MTG and EPS-SG, Europe's most advanced operational satellites for Numerical Weather Prediction

Rosemary Munro
EPS-SG Programme Scientist

ECMWF Annual Seminar, 14 – 18 September 2026



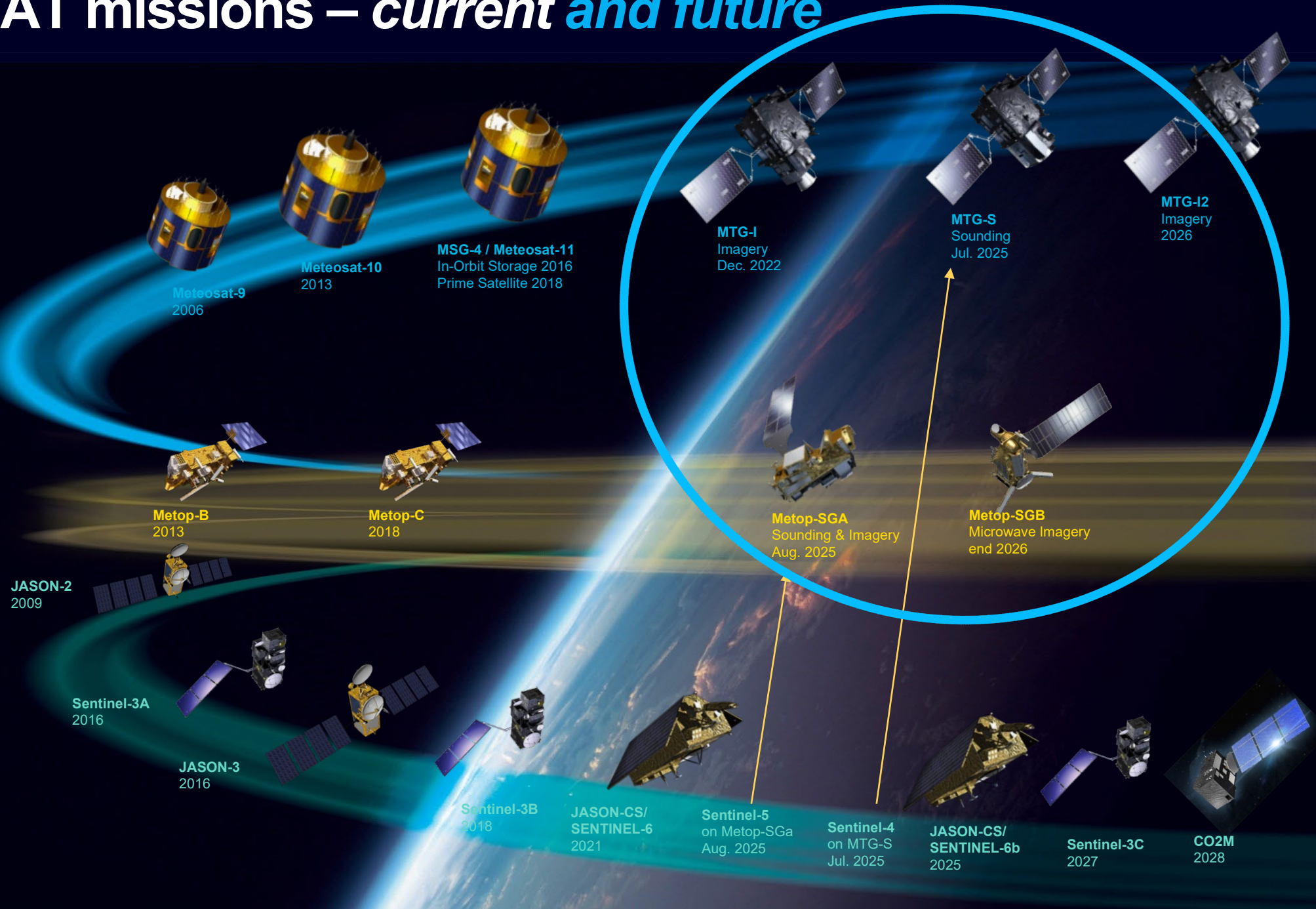
EUMETSAT missions – *current and future*

Geostationary Programmes

Mandatory Programmes

Polar Programmes

Optional and Third Party Programmes (incl. Copernicus)



Meteosat Third Generation (MTG) Mission Objectives

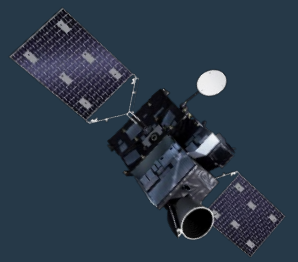
www.eumetsat.int



MTG-I1

Full Disc image service

- 16 spectral channels over Europe and Africa every 10 minutes
- Lightning Imager



