

Ocean Colour Satellite Sensor Calibration Feedback From Polarimeter – The 3MI instrument

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On behalf of the whole team involved in the 3MI activity

EUMETSAT

Remote Sensing & Products / *Cloud & Aerosol (RSP/CLA)*

1st December 2025

- Ocean Colour is known to be demanding about calibration
 - The useful signal from ocean is only a small fraction (~10%) of the observed signal
 - This challenges the need of radiometric performance (calibration in its large sense)
- Polarisation, especially for aerosol retrieval, is also very demanding
 - The useful signal (i.e. polarisation from aerosol) is usually also a small fraction of the observed signal
- Specificities of polarisation
 - The way to extract polarisation from 3 different measurements also add additional difficulties
 - Need of consistency between the 3 acquisitions: radiometry but also co-registration
 - The multi-directional information, needed for the retrieval, also add
 - Need of consistency between the N acquisitions: radiometry but also co-registration
- Consequently
 - Any radiometric error creates fake polarisation
 - Any geometrical error creates fake polarisation



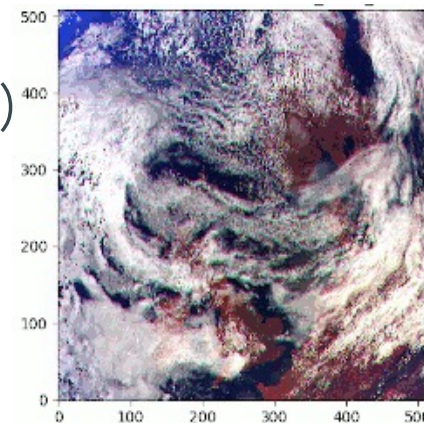
EPS-SG/3MI in a nutshell

- Multi-angle polarimeter (9:30 ECT)
- Very extensive information content with spectral/directional/polarisation
 - 14 views : from -50° backward to 50° forward
 - 12 spectral bands: from 410 to 2130nm
 - 3 polarisations providing I, Q, and U (except for absorption bands)
 - Potentially 420 information per pixel to feed the retrieval
- Allows an extensive aerosol & cloud characterisation:
 - Spectral optical and microphysical properties
 - More accurate load (optical thickness)
 - Aerosol: chemical components, type f/c, microphysics, size distribution, shape, absorption...

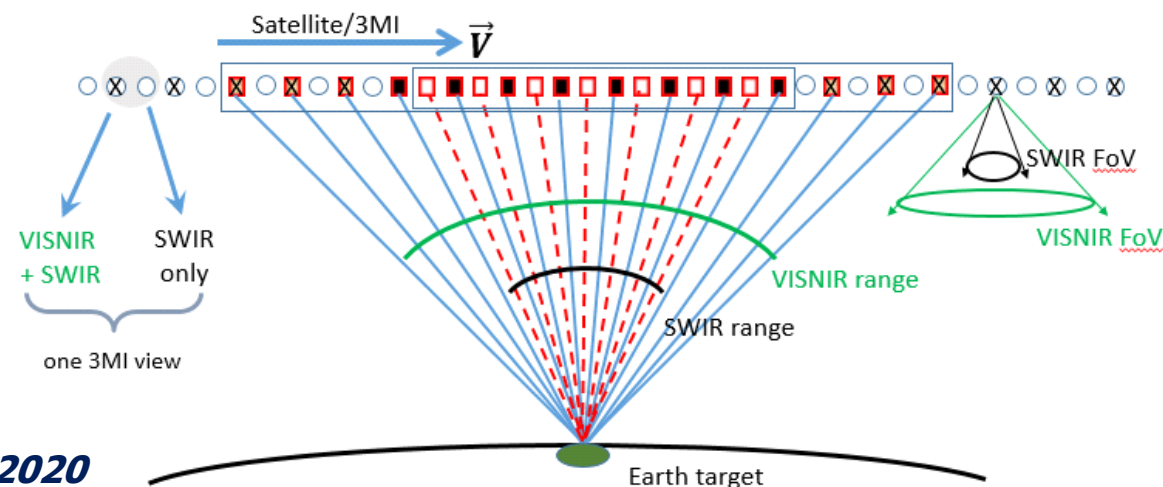
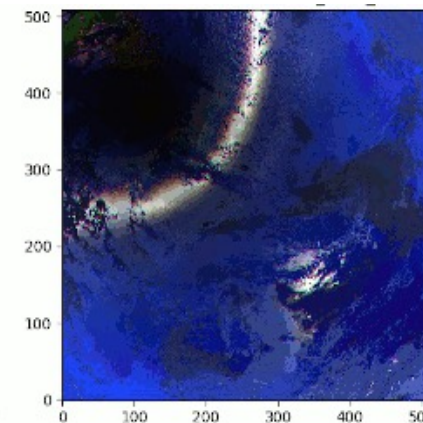
Launched 21st August 2025
First image 28th August 2025



