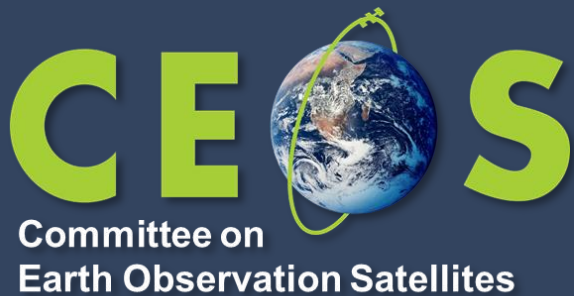


WGCV-51

Update on Cal/Val Activities of Belgian Groups



**J-C. Lambert, BIRA-IASB
on behalf of BELSPO**

Agenda Item 3.9

WGCV-51, Tokyo, Japan

3rd - 6th October 2022

EO Cal/Val Activities in Belgium



Federal Scientific Institutes under BELSPO authority

-  Royal Belgian Institute for Space Aeronomy, BIRA-IASB
-  Royal Institute of Natural Sciences of Belgium, RBINS
-  Royal Meteorological Institute of Belgium, RMIB
-  Royal Observatory of Belgium, ROB
-  Belgian User Support and Operation Centre, B-USOC

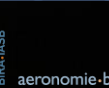
Regional partners and SME

-  Belgian Interregional Environment Agency, IRCEL-CELINE
-  Centre spatial de Liège, CSL
-  Rayference
-  Université de Liège, ULg
-  Université libre de Bruxelles, ULB
-  Universiteit Antwerpen, UA
-  Vlaamse Instelling voor Technologisch Onderzoek, VITO

ALTIUS - Atmospheric Limb Tracker for the Investigation of the Upcoming Stratosphere



POC for ALTIUS validation: Jean-Christopher Lambert, BIRA-IASB



2006 ... 2016 2017 2018 2019 2020 2021 2022

ALTIUS concept developed at BIRA-IASB, scientific and industrial studies funded by BELSPO through ProDEX

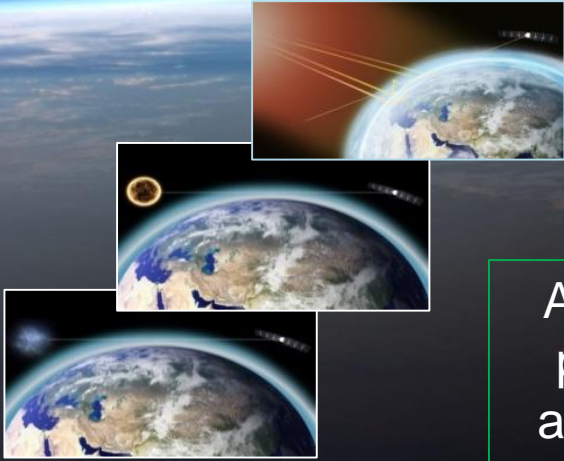
space segment consolidation phase

ground segment preparatory phase

Currently: phases B2, C, D for space and ground segments

Launch mid 2025

ALTIUS is handed to ESA and becomes an Earth Watch mission (BEL, CAN, ROM, LUX)



ALTIUS successfully passes ESA review against the OPEROZ requirements

ALTIUS L2 VALIDATION PLAN
 Operational validation incl. automated VAL system + ESA AO for ALTIUS VT
 Ground-/sonde-based validation + cross-validation with OMPS/JPSS-2 & any "surviving" limb instrument + DA/CTM (BASCOE, ECMWF)

Operational validation of S5P TROPOMI



POC: Jean-Christopher Lambert, BIRA-IASB

<https://mpc-vdaf.tropomi.eu> Home Search VDAF Server Log in

TROPOMI

VALIDATION FACILITY

SENTINEL-5 PRECURSOR MISSION PERFORMANCE CENTRE

Total Ozone, Tropospheric Ozone, Ozone Profile, Nitrogen Dioxide, Formaldehyde, Sulphur Dioxide, Carbon Monoxide, Methane, Clouds, Aerosols