MTG-S

Full Disc sounding service

- Hyperspectral Infrared Sounder
- Copernicus Sentinel-4 UVN

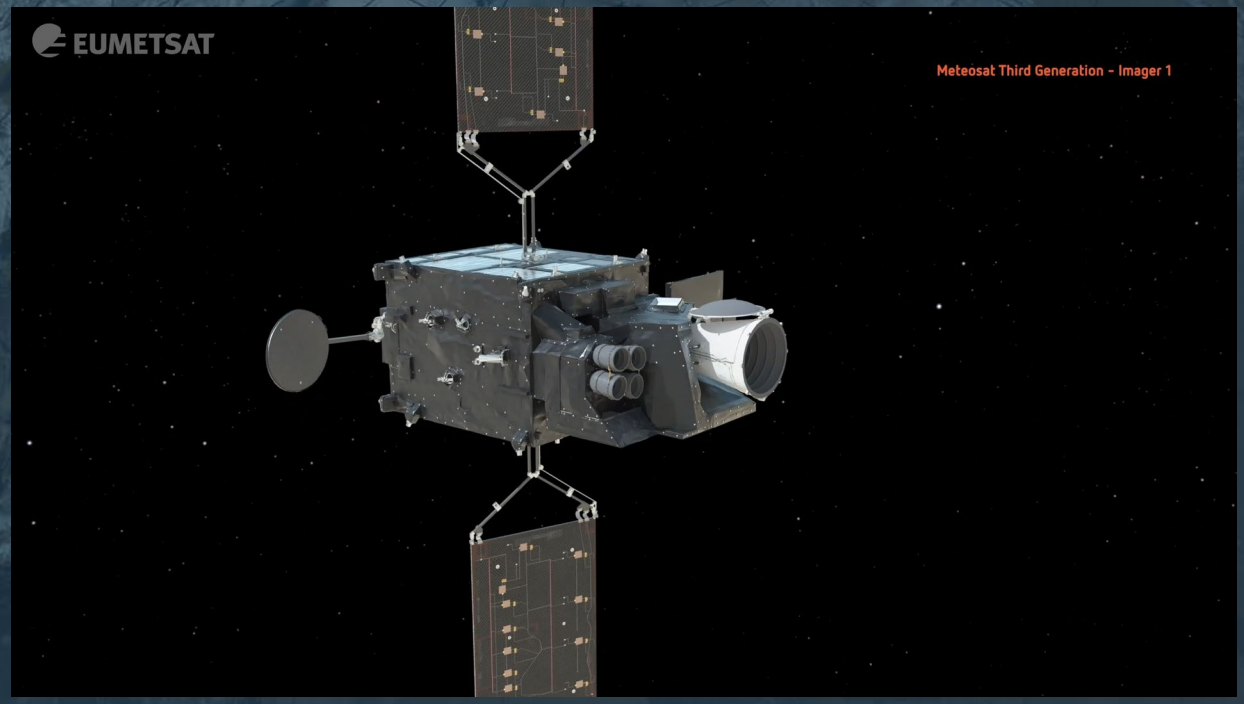


MTG-I2

Rapid Scanning Service

- 16 spectral channels over Europe every 2.5 minutes
- Lightning Imager

1. Nowcasting and short-range forecasting of high-impact weather
2. Air quality and atmospheric trace gas monitoring over Europe

