International
Ocean Colour Science
Meeting 2025

Advancing Global Ocean Colour Observations

Darmstadt, Germany

1-4 December 2025

Operational OC lessons learnt - OLCI calibration

International Ocean Colour Science Meeting 2025

Agenda

- Instrument overview
- Geometric Calibration
- Spectral Calibration
- Radiometric Calibration

OPT-MPC
Optical Mission Performance Cluster
Copernicus Sentinel
ACRI ST
Funded by the EU and ESA
European Union
esa
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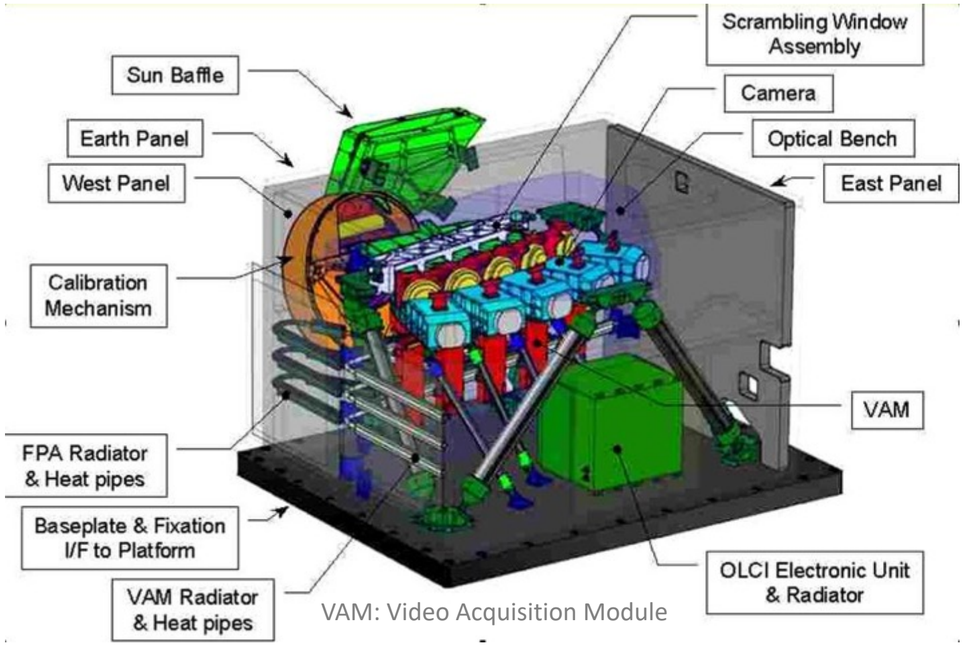
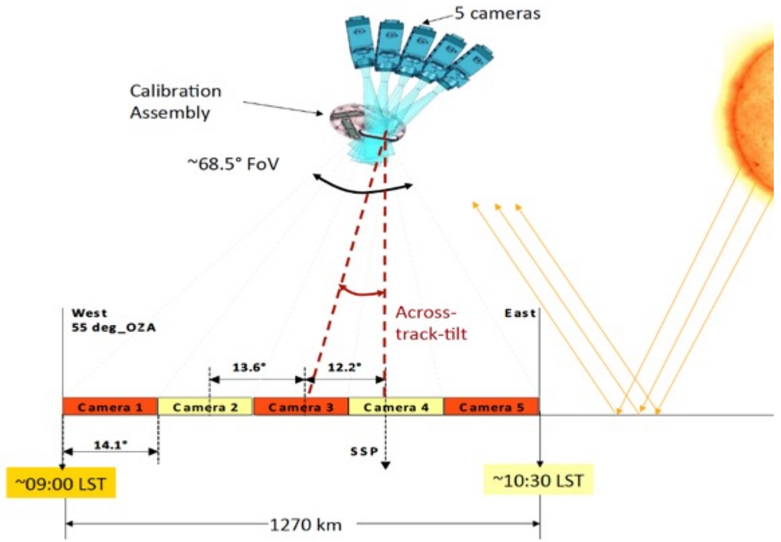
OLCI instrument

Push-broom imaging spectrometer with five camera modules sharing the field of view