The Sentinel-5P Validation Data Analysis Facility (VDAF) portal is the public entry point to the Routine Operations Validation Service for TROPOMI. Launched on 13 October 2017 on board of the ESA/Copernicus Sentinel-5 Precursor satellite, TROPOMI measures each day the global distribution of atmospheric trace gases and aerosols for a better understanding of air quality, the ozone layer, atmospheric chemistry and transport, ultraviolet radiation, and

New MPC validation activities

PICS-based evaluation of TROPOMI L1B_RA

AER_LH validation vs. EARLINET lidars

SO₂, HCHO and O₃ validation vs. PGN

Validation of full mission reprocessing in progress



FRM developments for Air Quality



POC: Michel Van Roozendaal, BIRA-IASB

CINDI-3 Intercomparison Campaign, September 2023

Fiducial Reference Measurements for
Ground-Based DOAS Air-Quality Observations

FRM4DOAS

Home Project overview Documents FRM4DOAS questionnaire FRM4DOAS guidelines Data Links Partners Contact us

<https://frm4doas.aeronomie.be/>



- ESA-funded Central Data Processing System for UV-Vis MAX-DOAS instruments
- Integrated as a service of the NDACC UV-VIS WG
- Implements community-based round-robin-selected retrieval algorithm baselines for total ozone, tropospheric and stratospheric NO₂ profiling, and tropospheric HCHO profiling