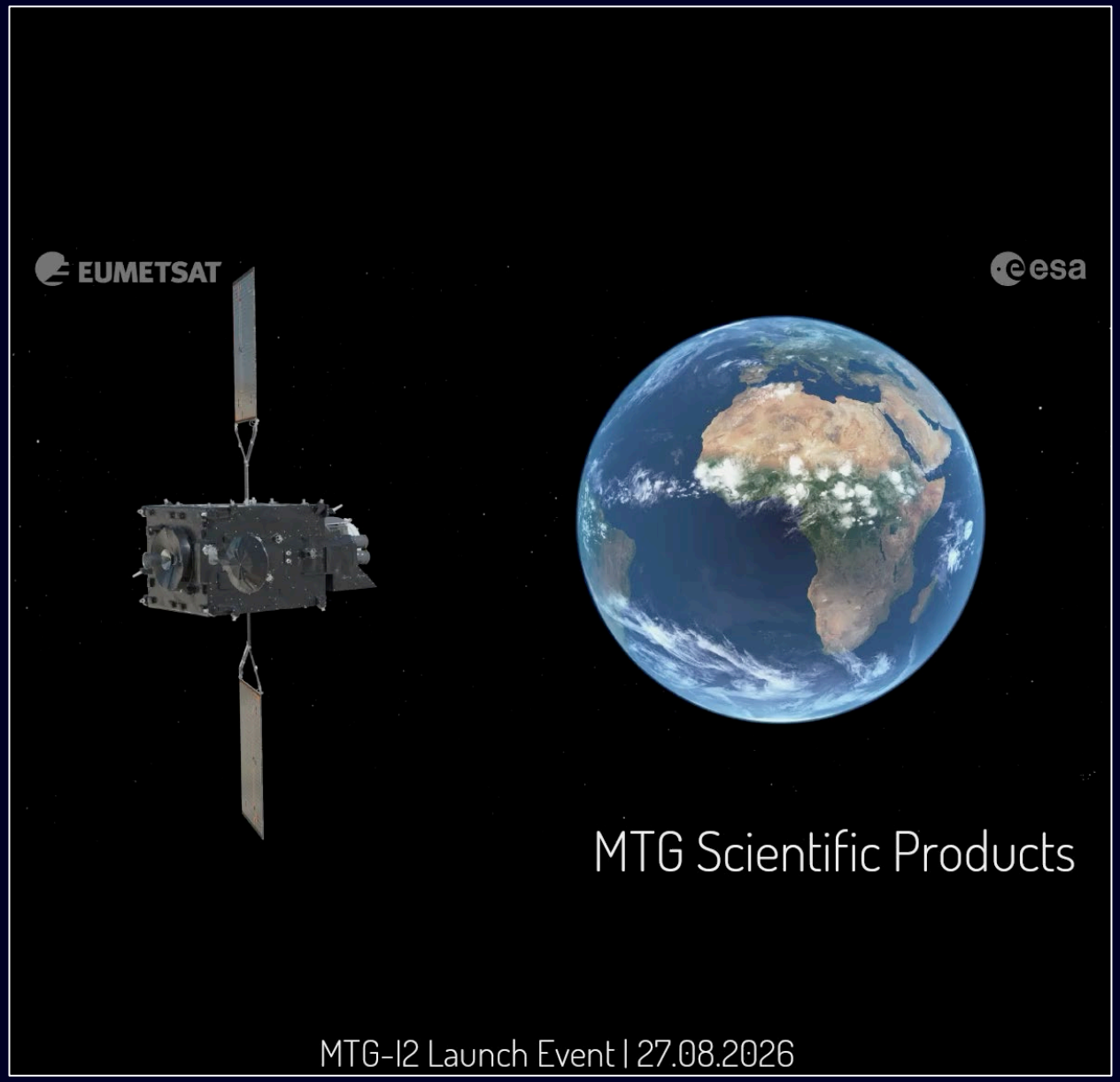


- MTG-I1 launched 13 December 2022
- MTG-S1 launched 1 July 2025
- MTG-I2 launched 27 August 2026

https://user.eumetsat.int/dashboard → User Guides

The western Mediterranean as seen from MTG-I1 (25-27 July, 2026)

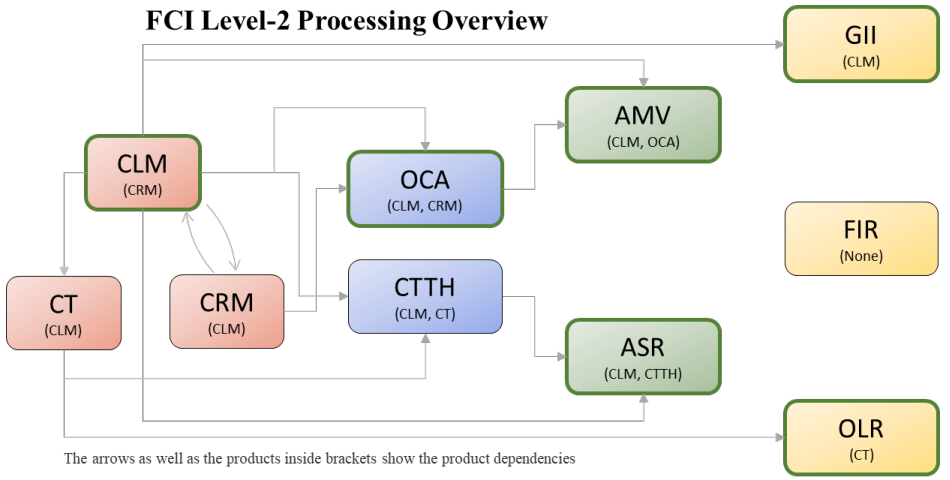
www.eumetsat.int



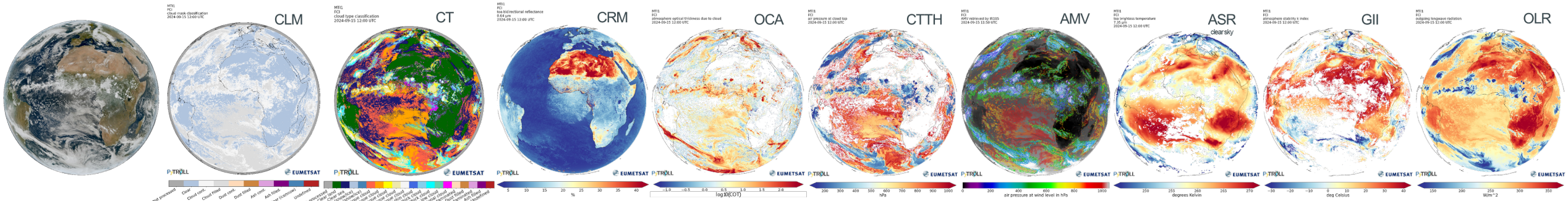
EUMETSAT Central Facility FCI L2 products

- A total of 10 products
- Day-1 priority: ensure SEVIRI continuity → FCI's full potential not yet fully exploited
  - Only normal resolution (FDHSI) data at 1km (VIS/NIR) and 2km (IR)
  - New VIS/NIR channels are generally not used yet
- 7 / 10 products now have **operational status**
- Additional FCI L2 products available via the Satellite Application Facilitates (SAFs)

