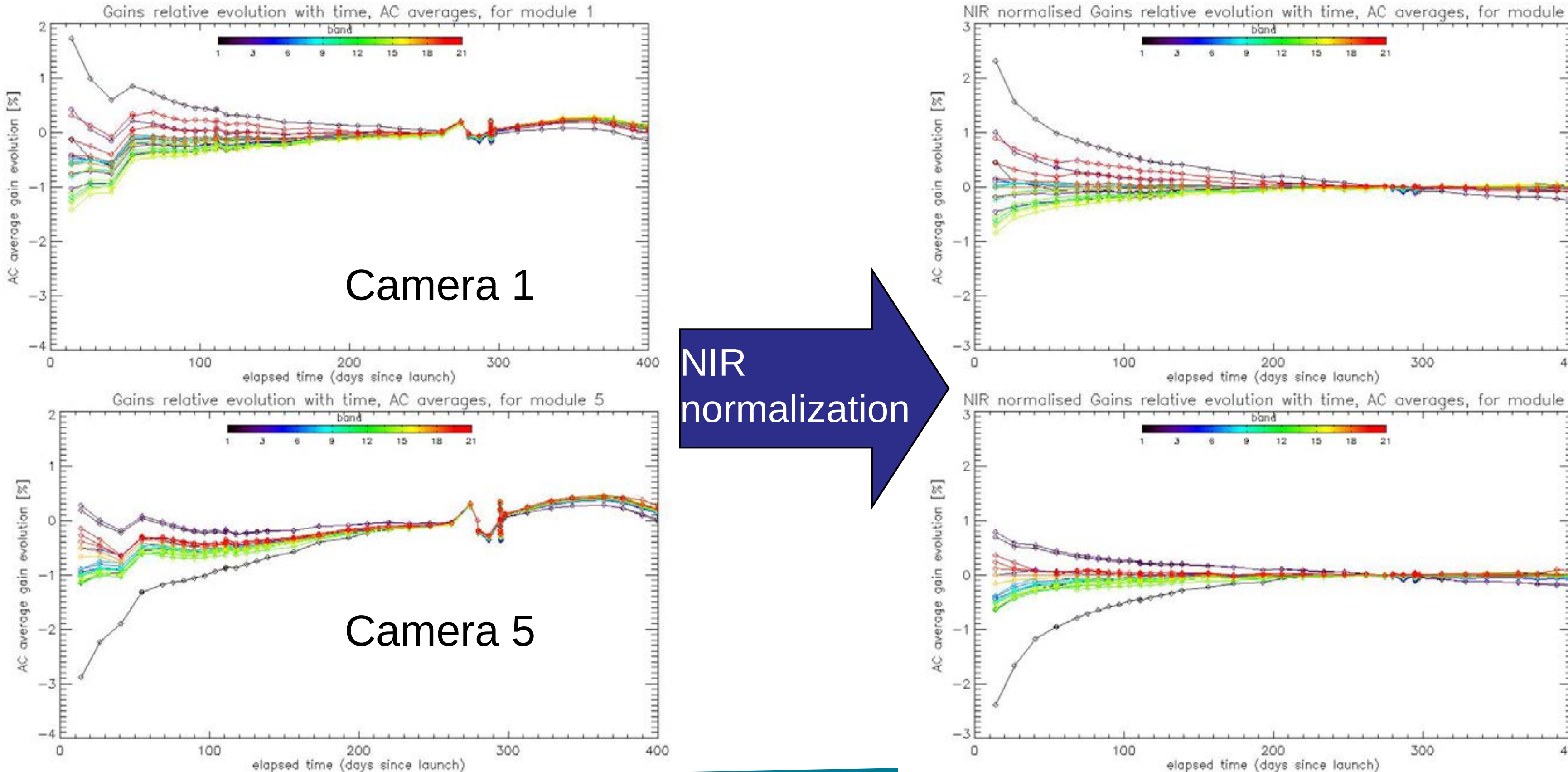
Radiometric stability

Cure SAA dependency : 1) NIR-normalization

As SAA dependency is mostly white, and NIR more stable

- **Use modified definition of evolution:**

$$G(t,b)/G(t_{ref},b) \rightarrow \left(G(t,b)/G(t,b_{ref}) \right) / \left(G(t_{ref},b)/G(t_{ref},b_{ref}) \right)$$