- Current status: demonstration, daily processing of data from 16 instruments routinely delivered to NDACC RD repository, tested in S5P MPC validation
- 4-year FRM4DOAS-2.0 R&D project started 2022 to further develop NO₂, AER and CLOUD products

- Follow-up of second Cabauw Intercomparison of Nitrogen Dioxide (CINDI-2, September 2016)
- Part of activities of the EU ACTRIS CREGARS topical center, where UV-Vis intercalibration campaigns are scheduled every 5 years
- Focus : (1) in-field calibration, (2) formal NDACC-type intercomparison and (3) investigation of capabilities for characterization of NO₂ vertical and horizontal variability
- Scheduled in September 2023 with large international participation, incl. NDACC and PGN

ACTRIS – GREGARS Infrastructure



POC: Martine De Mazière, BIRA-IASB

ACTRIS is a European Research Infrastructure (RI)

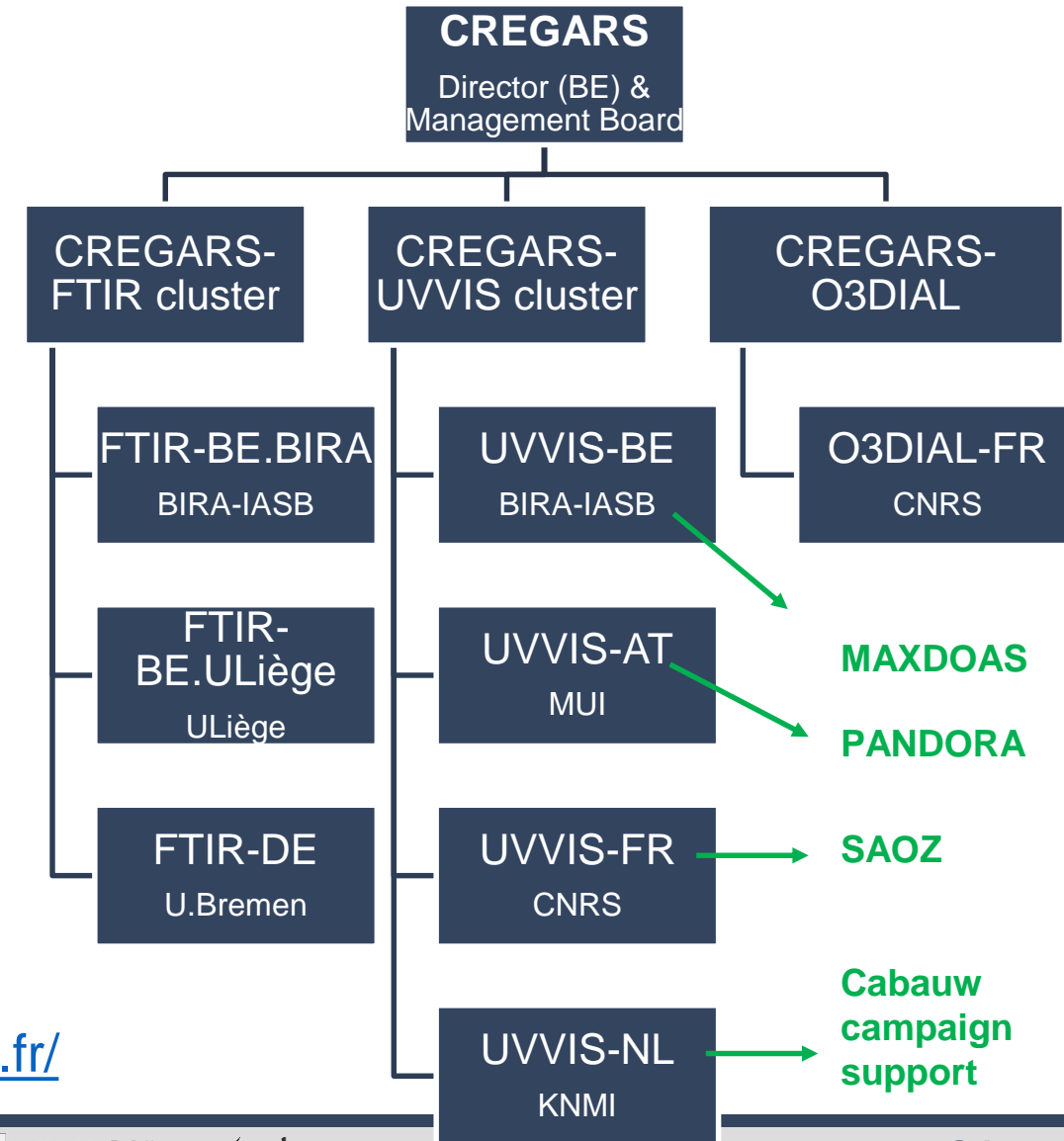
- constructed around atmospheric **research facilities** distributed in Europe
- that coordinates activities for the acquisition of *reliable, accurate, and high-quality* ground-based data to document the distribution and variability of short-lived climate pollutants in the natural or controlled atmospheres
- with legal status end 2022.