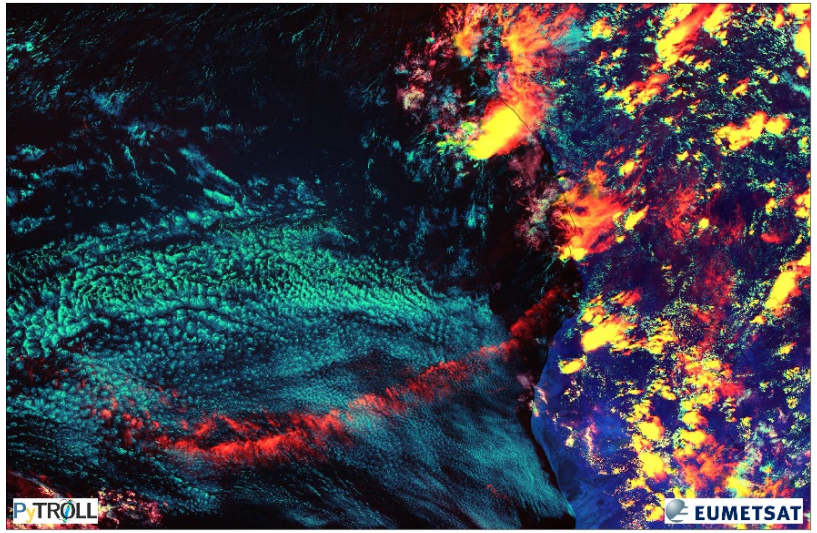
www.eumetsat.int

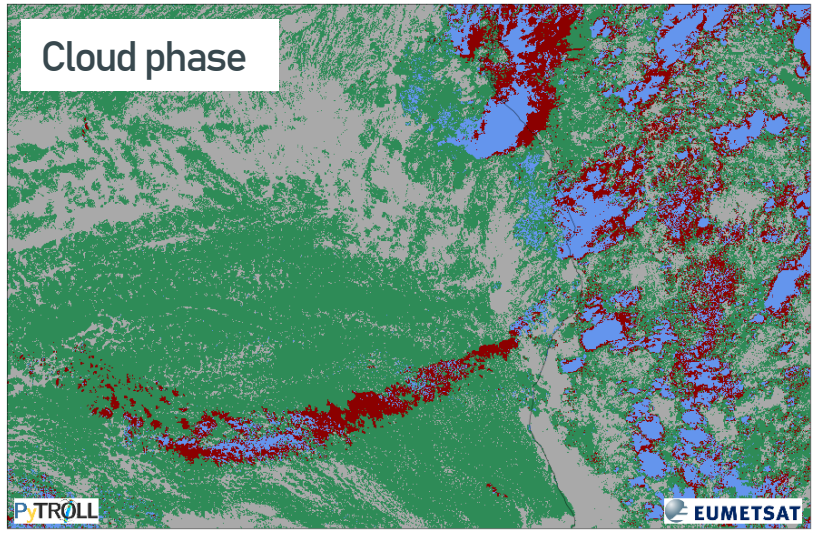


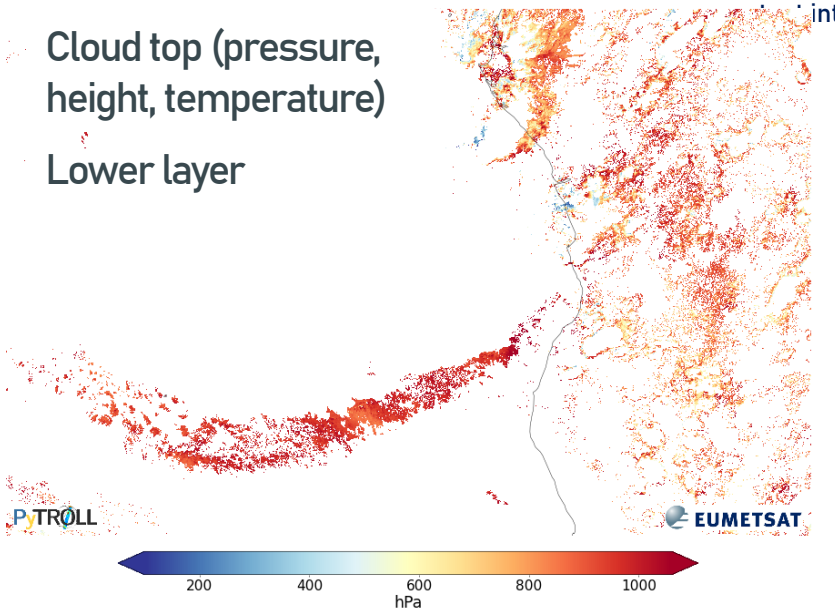
Operational	Pre-operational	Demonstrational
• Cloud Mask (CLM) • Clear-sky Reflectance Maps (CRM) • Optimal Cloud Analysis (OCA) • All-Sky Radiances (ASR • Atmospheric Motion Vectors (AMV) • Global Instability Indices (GII) • Outgoing Longwave Radiation (OLR)	• Cloud Top Temperature and Height (CTTH) • Active Fire Monitoring (FIR)	• Cloud Type (CT)