Radiometric stability

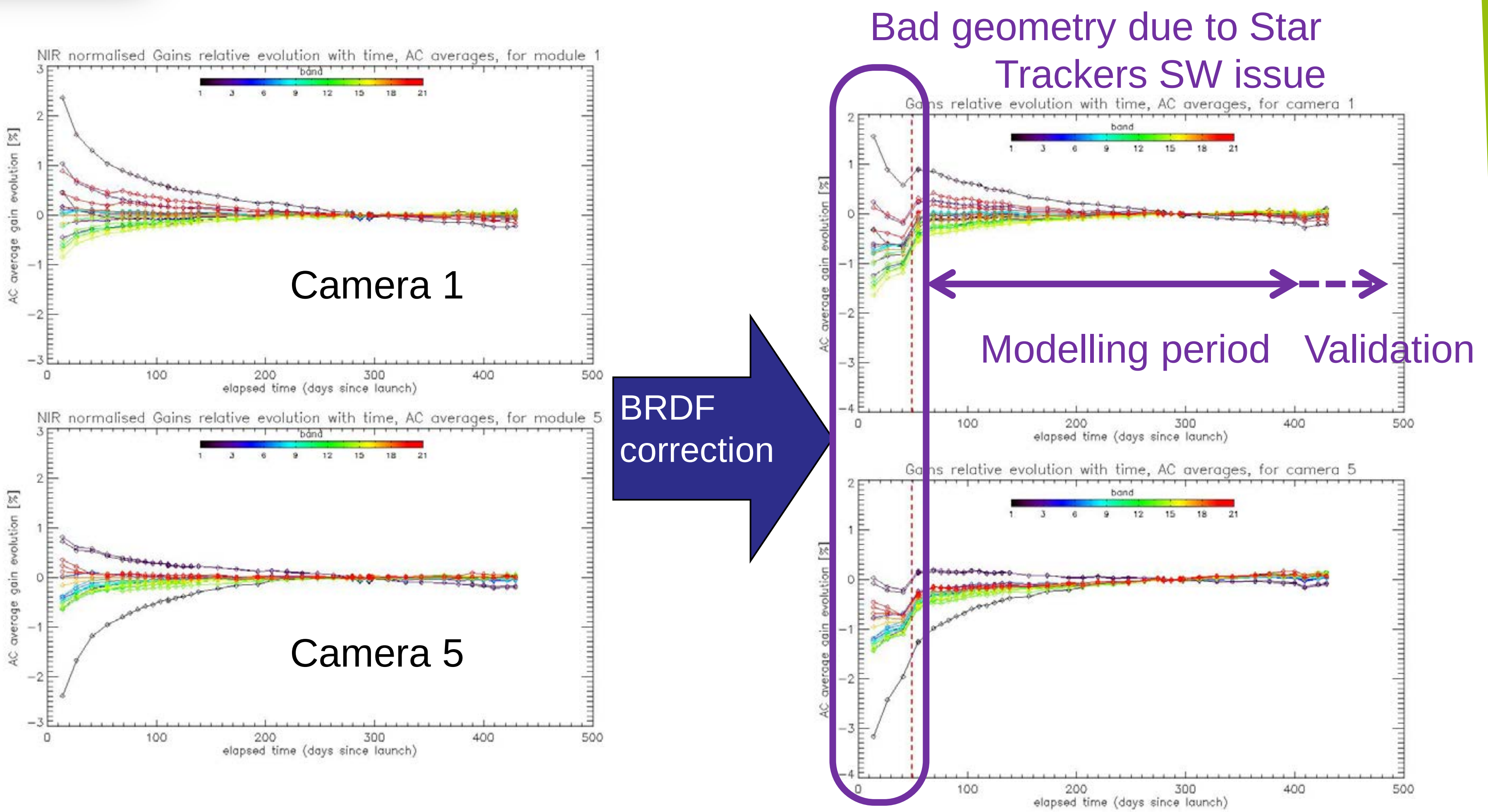
Cure SAA dependency : 2) in-flight BRDF model

Here should take place a long story on:

- **Yaw Manoeuvres (set of RC at controlled SAA over a single day)**
- **In-flight BRDF model:**
  - **Absolute relies on ground characterization,**
  - **Complementary relative measures from in-flight**
  - **Correctly fits in-flight geometrical behaviour**