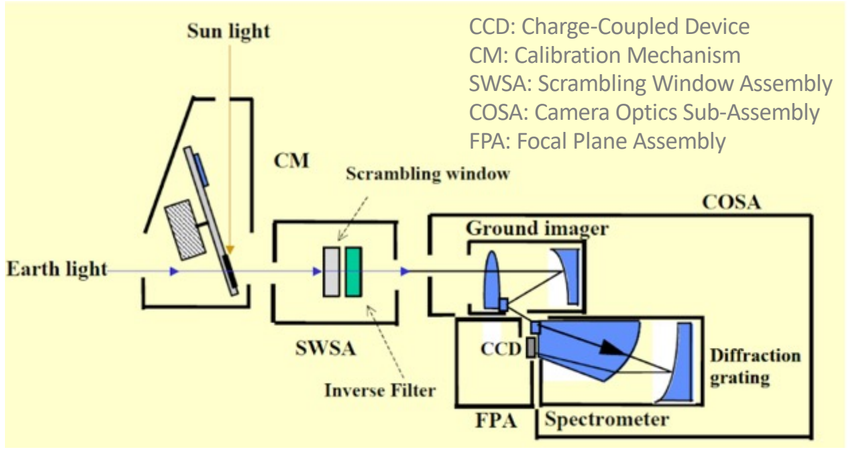


VAM: Video Acquisition Module



Full Resolution: 300 m globally,
Reduced Resolution: 1.2 km globally

OLCI spectral bands		λ center	width
1	aerosol, in-water properties	400	15
2	yellow substance, detritus	412.5	10
3	chlorophyll absorption max	442.5	10
4	chlorophyll and other pigments	490	10
5	suspended sediments, red tide	510	10
6	chlorophyll absorption min	560	10
7	suspended sediments	620	10
8	chlorophyll absorption, fluorescence	665	10
9	fluorescence	673.75	7.5
10	chlorophyll fluorescence peak	681.25	7.5
11	chlorophyll fluoresc. ref., atm. corr.	708.75	10
12	vegetation, clouds	753.75	7.5
13	O_2 R-branch absorption	761.25	2.5
14	atmospheric parameters	764.375	3.75
15	cloud top pressure	767.5	2.5
16	O_2 P-branch absorption	778.75	15
17	atmospheric correction	865	20
18	vegetation, water vapour reference	885	10
19	water vapour, land	900	10
20	atmospheric correction	940	20
21	atmospheric correction	1020	40



CCD: Charge-Coupled Device
CM: Calibration Mechanism
SWSA: Scrambling Window Assembly
COSA: Camera Optics Sub-Assembly
FPA: Focal Plane Assembly

Calibration wheel with 5 positions:

- **Shutter**: dark offset (calibration zero)
- **Radiometric diffuser**: calibration gains
- **Reference radiometric diffuser**: ageing of nominal diffuser
- **Spectral diffuser**: spectral calibration at 3 wavelengths
- **Earth Observation aperture**

Geometric calibration: principle

OLCI georeferencing is deterministic, based on:

- NAV/ATT data from platform
- Camera to platform alignment quaternions (calibrated in-flight)
- Instrument pixels pointing vectors (camera frame, calibrated in-flight)

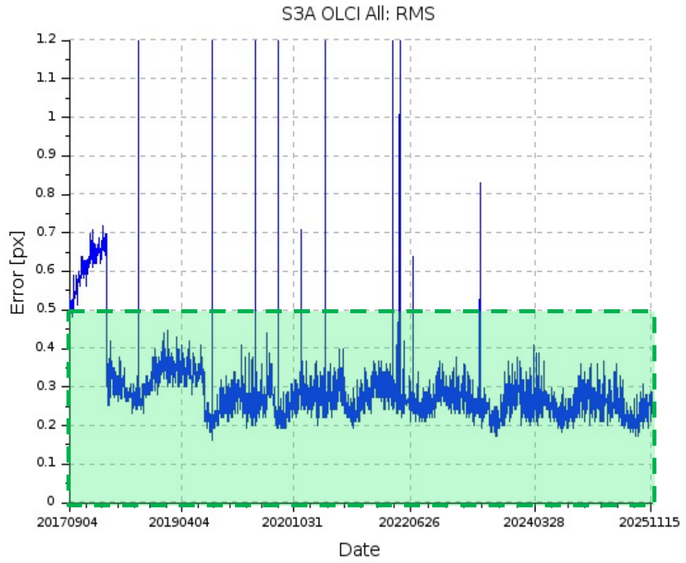
In-flight calibration is GCP based, from L1 data with feedback:

- Camera to platform alignment quaternions: along-orbit + seasonal dependencies
- Instrument pixels pointing vectors: static
- *ad-hoc* tool to measure performance and propose optimized parameters