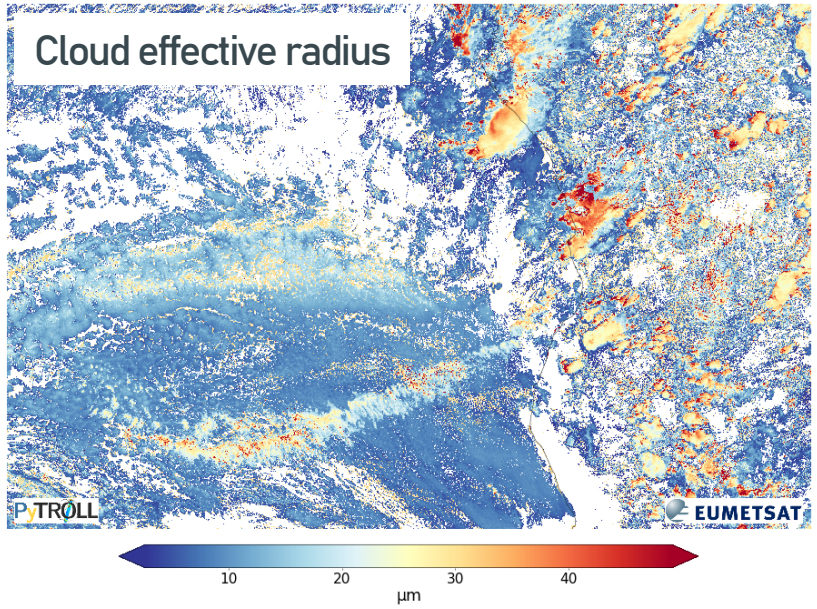


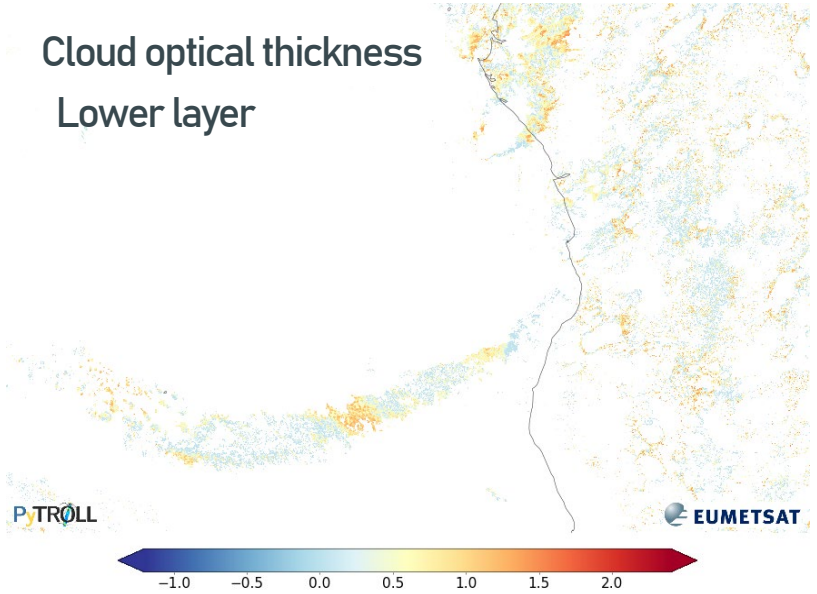
OCA datasets







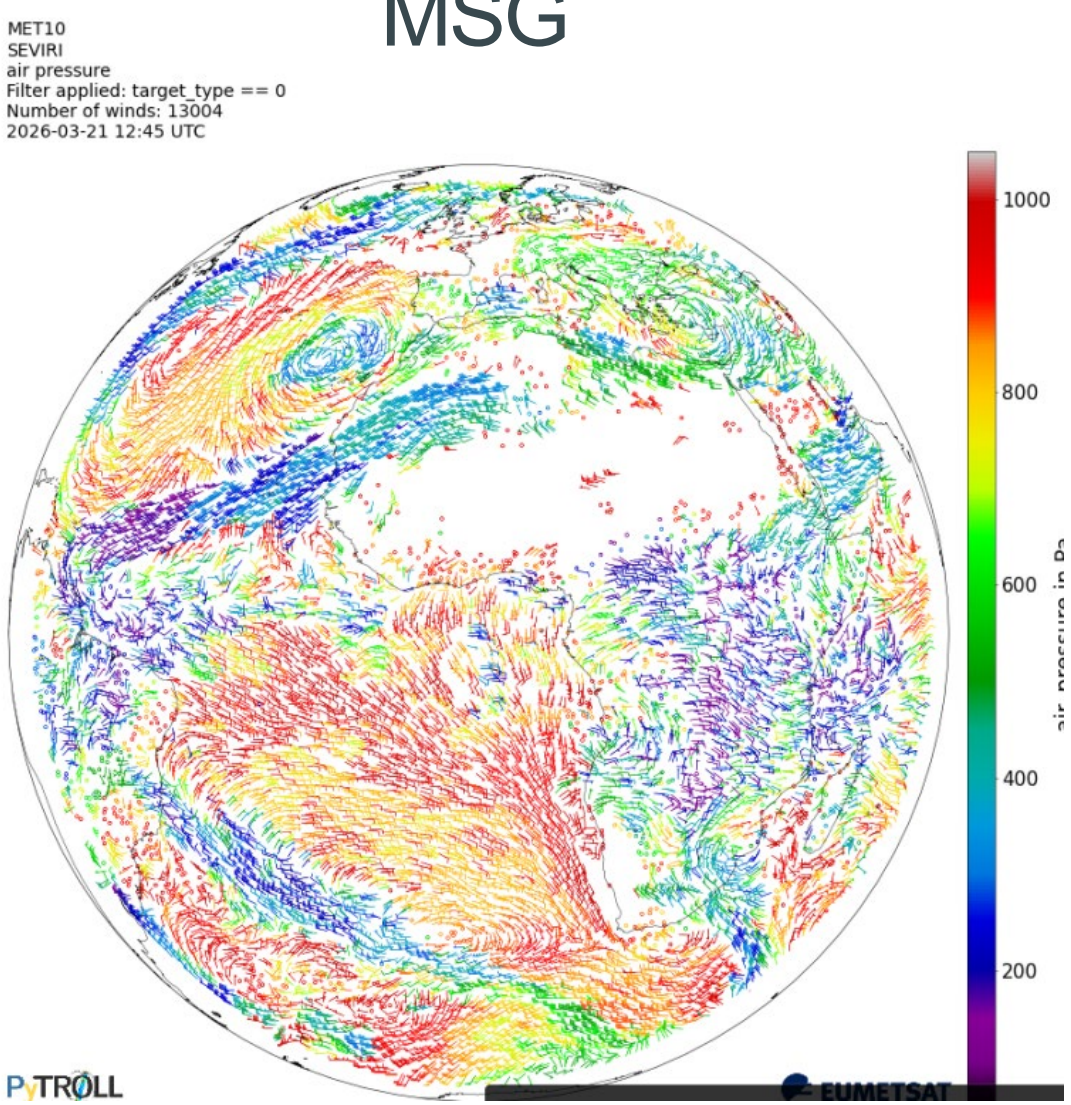