Standard RGB



Polarisation



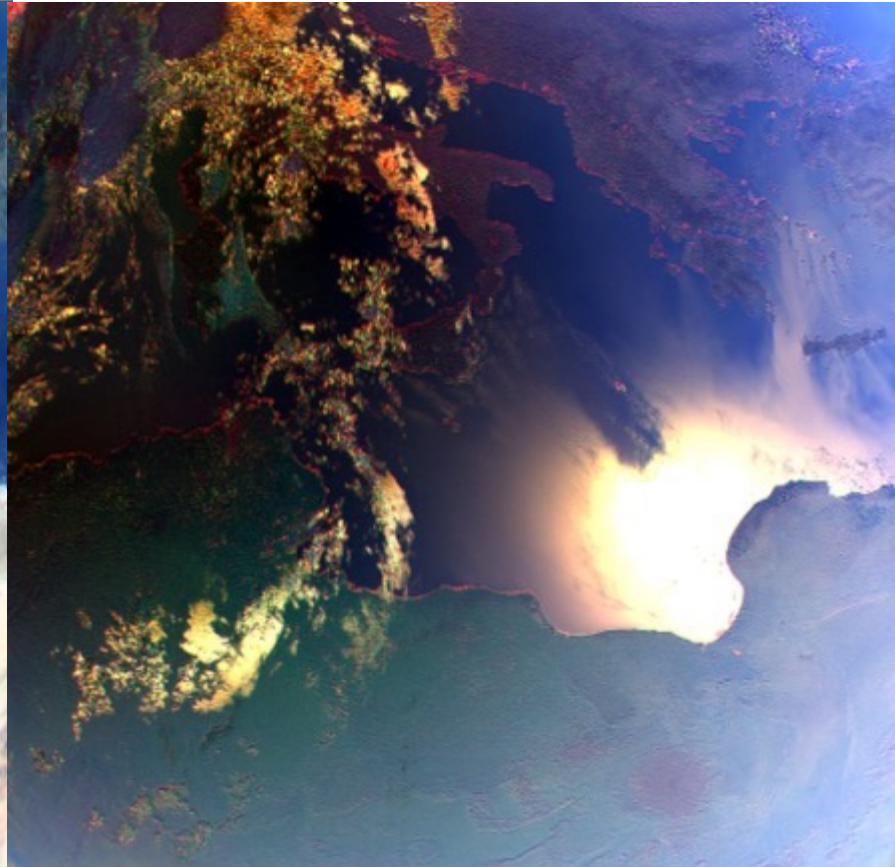
For more details, see Fougnie et al., JQSRT, 2018 & 2020



Intensity



Polarised intensity



EPS-SG/A

Launch 12st August 2025

First image 21st August 2025

Instrument in de-contamination mode
(not nominal acquisition)

Only VNIR acquired
(443, 670, 865nm presented)

Raw performance
(no radio/geo recalibration)

Credits: 3MI Project

➔ Today continuous acquisitions are done in nominal mission mode (VISNIR+SWIR)



Revealing Aerosol Events

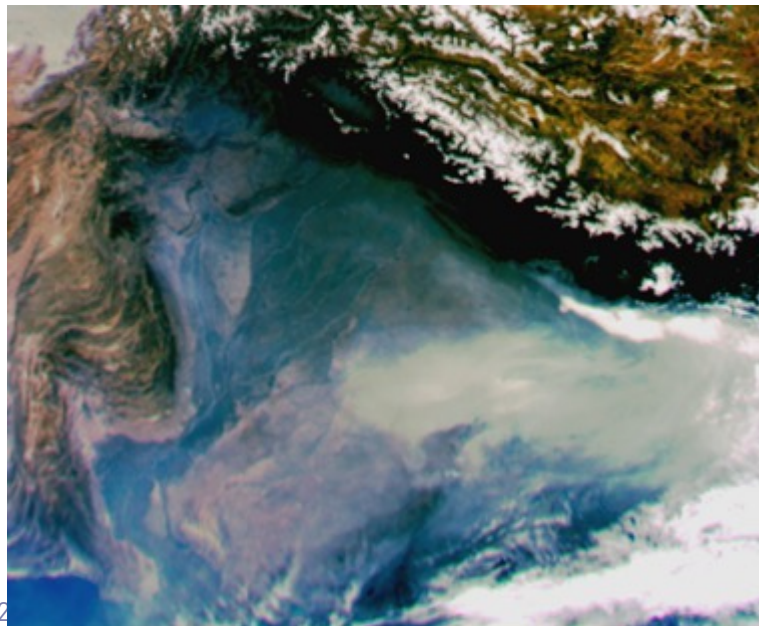
Intensity

Polarised intensity

Greece
& Crete



New Delhi





L1 Product generation

Rad corrections

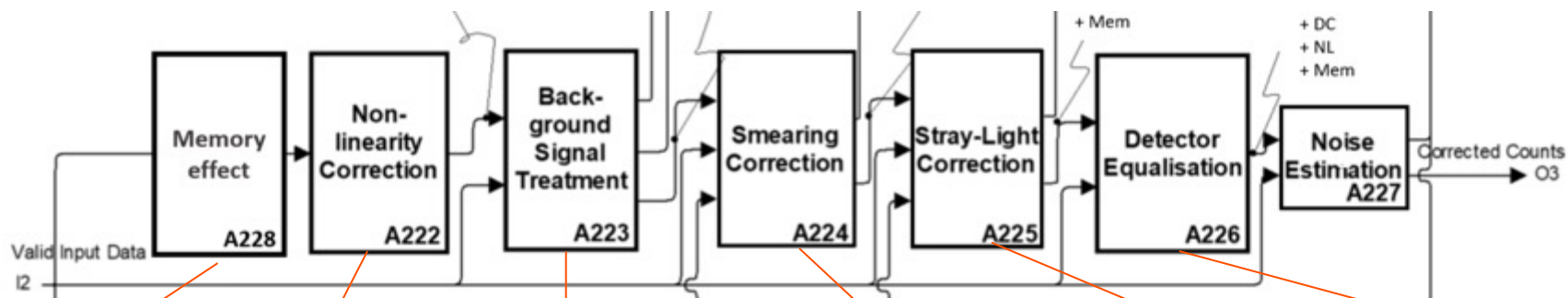
Co-registration

Inversion

L1B

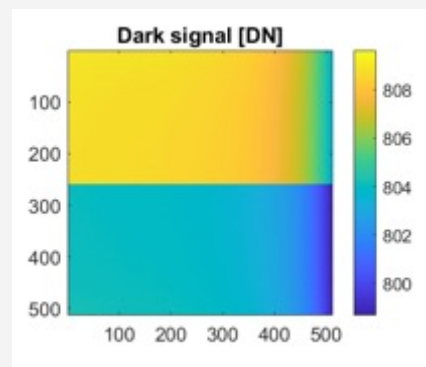
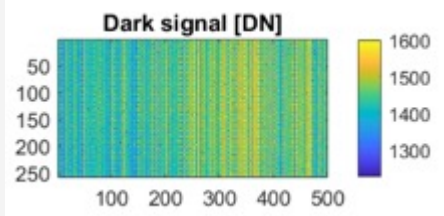
L1C