GCP database currently based on Landsat

- No easy way to split between CAL and VAL
- May evolve to S2 GRI

Geometric calibration: performance

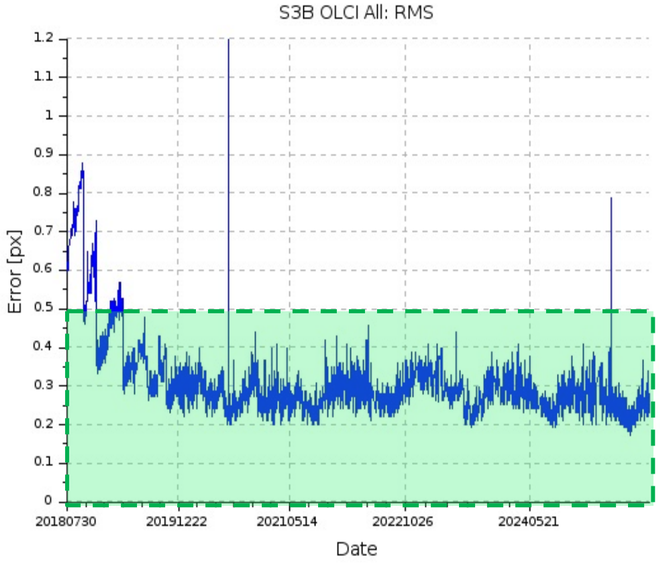


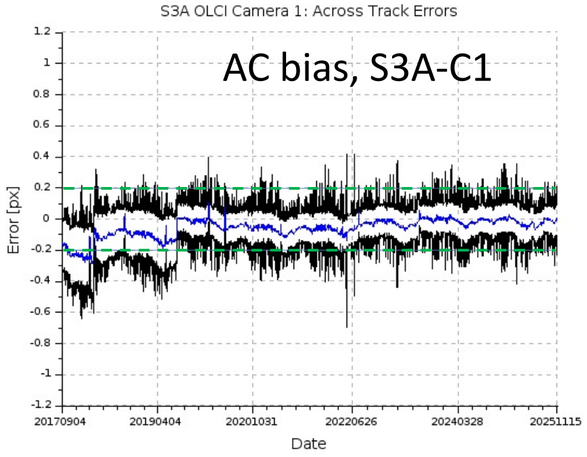
Overall RMS

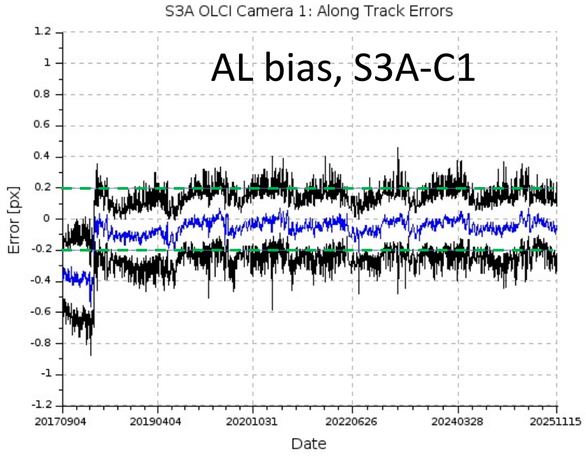
← S3A S3B→

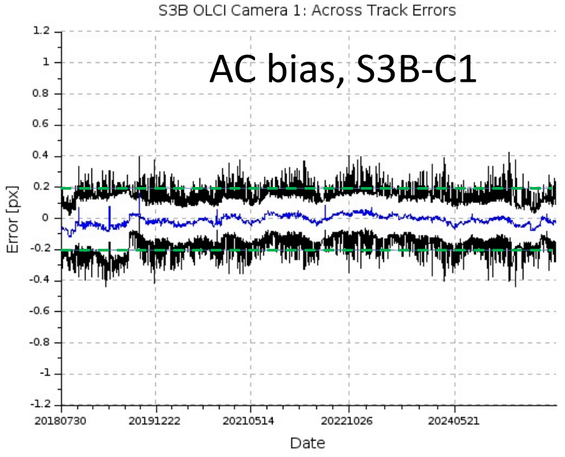
RMS < ~0.3 pixel

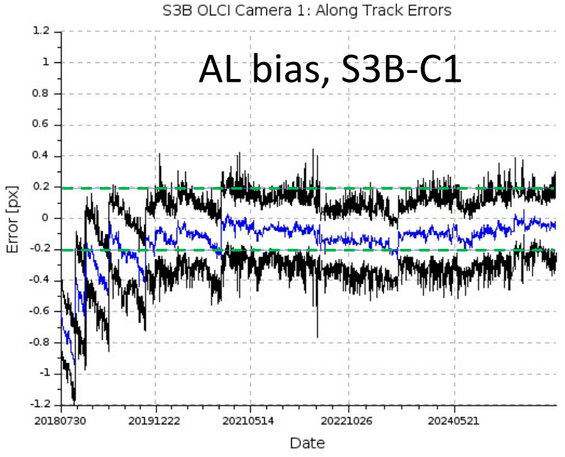
Biases < ~0.2 pixel











Geometric calibration: lessons learnt

1. Calibration tool operation shall start as early as possible in mission life, with frequent parameters updates, until stabilization (if any)

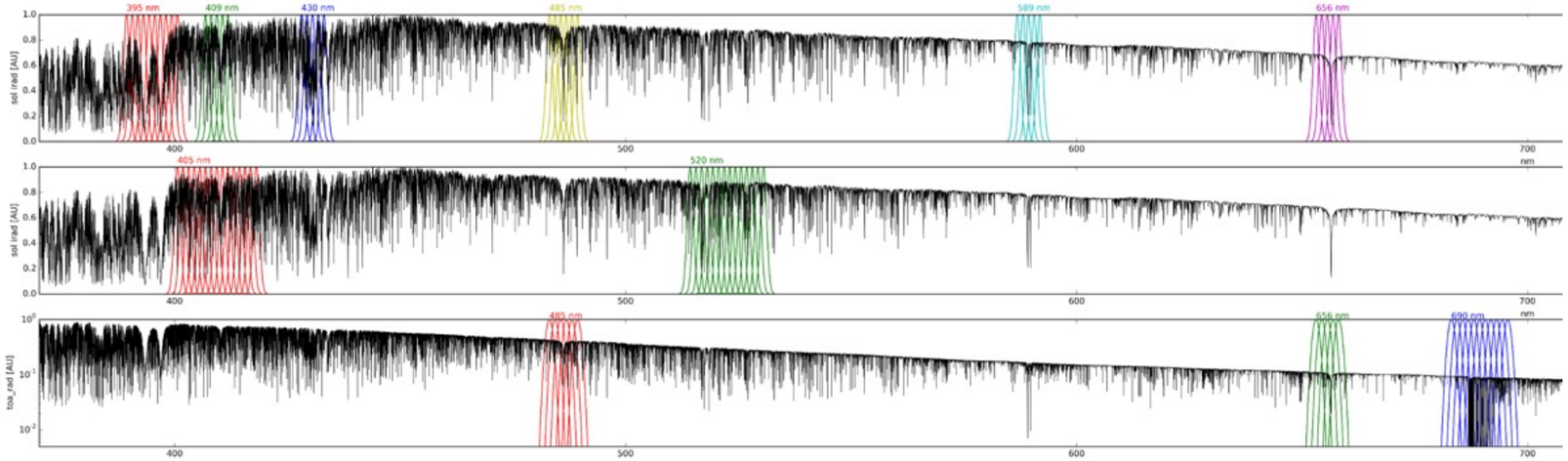
2. A commonly agreed / shared GCP database would favour cross mission interoperability / intercomparisons