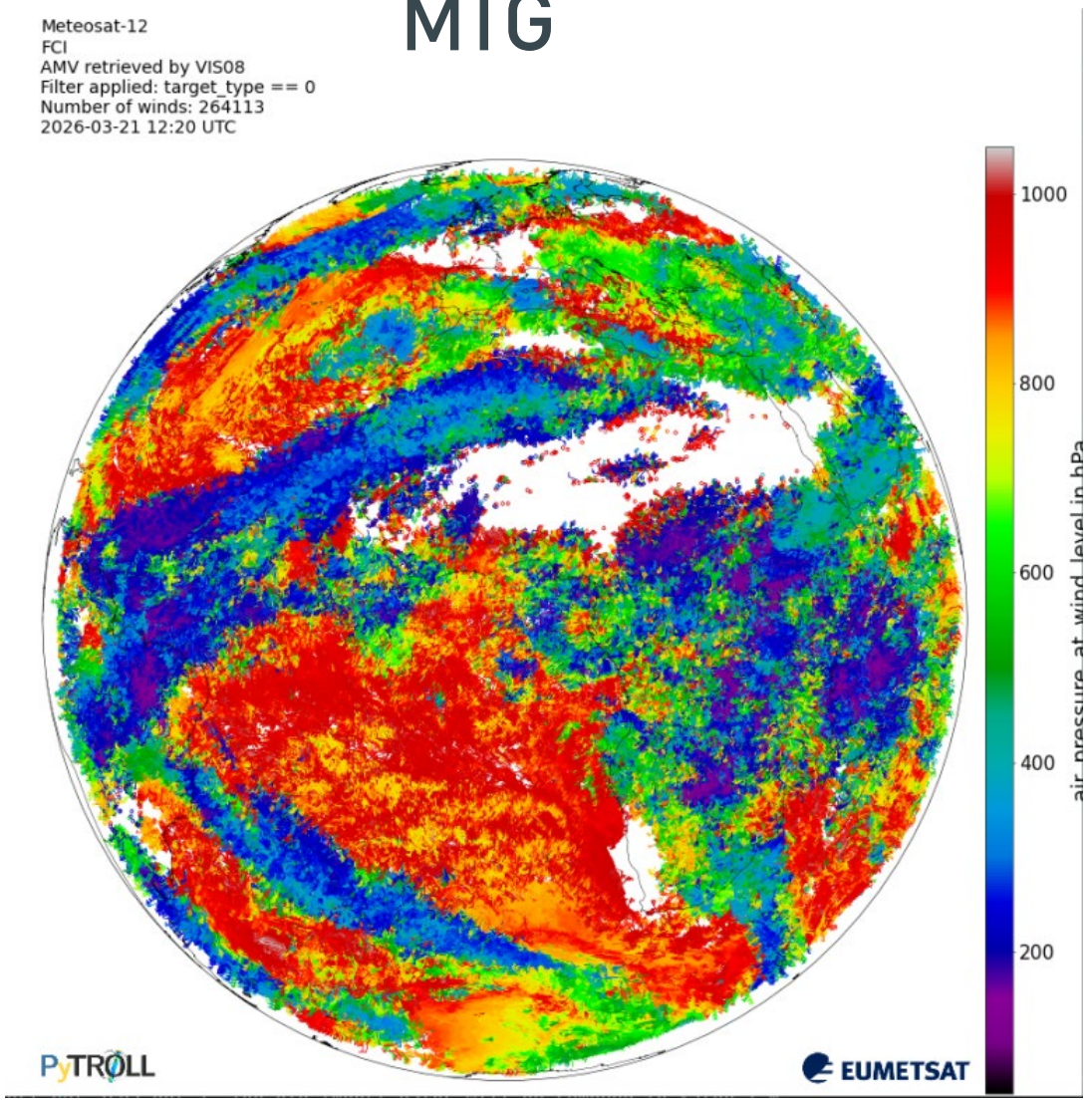
- Microphysics only available for upper layer
- Two-layer retrieval quality depends on the relative optical thickness of the overlapping layers