- Radiometric corrections

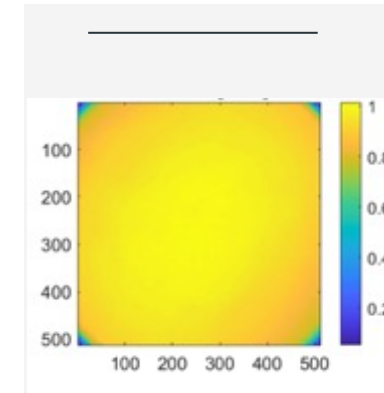
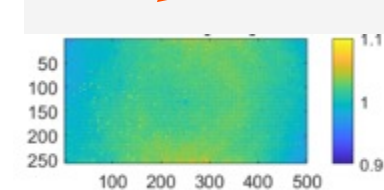
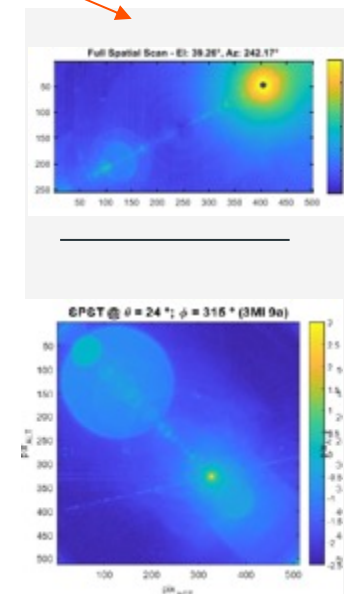
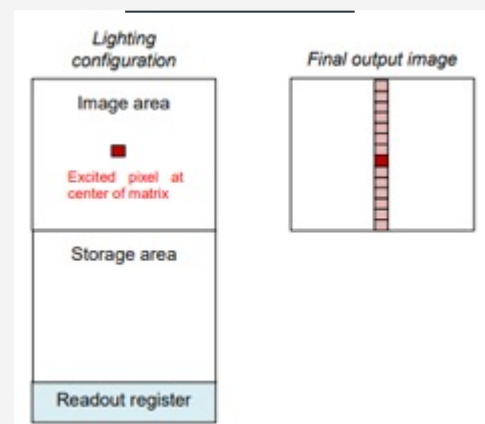


(not affecting VNIR)

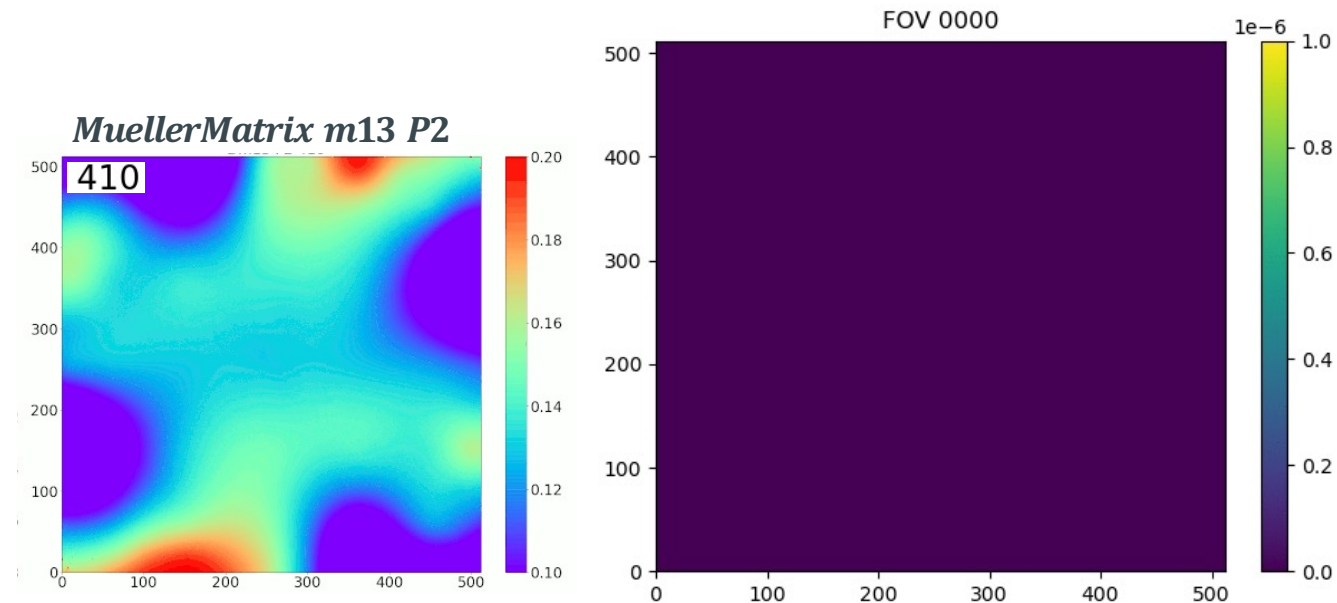
Polynomial
5th degree



(not affecting SWIR)



- Ground-characterisation: advanced characterisation for:
 - Detector behaviour: dark current, memory effect (SWIR), smearing (VNIR)
 - Non-linearity
 - Straylight: very heavy campaign
 - Polarisation
 - Detector equalisation



- Challenges:
 - Impossible to characterise all pixels: simplifications are needed
 - Assumption about symmetry or spectral behaviours were very risky
 - Accuracy sometimes difficult to reach: noise, set-up with its limitations, processing...