<https://actris.eu>



- GREGARS is its topical service center for **reactive trace gas remote sensing** data: calibration, central processing, QA/QC...
- initial targets: O3P, NO2, HCHO, NH3, C2H6 by FTIR, Lidar and UV-VIS instruments

<https://gres.aeris-data.fr/>

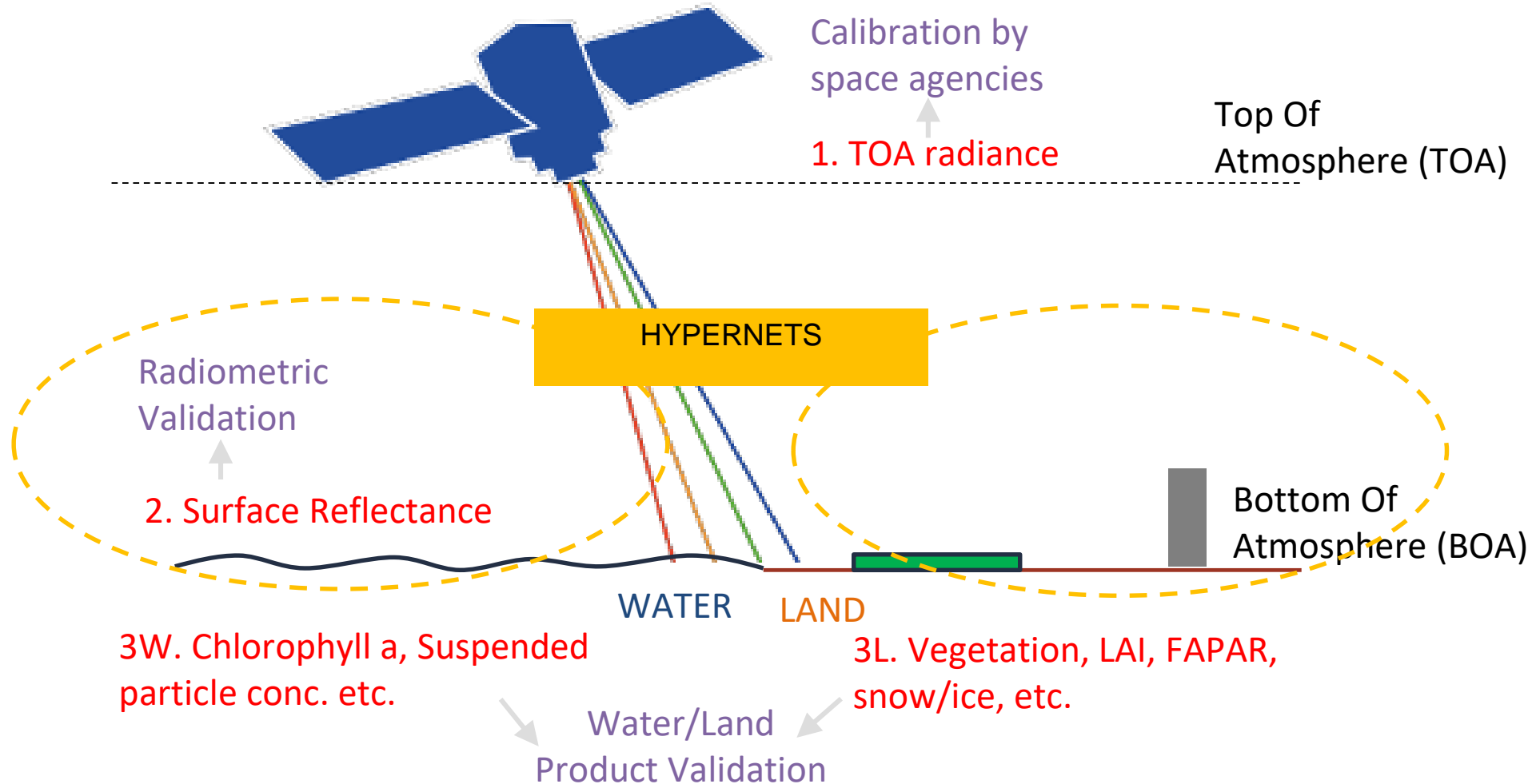


HYPERNETS for water and land reflectance



POC: Kevin Ruddick, RBINS

HYPERNETS - Automated measurements for validation of water and land surface reflectance at all VIS/NIR spectral bands (400-1700nm, @3nm FWHM)



HYPERNETS for water and land reflectance



POC: Kevin Ruddick, RBINS

INSTRUMENTS

Automated hyperspectral measurements



PANTHYR system
[Vansteenkoven et al, 2019]
400-900nm, 10nm FWHM



HYPSTAR® system
[https://hypstar.eu/]
380-1700nm, 3-10nm FWHM

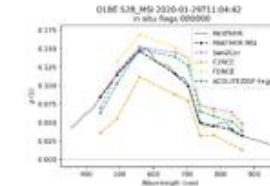
NETWORK

RBINS (BE, coordinator)
+ VLIZ (BE), CNR (IT), LOV (FR),
NPL (UK), GFZ (D), TARTU (ES),
CONICET (ARG)



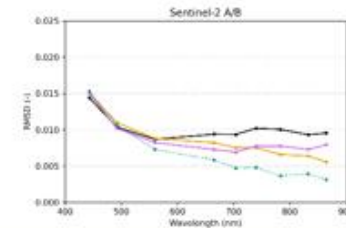
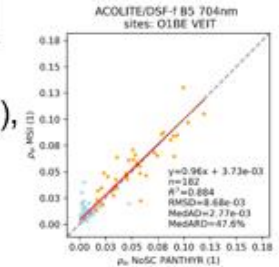
12 water and 12 land sites by Dec 2022
Many international requests to join in 2023 ...

DATA PROCESSING and ANALYSIS



e.g. one matchup

one band (S2/704nm),
many matchups



spectral stats,
many matchups

Prototype network has provided validation data and information to:

Sentinel-2A&B, Sentinel-3A&B/OLCI, Landsat-8&9, Planetscope Doves, PRISMA, Pléiades, ENMAP, ...

in progress for:

MODIS-A&T, VIIRS-1&2, ...

and preparing for:

MTG, CHIME, PACE, GLIMR, SBG, PROBAV-CC, various Newspace, ...