3. Computing power and storage capacity should be available to show updated performance after any reprocessing

Spectral calibration: principle

Observation at instrument highest resolution of spectral features of:

- Spectral diffuser (normalised by nominal one)
- Fraunhofer lines on either radiometric diffuser or bright Earth targets
- Atmospheric O2 absorption over bright Earth targets



Shape matching on reference spectra provides central wavelengths and FWHM of selected CCD lines (~iso-wavelength)

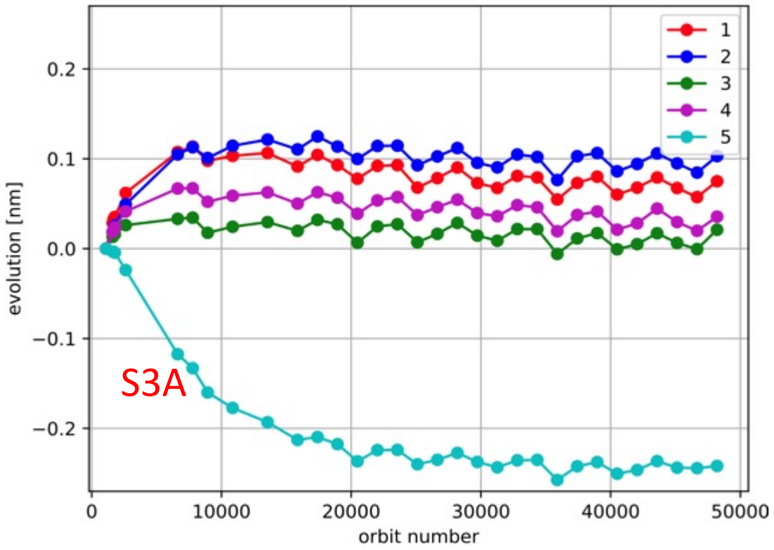
Used to build an instrument spectral model providing SRF for every band and pixel

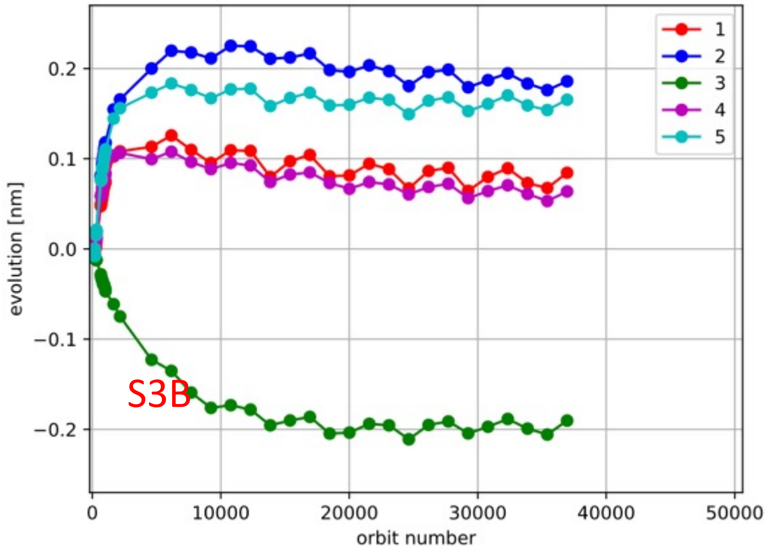
Acquired 3 times a year → provides trending monitoring and modelling

Spectral calibration: performance

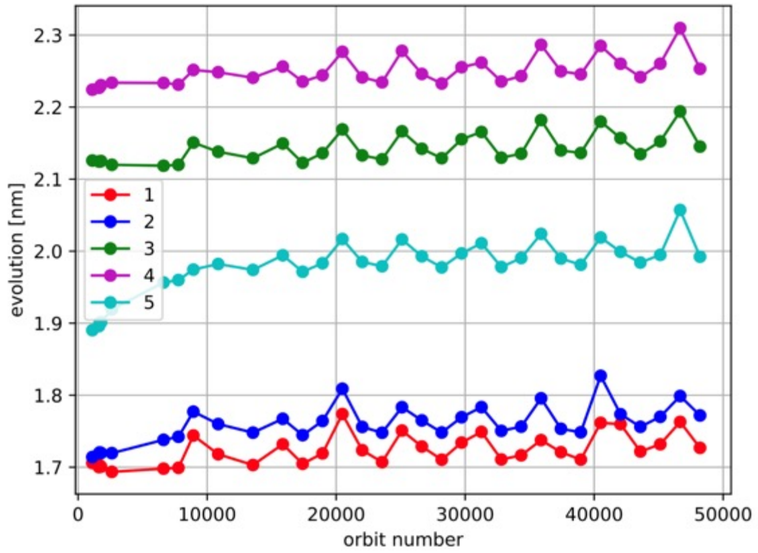
Trending monitoring:

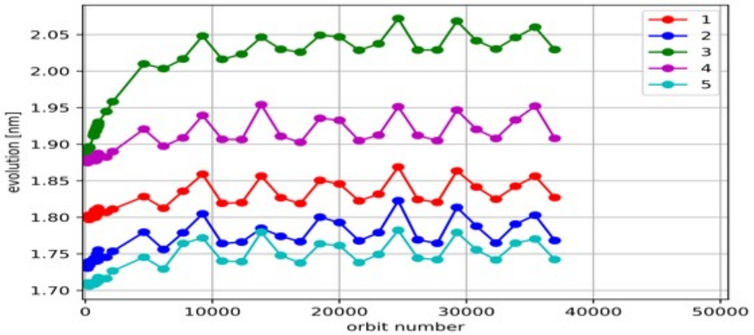
Central wavelength





Single cell FWHM

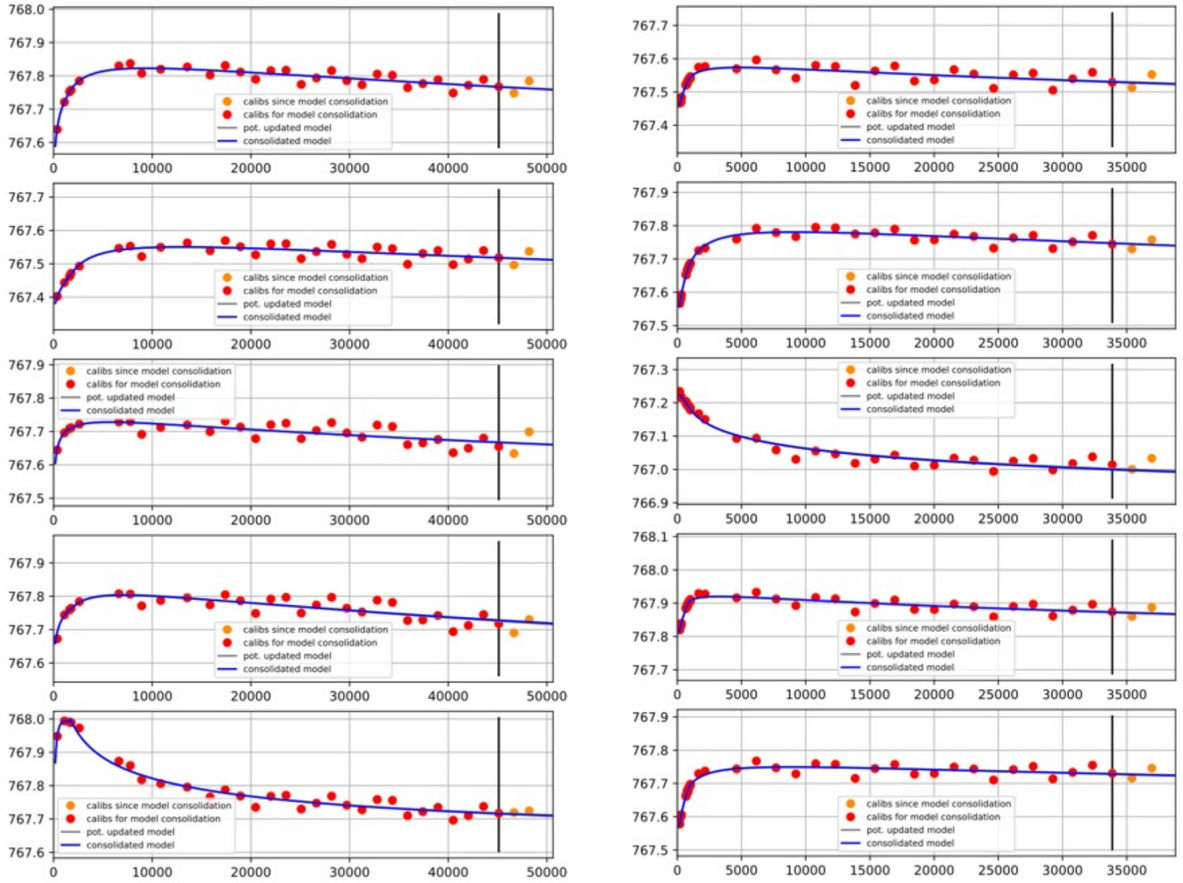




Spectral calibration: performance

Trending modelling:

Example of central wavelength



Also available for FWHM and in-band irradiance

Spectral calibration: lessons learnt

1. The spectral temporal model improves radiance accuracy through in-band-irradiance (<0.5% variation)

2. It also provides more accurate Central Wavelength data to users (incl. L2) as data provided in L1b products (<0.25 nm, negligible for most applications)

3. Spectral diffuser is a plus but not mandatory: the spectral model is based only on Fraunhofer and O2-A EO observations

Radiometric calibration: principles

Radiometric calibration based on on-board diffusers:

- **Nominal Radiometric diffuser** → calibration gains, about every 2 weeks
- **Reference radiometric diffuser** → ageing of nominal diffuser, 4 times a year

- **Spectral Calibration** → in-band irradiance (TSIS-1 ref. spectrum)

→ **Radiometric Gain Models** = Gain at ref. date x trending function, at every pixel and band

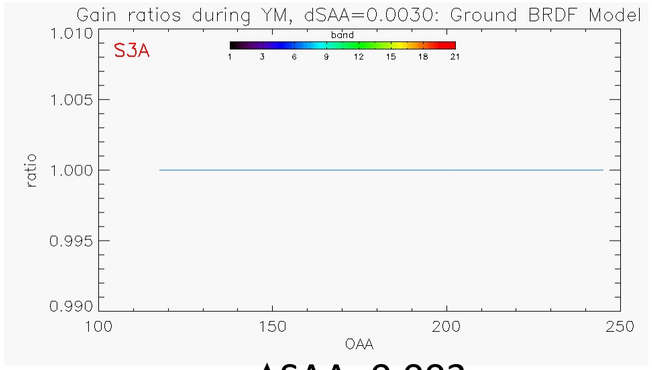
- **Calibration gains:** based on
  - Counts corrected for instrument effects (NL, dark offset, smear …)
  - computed Lcal from diffuser BRDF model, in-band irradiance and acquisition geometry