L1 Product generation

Rad corrections

Co-registration

Inversion

L1B

L1C

- Coregistration:
Satellite displacement between P1, P2 and P3 acquisitions

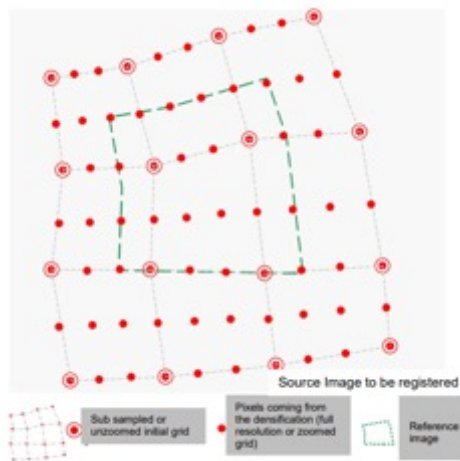
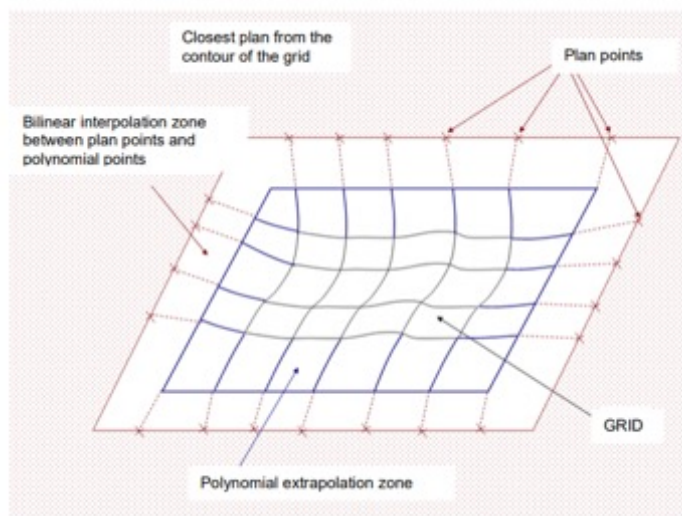
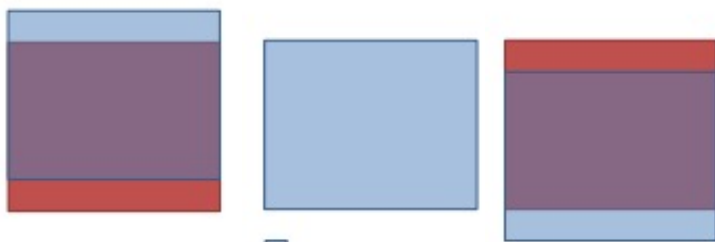
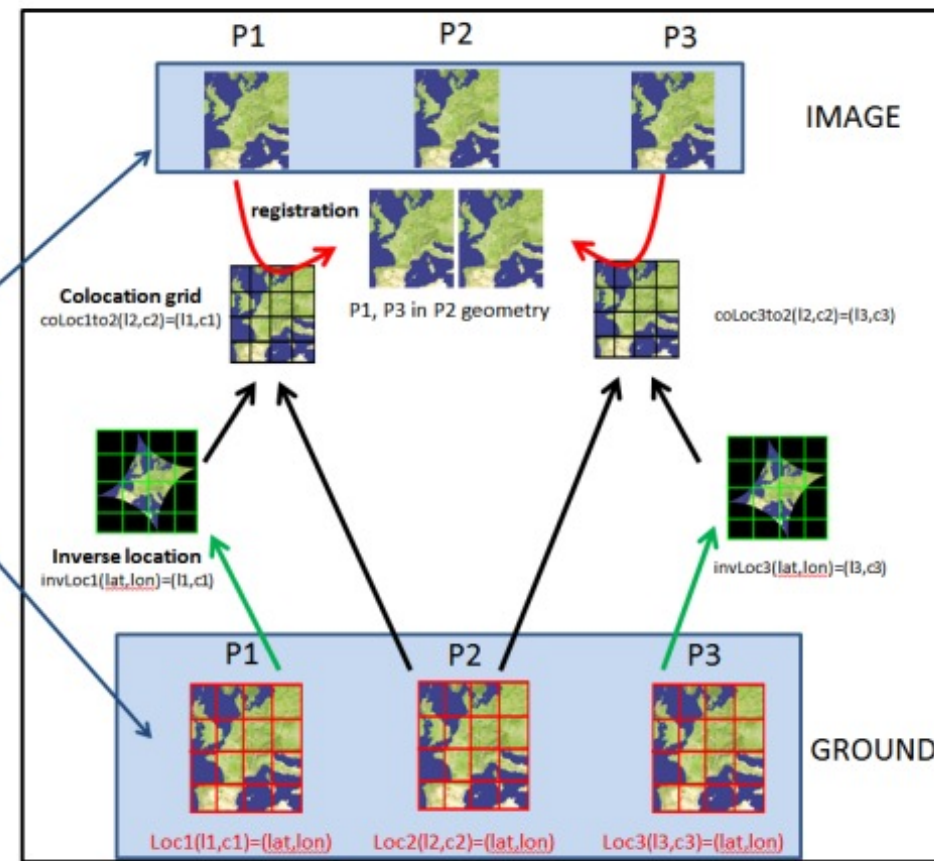


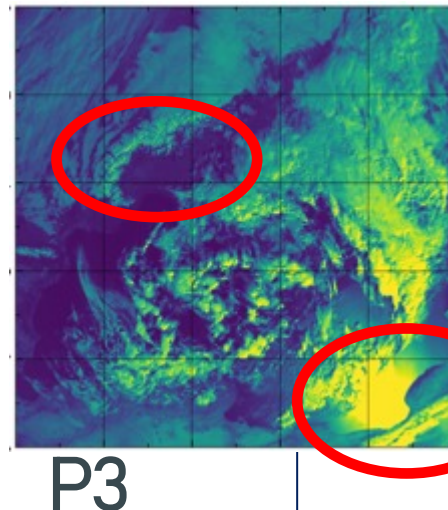
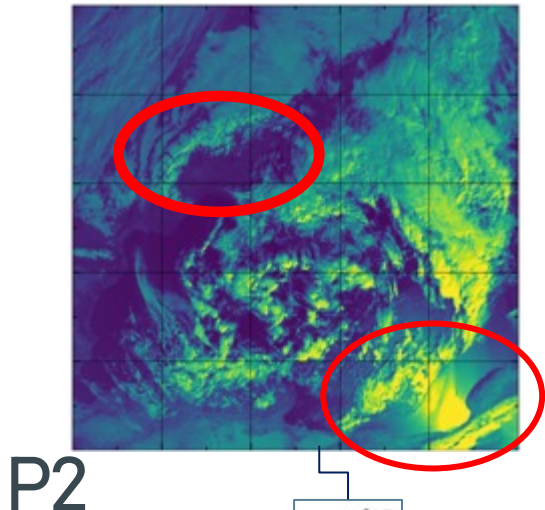
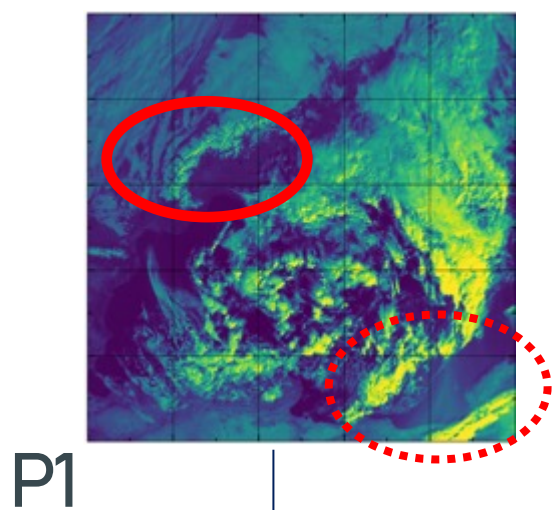
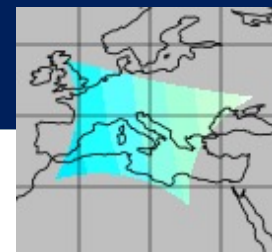
Figure 17: Resampling Grid bounding the reference image