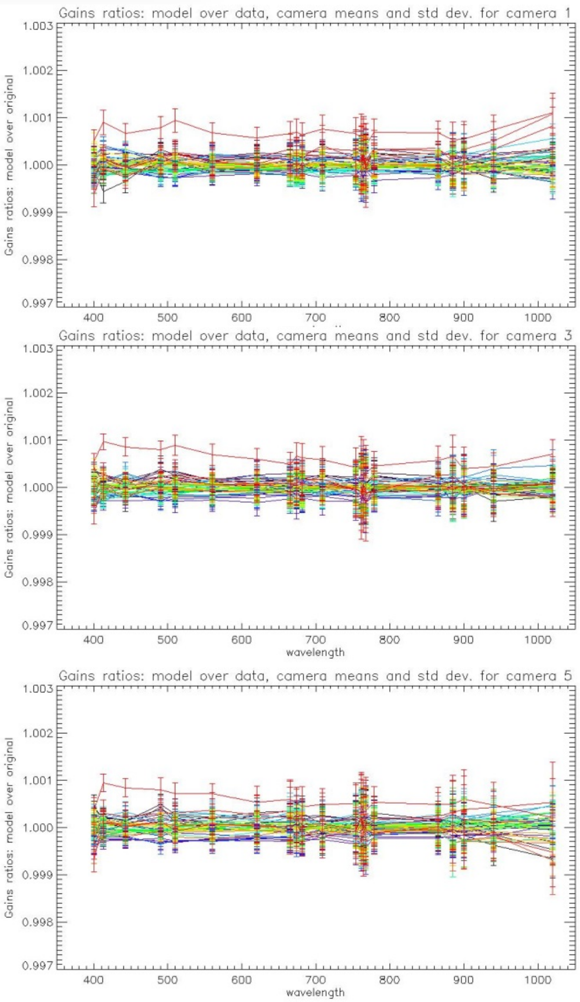
But they are covered by the next two presentations, please wait.

Radiometric stability
Cure: 2) in-flight BRDF model



→ First 2 months of mission not usable for absolute calibration
NIR normalization can however provide reliable evolution over this period