→ **The radiometric standard = diffuser BRDF** (+ solar irradiance model)
  - Diffuser BRDF required at every pixel + band and various illumination geometry → **need a model**
  - **Model based** on **ground characterisation** (absolute at ref. geometry) + in-flight measurements with **Yaw Manoeuvres** (angular dependencies)

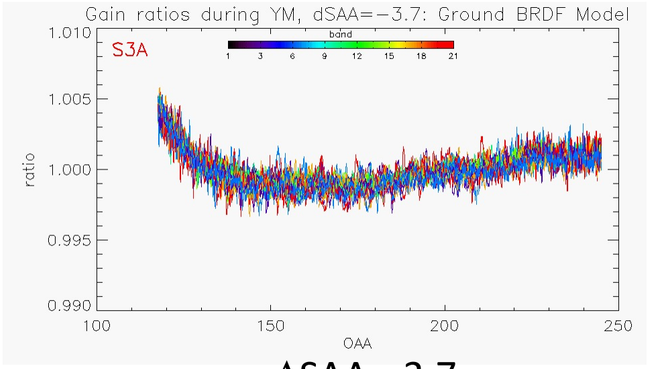
Radiometric calibration: lessons learnt

1) YAW manoeuvres and BRFD model

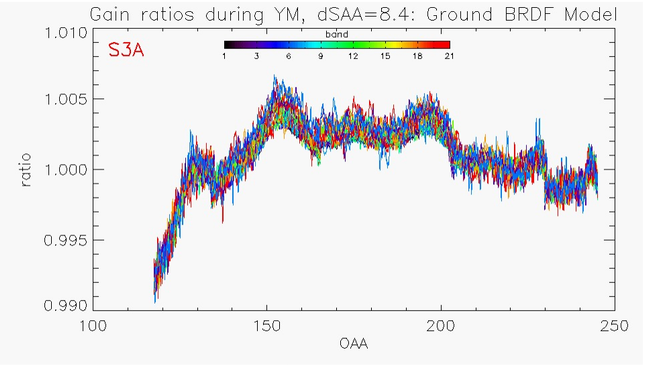