VIS08 21/03/2026 12:00 UTC

MSG



MTG



MTG-S sounding mission



- Hyperspectral infrared sounding mission
- 4D weather cube: temperature, water vapour, O_3, every 30 minutes over Europe
- Air quality monitoring and atmospheric chemistry in synergy with Copernicus Sentinel-4 instrument

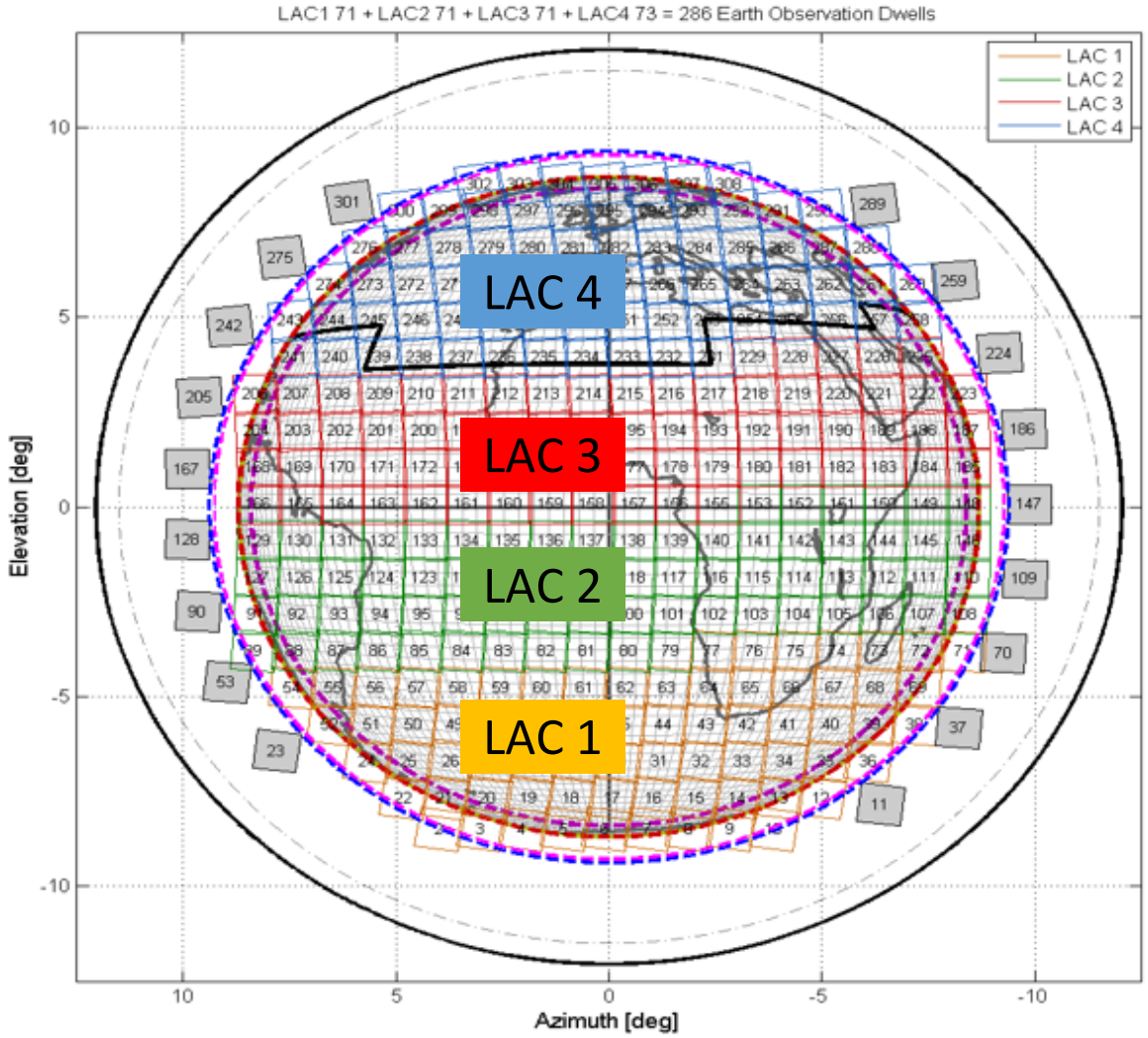
MTG-S IRS Quick Facts

www.eumetsat.int



	Platform	Lifespan	Orbit	Sampling	Footprint
IRS	MTG-S	2025-2041	GEO	0.61 cm^{-1}	4 km