Radiometric evolution model: Model performance

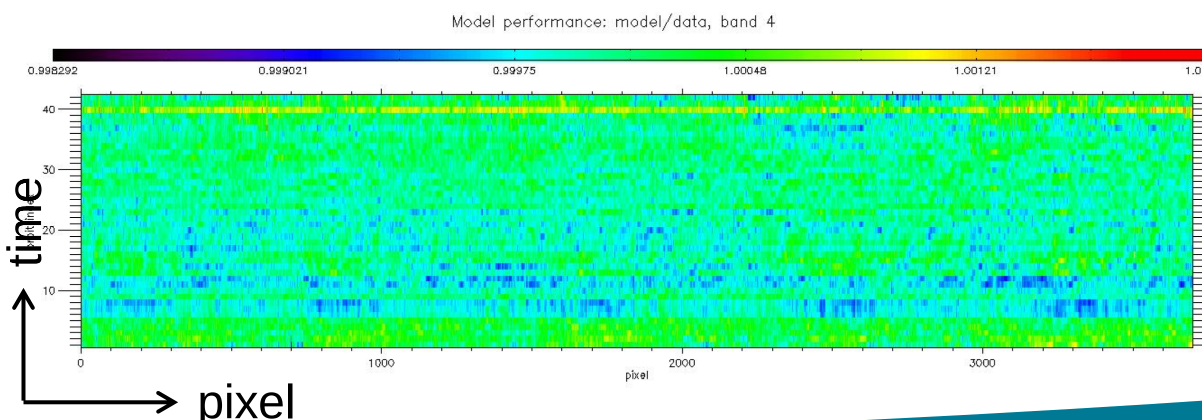


Within 0.2%

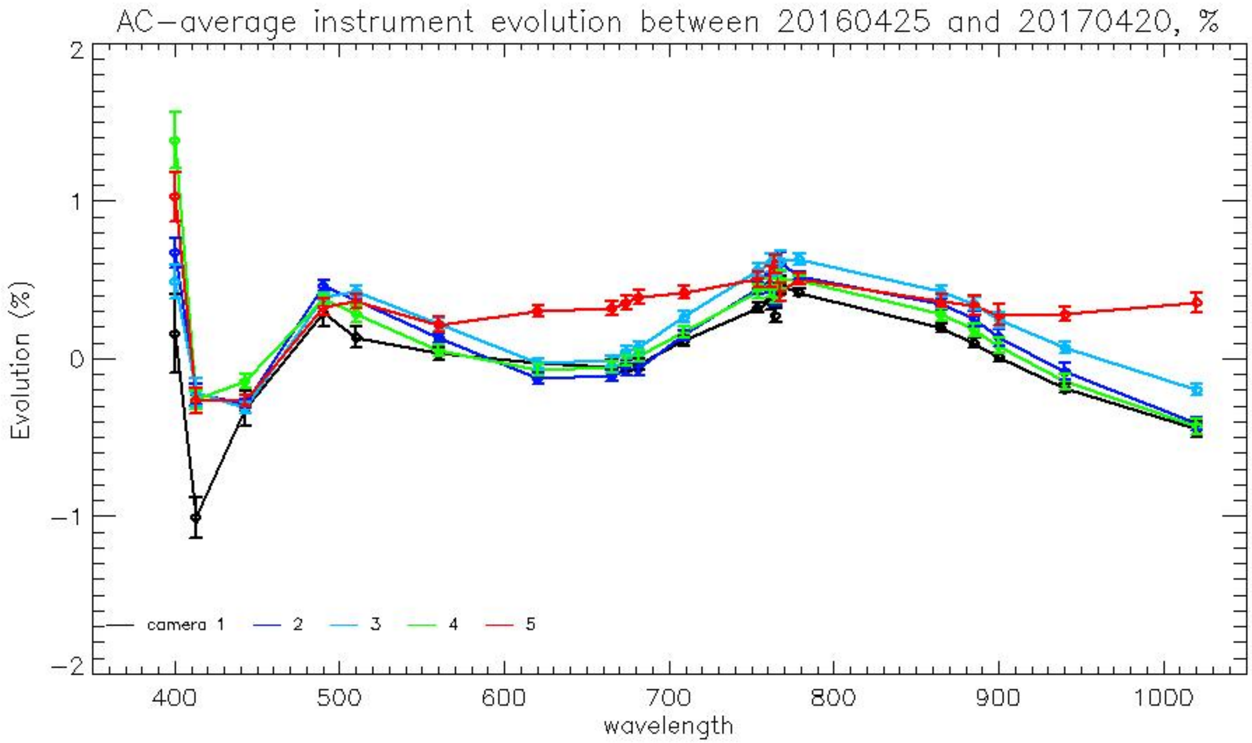
← Data/model, including validation calibrations (averages and RMS), all bands, for each camera

Data/model for band 4 vs. pixel and time: the outlier is not the most recent

↓



Radiometric evolution
1 year overall drift



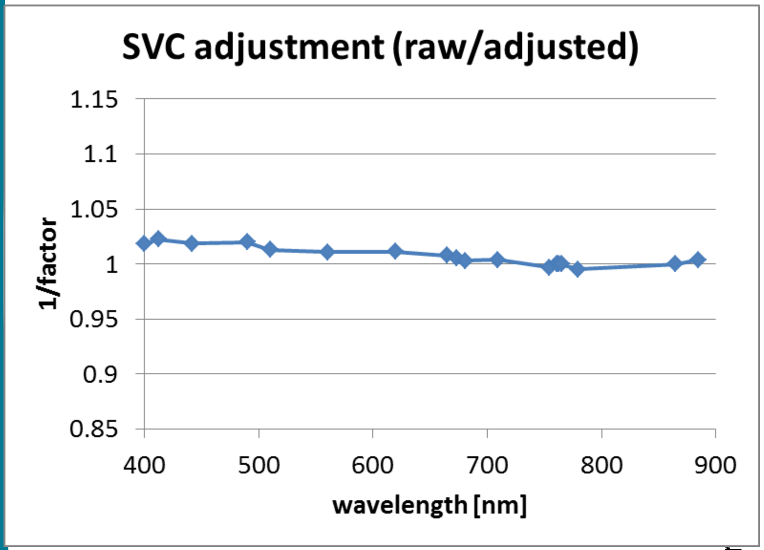
Camera-averaged instrument evolution versus wavelength
between 26/04/2016 to 20/04/2017
(channel programming change to a recent calibration)