Ground model



ΔSAA=0.003

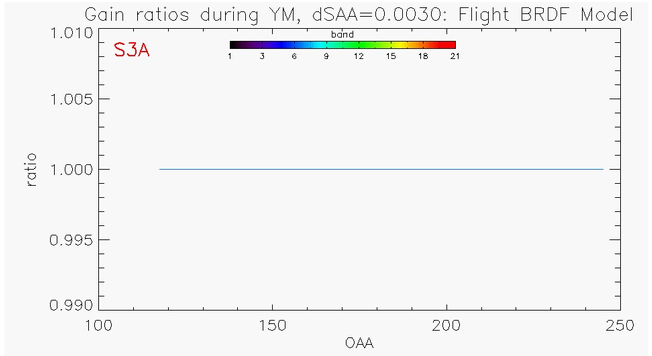


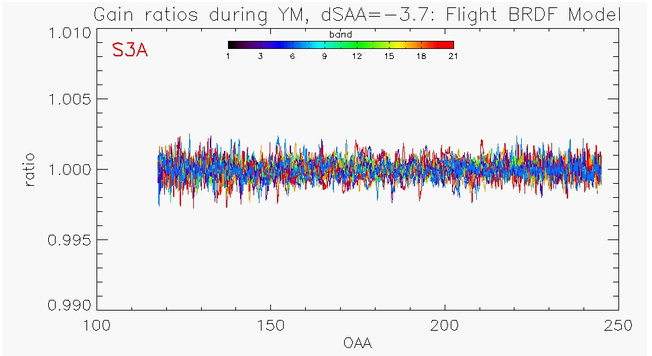
ΔSAA=-3.7

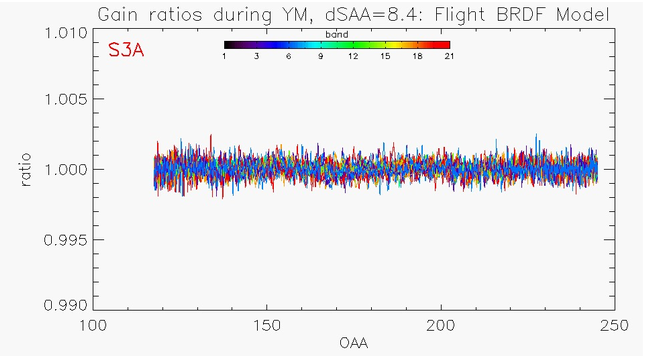


ΔSAA=+8.4

In-flight model



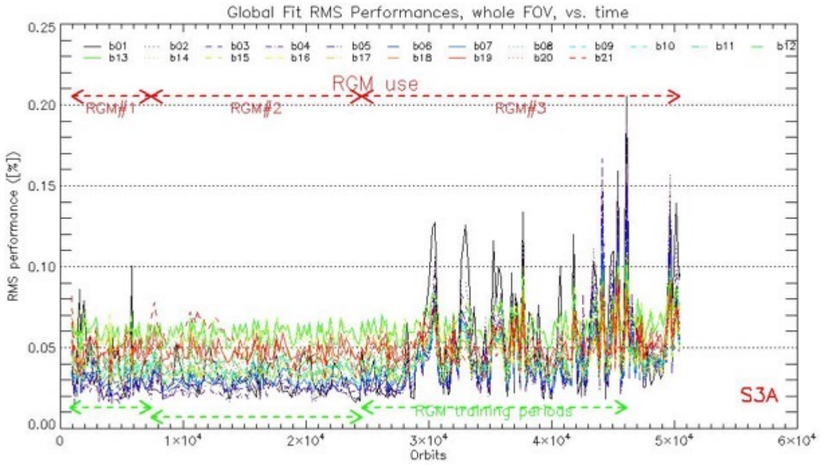


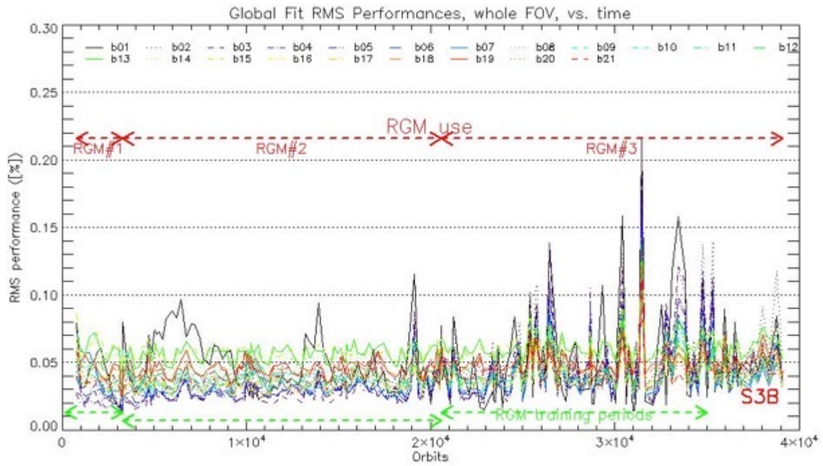


→ LL: Yaw Manoeuvres are mandatory to correct BRDF geometric dependencies

Radiometric calibration: performance

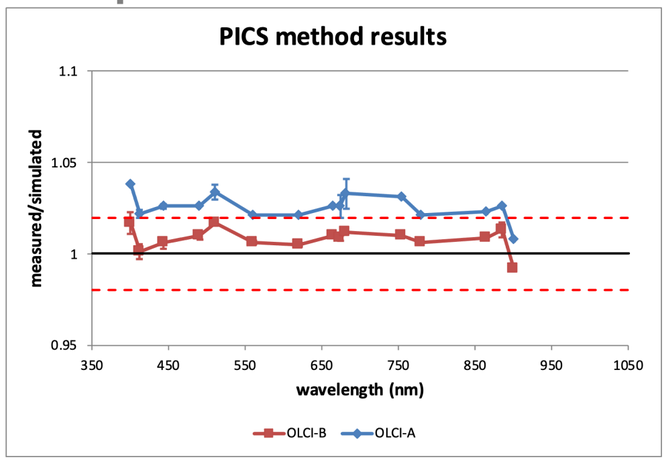
RGM performance
(model vs. data, % RMS)