OBJECTIVE: To validate all VIS/NIR spectral bands (400-1700nm, @3nm FWHM) for all satellite missions measuring water or land surface reflectance

HYPERNETS for water and land reflectance



POC: Kevin Ruddick, RBINS

HYPERNETS: acknowledgements, partners and more info

- www.hypernets.eu
- www.hypstar.eu
- www.waterhypernet.org
- <https://odnature.naturalsciences.be/hypermaq/>
- Selected publications
 - Vanhellemont Quinten, Ruddick Kevin Atmospheric correction of **Sentinel-3/OLCI** data for mapping of suspended particulate matter and chlorophyll-a concentration in Belgian turbid coastal waters (2021) DOI : <https://doi.org/10.1016/j.rse.2021.112284>
 - Vanhellemont Q. Sensitivity analysis of the dark spectrum fitting atmospheric correction for **metre- and decametre-scale satellite imagery** using autonomous hyperspectral radiometry (2020) Optics Express, Vol. 28, 20 p. 397456. DOI: <https://doi.org/10.1364/OE.397456>
 - Tilstone Gavin, Dall'Olmo Giorgio, Hieronymi Martin, Ruddick Kevin, Beck Matthew, Ligi Martin, Costa Maycira, D'Alimonte Davide, Vellucci Vincenzo, Vansteenwegen Dieter, Bracher Astrid, Wiegmann Sonja, Kuusk Joel, Vabson Viktor, Ansko Ilmar, Vendt Riho, Donlon Craig, Casal Tânia Field Intercomparison of Radiometer Measurements for Ocean Colour Validation (2020) DOI : <https://doi.org/10.3390/rs12101587>
 - Giardino Claudia, Bresciani Mariano, Braga Federica, Fabbretto Alice, Ghirardi Nicola, Pepe Monica, Gianinetto Marco, Colombo Roberto, Cogliati Sergio, Ghebrehiwot Semhar, Laanen Marnix, Peters Steef, Schroeder Thomas, Concha Javier, Brando Vittorio First Evaluation of **PRISMA** Level 1 Data for Water Applications (2020) DOI : <https://doi.org/10.3390/s20164553>
 - Vansteenwegen Dieter, Ruddick Kevin, Cattrijsse A., Vanhellemont Q., Beck M. The pan-and-tilt hyperspectral radiometer system (**PANTHYR**) for autonomous satellite validation measurements – prototype design and testing (2019) DOI : <https://doi.org/https://doi.org/10.3390/rs11111360>
 - Goyens Clémence, Ruddick Kevin, Kuusk Joel Spectral Requirements for the Development of a New Hyperspectral Radiometer Integrated in Automated Networks - the **Hypernets Sensor** (2019) DOI : <https://doi.org/10.1109/WHISPERS.2018.8747259>



POC: Yves Govaerts, Rayference

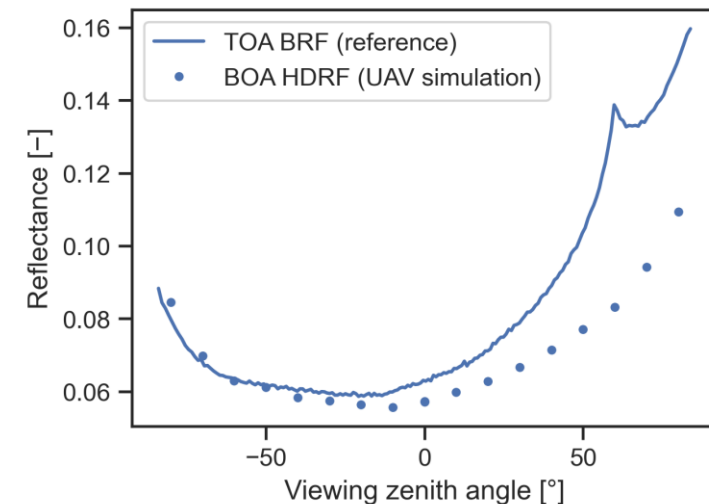
- In the context of the ESA [SPAR@MEP](#) study, Rayference has worked on the radiometric harmonisation of Vegetation-1, Vegetation-2 and PROBA-V data.
- The harmonisation reference consists in simulated hyperspectral radiance over Libya-4 with a mean accuracy of about $\pm 2.5\%$.
- PROBA-V calibration appears very consistent and robust while some adjustments are needed for the two Vegetation instruments.
- Similar harmonisation has been performed for [Meteosat-8 and -11](#).