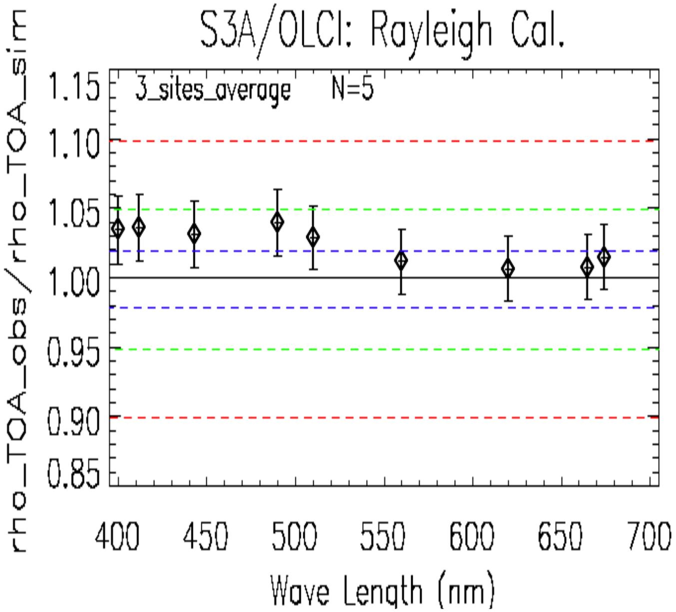
→ Spectral shape similar to that of the spectrometers correcting filter…

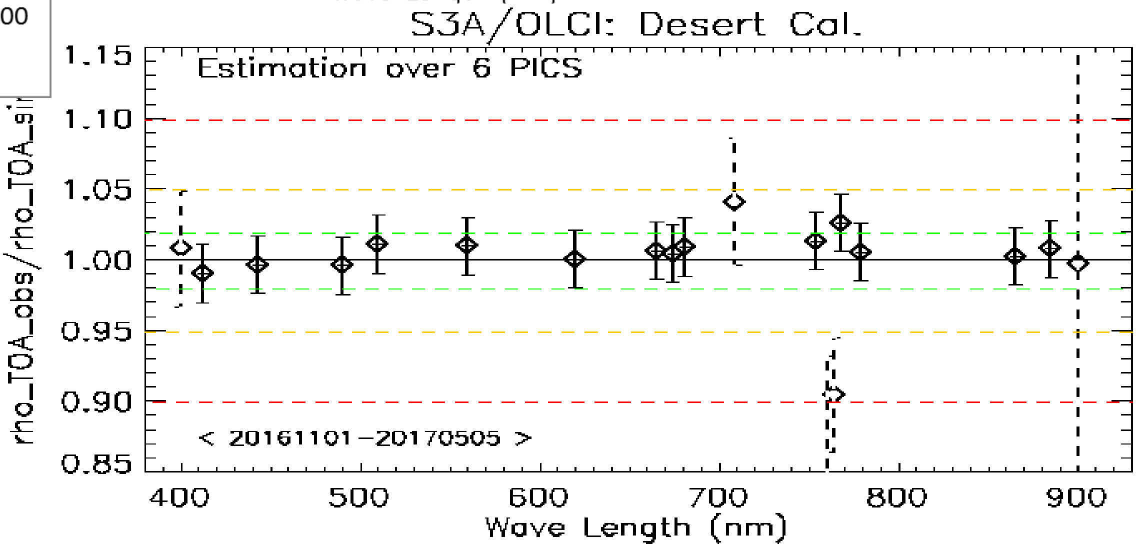
Recent progress

- Thanks to in-flight BRDF model, long-term drift has been modelled, to be applied to EO calibration
- The model is under test in a partial reprocessing aiming at Marine System Vicarious Calibration
- SVC ended-up with adjustment factors, assuming 865 perfectly calibrated, all within 2% except 1020 nm (9% ☹).
- No trending detected in SVC gains (but significant variability)
- If validated at L2 OC, drift correction will be put in production

Recent progress: SVC







Conclusion

- OLCI has excellent geometric and spectral performances
- Radiometric evolution is limited (±2%), and rate decreases
- SNR and dynamic range are well within specifications
- Radiometric validation shows excess of brightness up to 3%, improving with wavelength. Not confirmed by all methods. Need to be reiterated on homogeneous dataset
- Radiometric evolution has been modelled and used for a partial reprocessing focused on Marine System Vicarious Calibration. Computed SVC gains has show features similar to Rayleigh RadVal