L1b1 Inputs





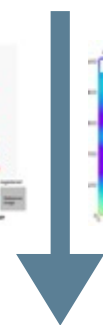
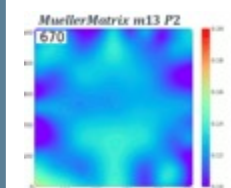
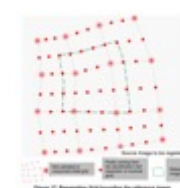
L1B1 to L1B



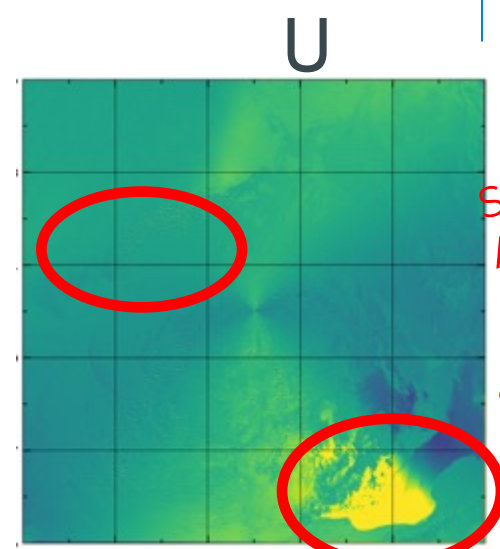
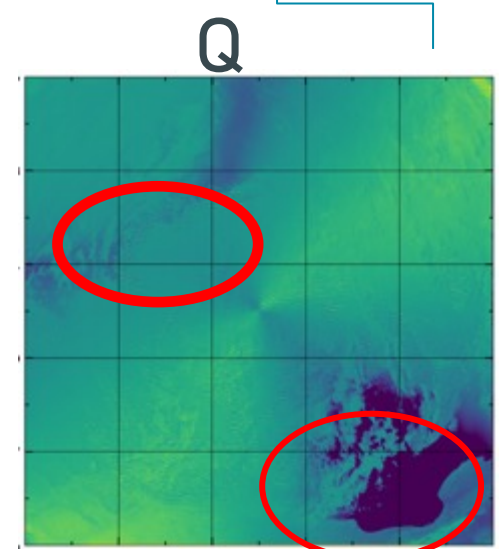
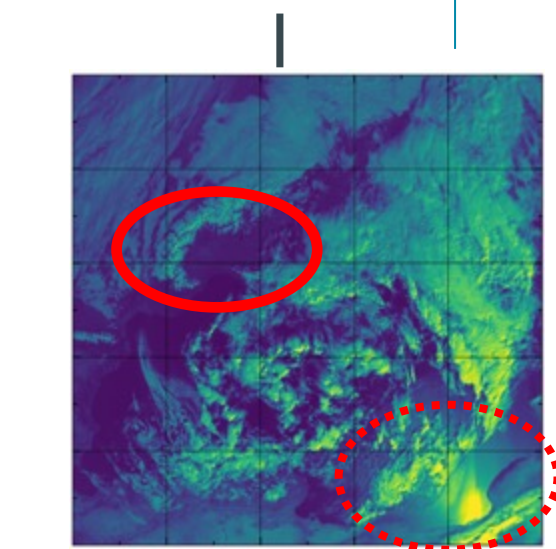
Snow-covered Alps

Sunlight, Highly polarised

L1B1



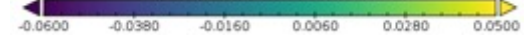
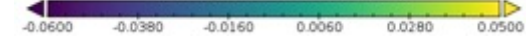
L1B



Snow-covered Alps

Sunlight, Highly polarised

and also for SWIR!