	BLUE	RED	NIR	SWIR
SPOT-VGT1				
	1.042	1.028	1.020	1.026
SPOT-VGT2				
	1.036	1.024	1.013	1.019
PROBA-V				
ALL	1.024	1.005	0.997	1.004
LEFT	1.040	1.005	0.997	1.001
CENTRAL	1.011	1.012	1.001	1.003
RIGHT	1.010	0.999	0.993	1.014



POC: Yves Govaerts, Rayference

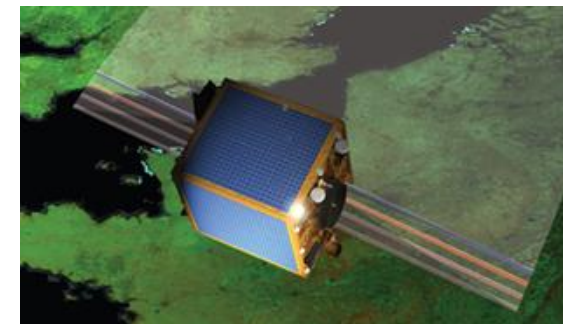
- Within the framework of [CCVS](#), Rayference is assessing the impact of measuring bottom-of-atmosphere HDRF (can constitute the intended FRM database) to estimate top-of-canopy BRF.
- This study uses the [Eradiate](#) radiative transfer model to simulate in-situ (UAV) and top-of-canopy measurements on a 3D vegetated cover.
- Conclusions and recommendations are in preparation.



POC: Sindy Sterckx, VITO

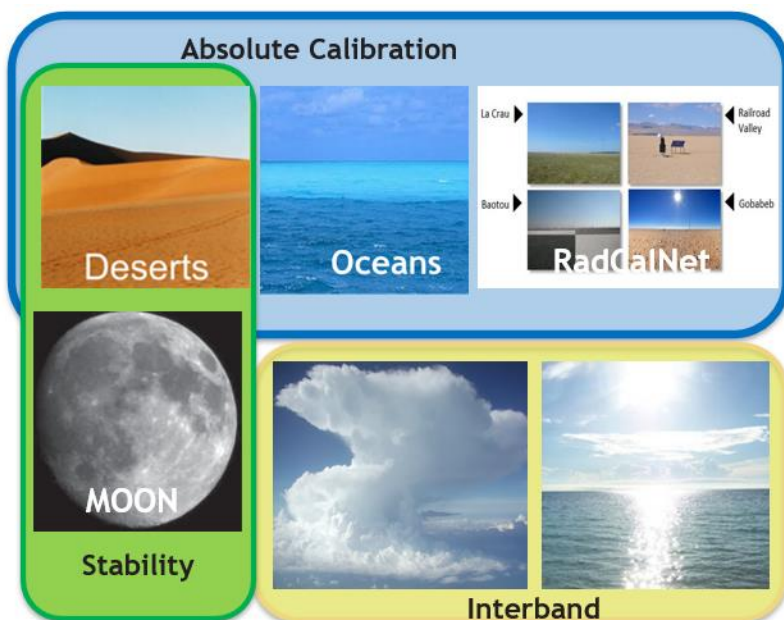


The IQC is in charge of the assessment of the PROBA-V performance, the analysis of the image quality, and the radiometric and geometric calibration after launch.



Radiometric Calibration

OSCAR* (Optical Sensor Calibration with simulated Radiances)