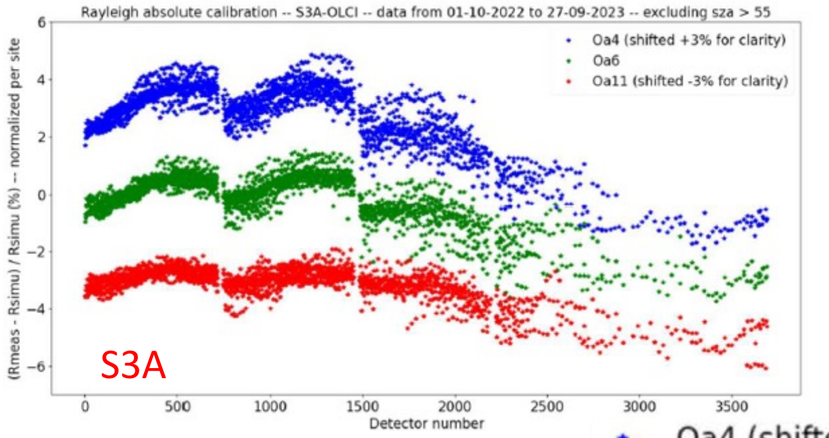


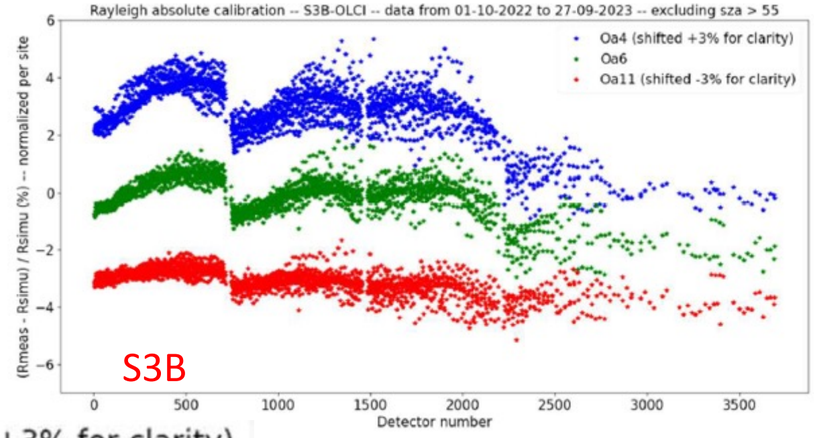
Vicarious Performance

X-platform over PICS



X-FOV over Rayleigh



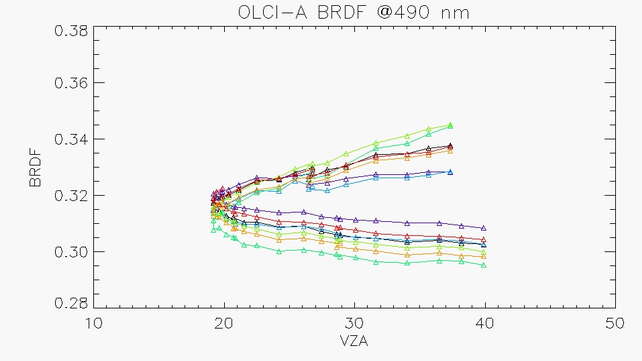


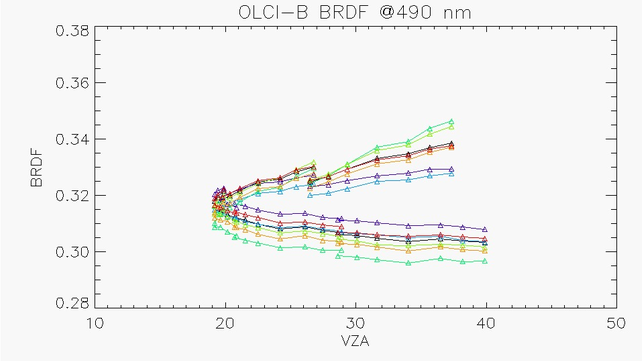
Oa4 (shifted +3% for clarity)
Oa6
Oa11 (shifted -3% for clarity)

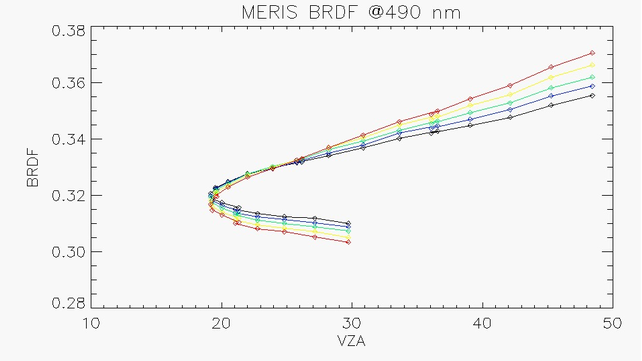
Radiometric calibration: Performance

2) Diffuser BRFD characterisation and ground model

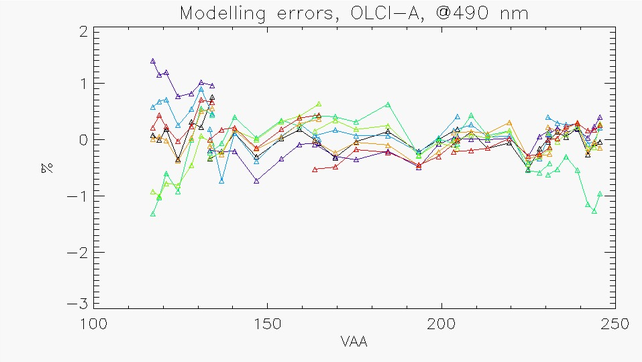
BRDF characterisation

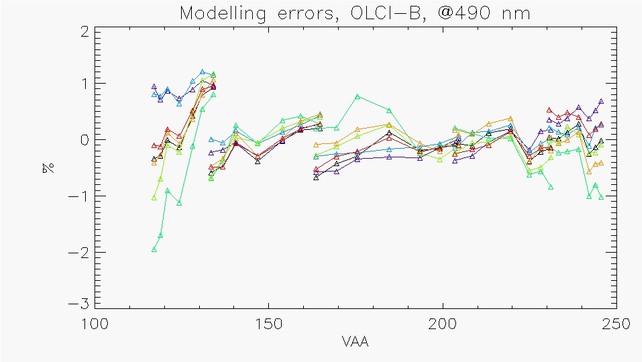


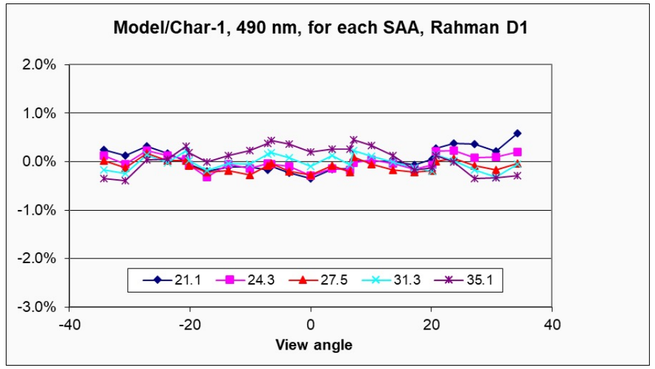




Ground BRDF model residuals







→ LL: Ground characterisation remains the keystone of radiometry
To be characterised with higher accuracy & precision, at finer X-FOV sampling.
Better sampling may allow per camera models, more representative.

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Thank you!

Questions and Answers

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