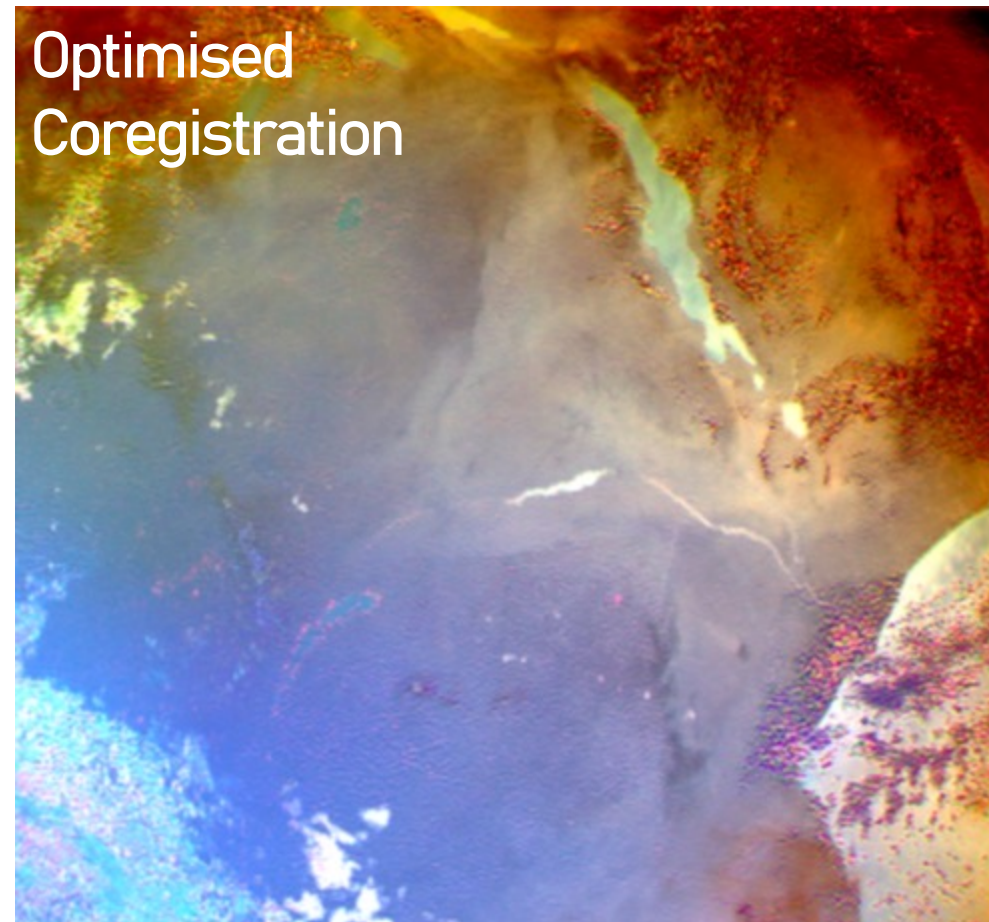
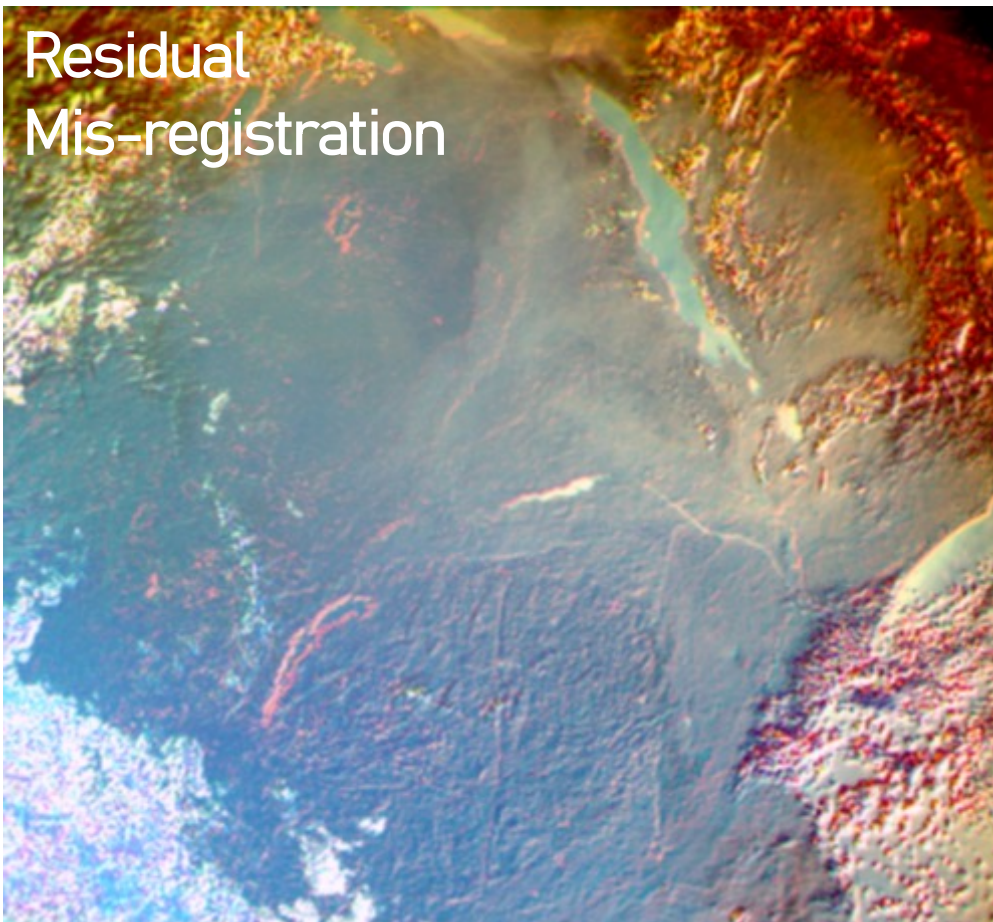


Impact of geometrical errors



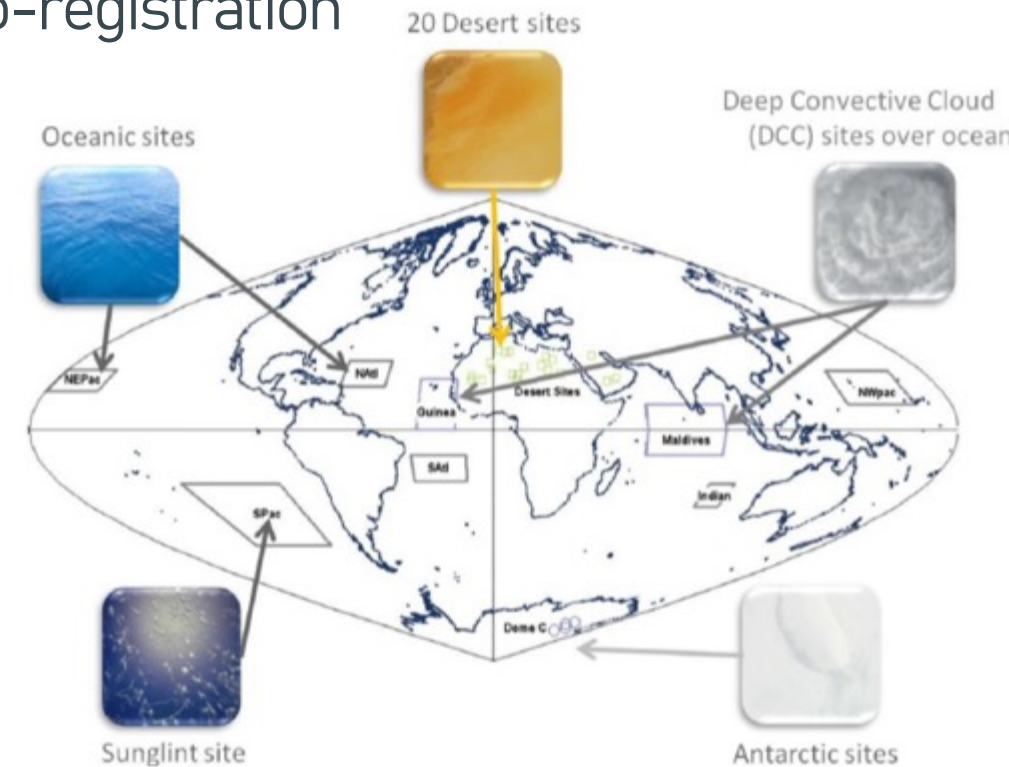
- Inaccurate co-registration of polarised triplet = radiometric noise, especially in polarisation