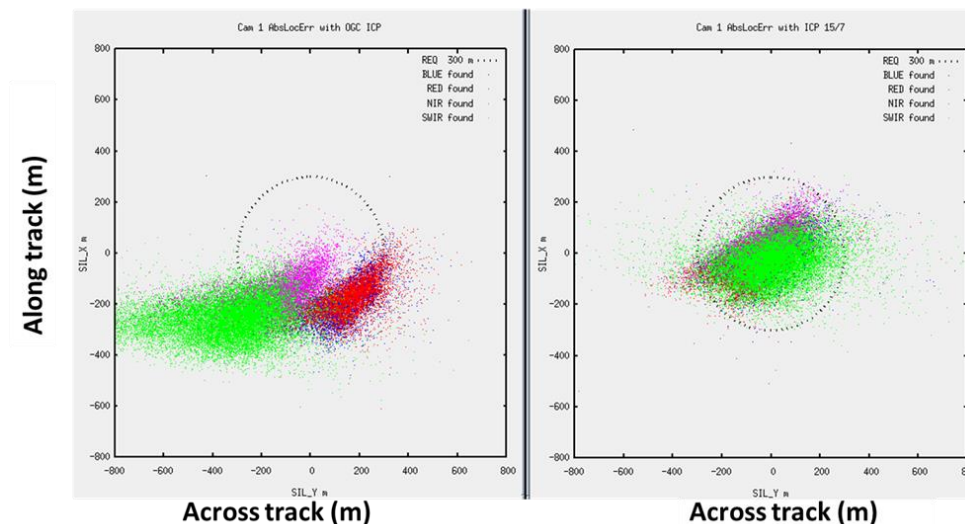


Geometric calibration/performance

Left camera

On-ground ICP

1st in-flight ICP



POC: Sindy Sterckx, VITO



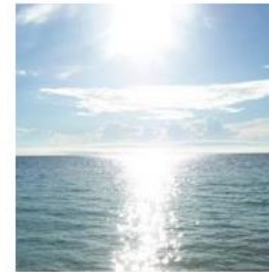
Validation of the OLCI L1 radiometry with:



OSCAR Rayleigh

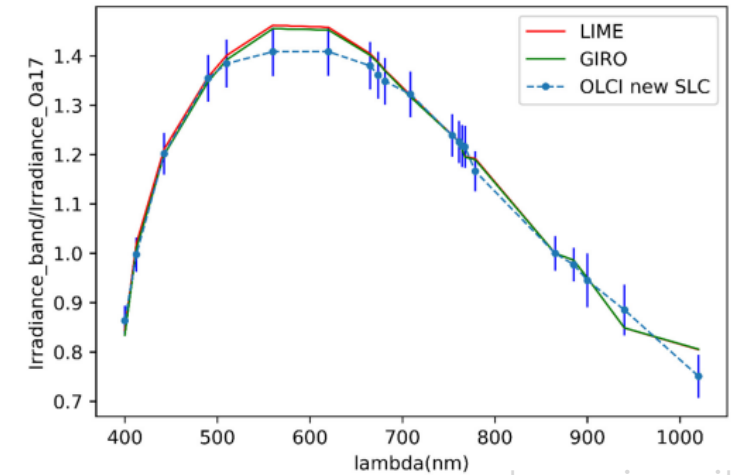
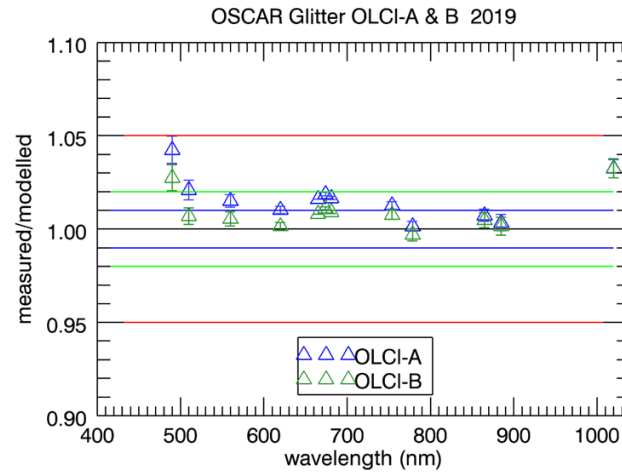
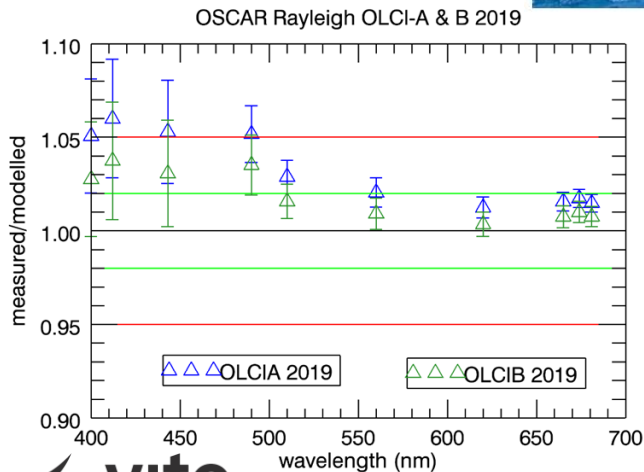