Polarised reflectance



EPS-SG/3MI – Biomass Burning in Zambia & Mozambique – 30th October 2025

- In-flight Strategy:
 - Relies on a proper understanding of the instrumental behaviour
 - All behaviours have to be reassessed – or validated – in-orbit (when possible)
 - For polarimeter, this includes the geometrical co-registration
 - The radiometric calibration is only the last step
 - Specific acquisitions
 - Vicarious calibration over natural target
(PARASOL heritage)



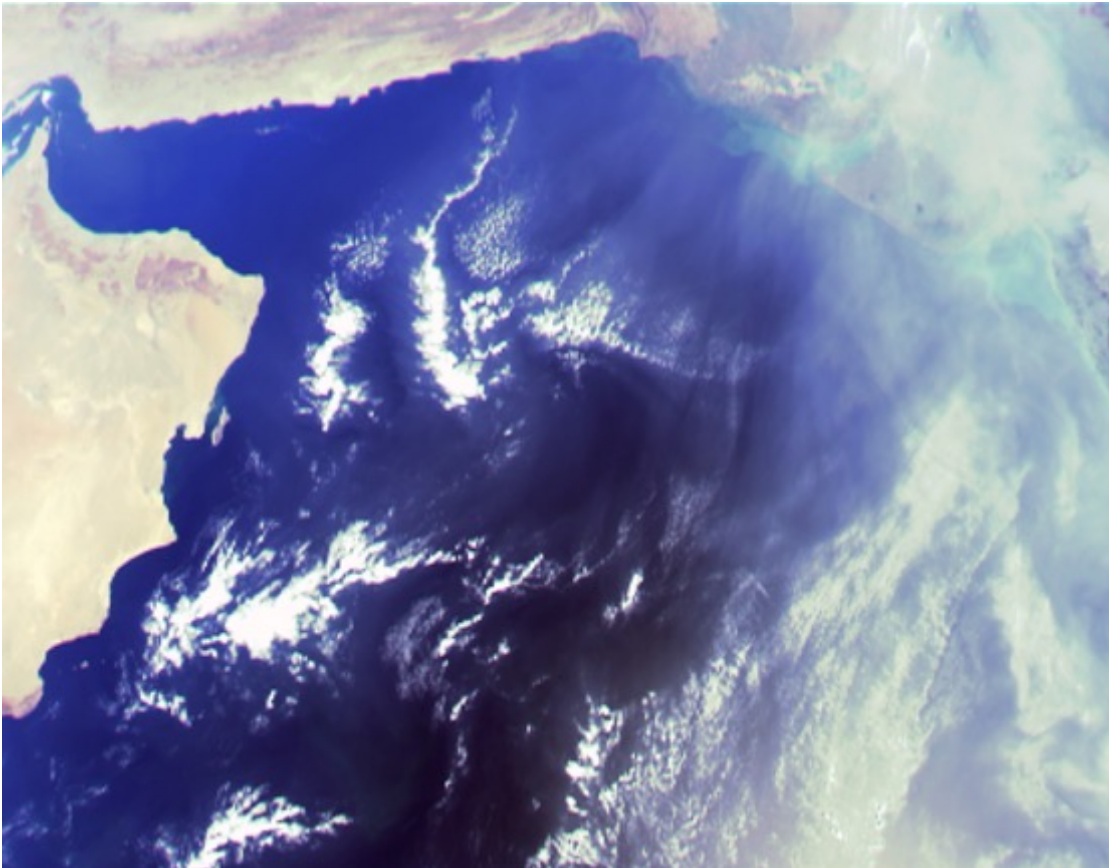


L1B1 to L1B, RGB – Supporting Ocean Colour Applications

28 November 2025

www.eumetsat.int

TOA reflectance



TOA polarised reflectance
(Rayleigh-corrected)