OSCAR Sun glint



Lunar Lime Model

<https://calvalportal.ceos.org/lime>



remotesensing.vito.be

Calibration of in-orbit demonstration HyperScout

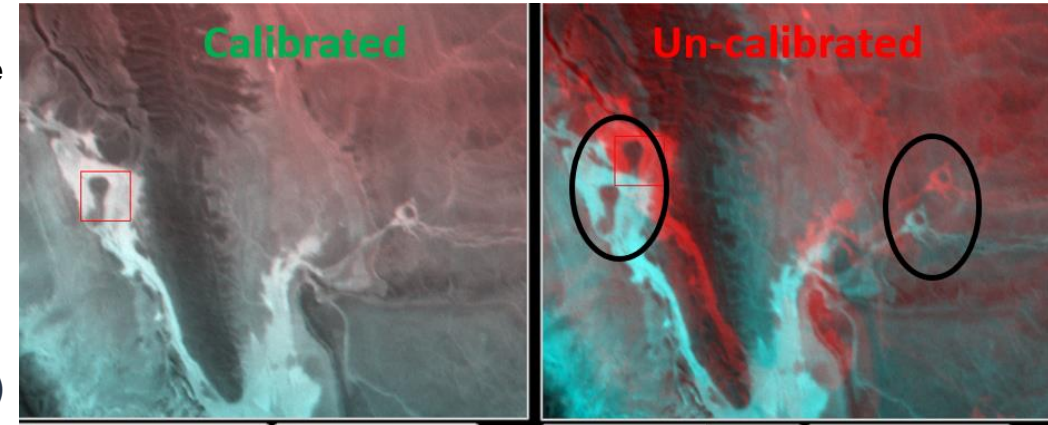


POC: Sindy Sterckx, VITO



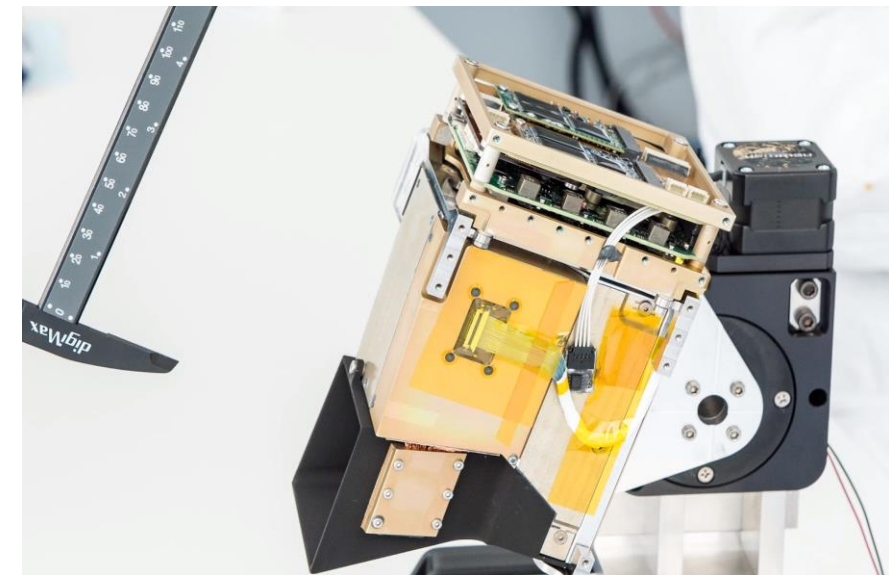
Projected DN frame

False color
R: frame1
G: frame15
B: frame15



Project partners: Cosine (NI), s[&]t (NI), VITO (B), TUDelft (NI), VDL(NI)

- “Push the limits of current technology and see how far we get”
- Develop an engineering model of a **miniaturized** LVF based compact hyperspectral for a cubesat
- Evaluate on board-processing strategies to reduce the data volume to fit within the downlink data rate
- Implement **on-board processing** algorithms into the software of the cube-sat instrument and validate
- Develop a Flight model + data acquisition + validation



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