- Avoidance of the sun glint
- Enhanced estimation of the aerosol contribution



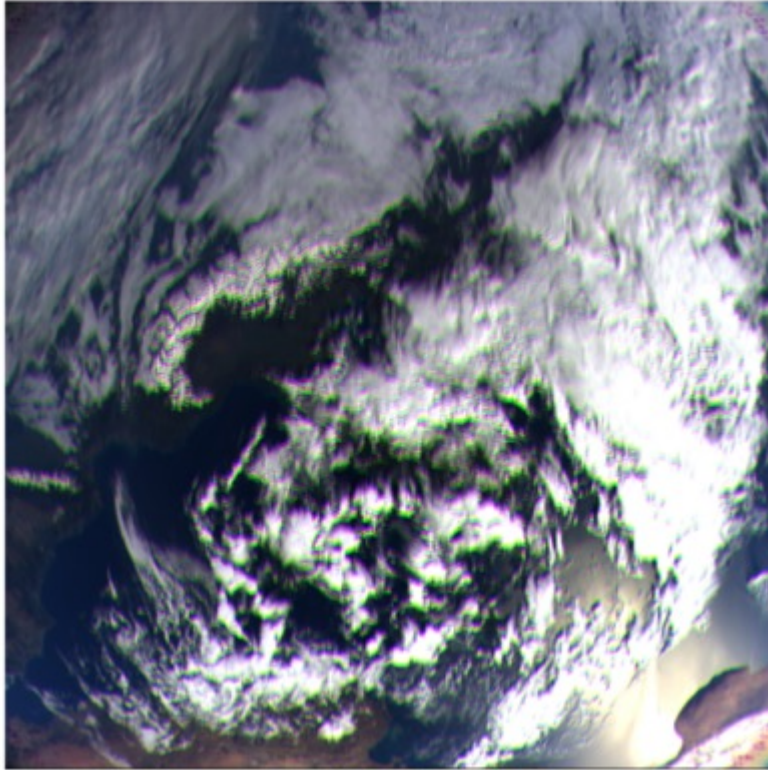
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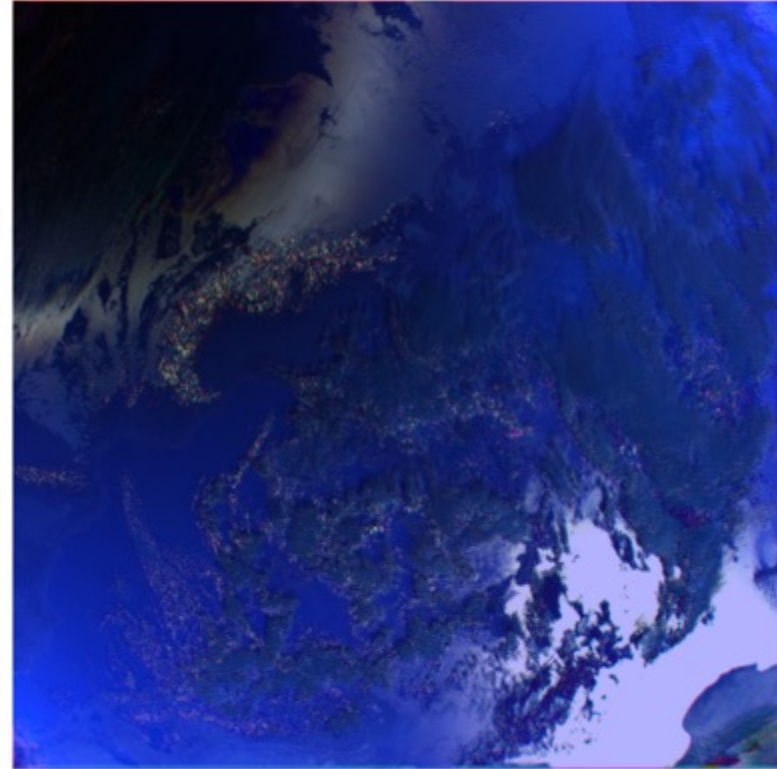
L1B1 to L1B, RGB

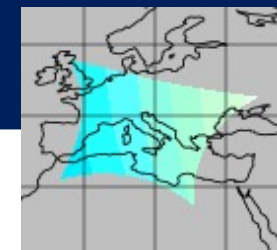


EPS-SG 3MI L1B 20251127091158

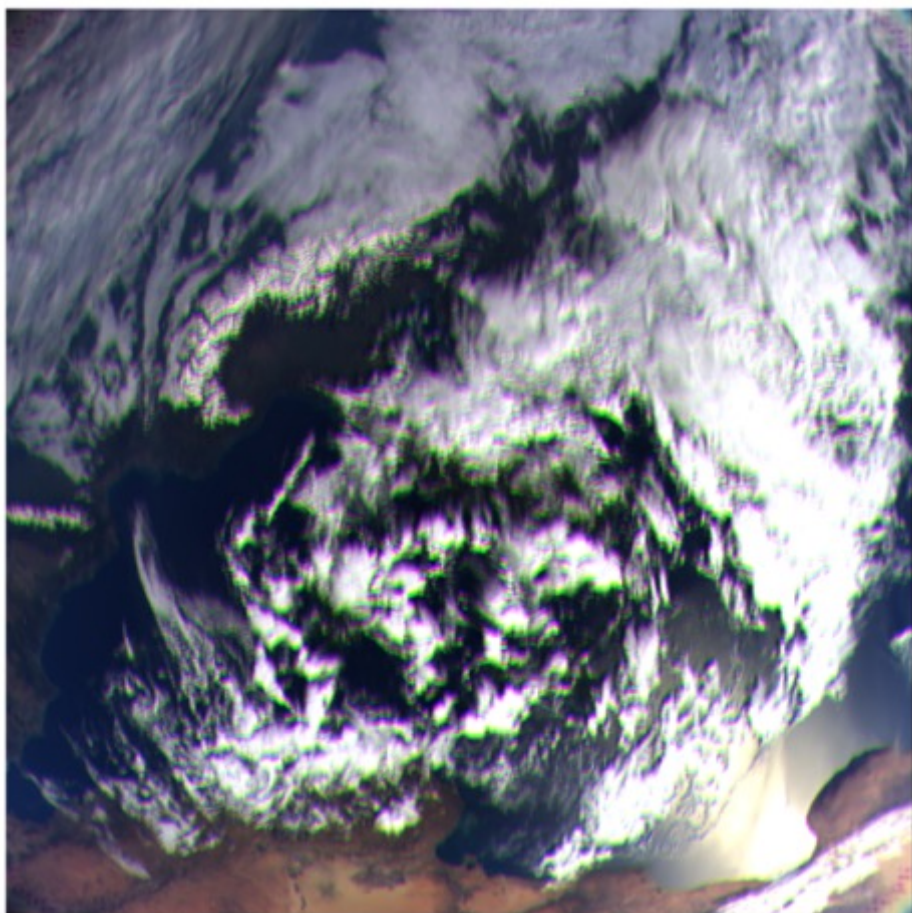


EPS-SG 3MI L1B 20251127091158





EPS-SG 3MI L1B 20251127091158



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