- 4 Local Area Coverages (LACs)
- step-and-stare approach, scans single dwell in 9.7 seconds
- each LAC fully scanned in 15 minutes. LAC 4 (covering Europe) is scanned every 30 minutes
- Horizontal resolution 4x4 km at Sub satellite point (SSP), varies with satellite viewing angle (~7 km Central Europe)



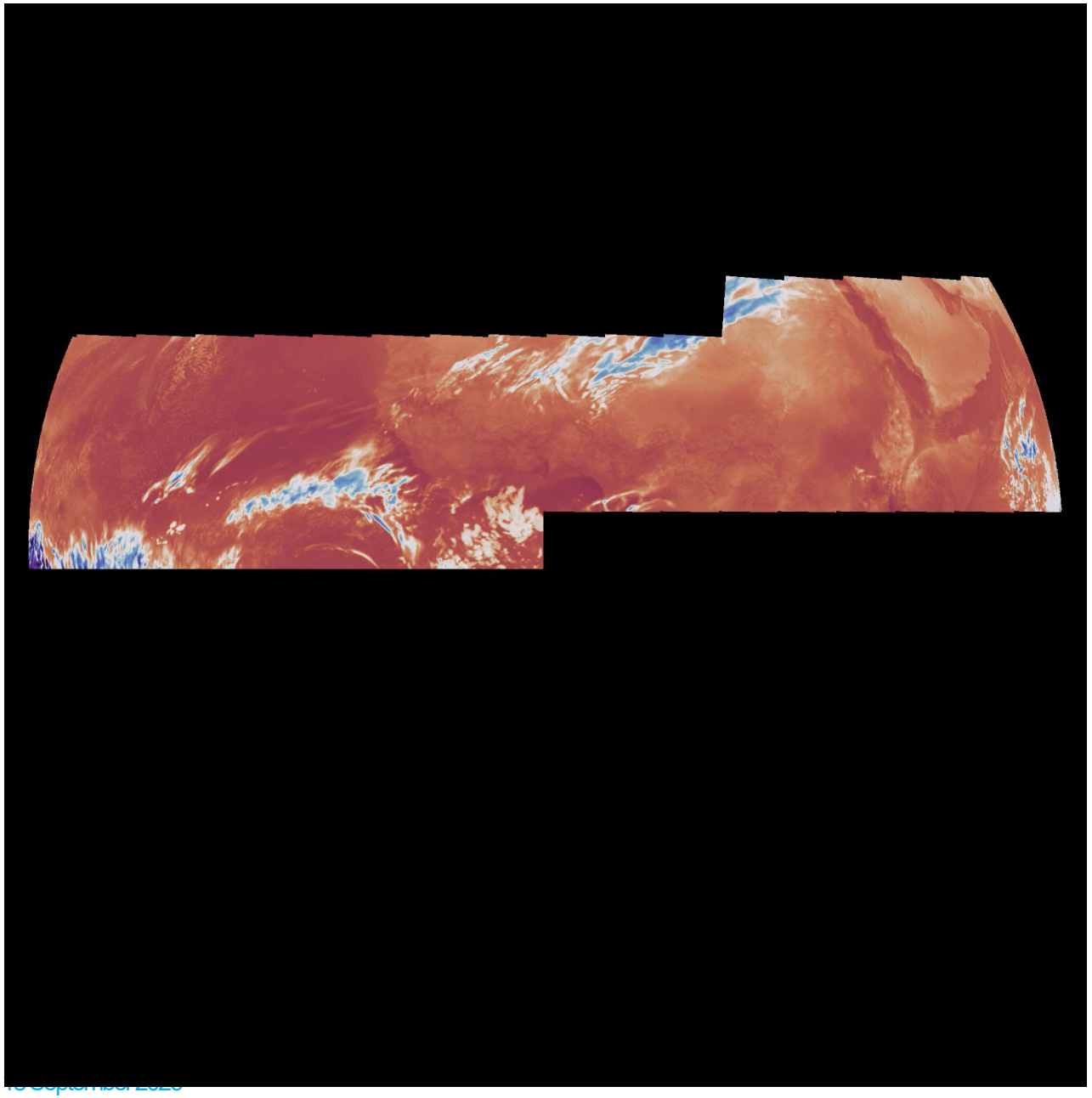
Scan Pattern: Simulated Brightness Temperatures: LWIR channel 438

LAC 4

LAC 3

LAC 2

LAC 1

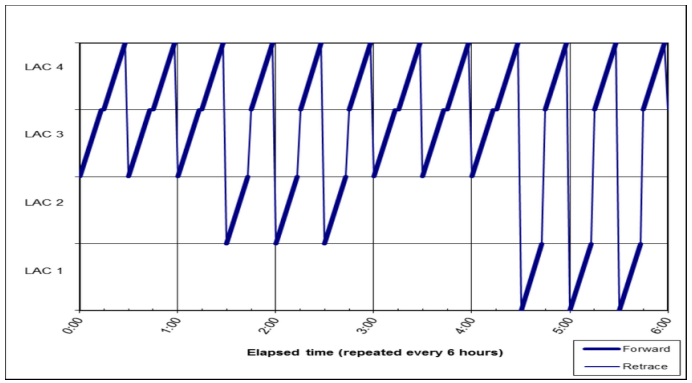




Nominal Scan Pattern

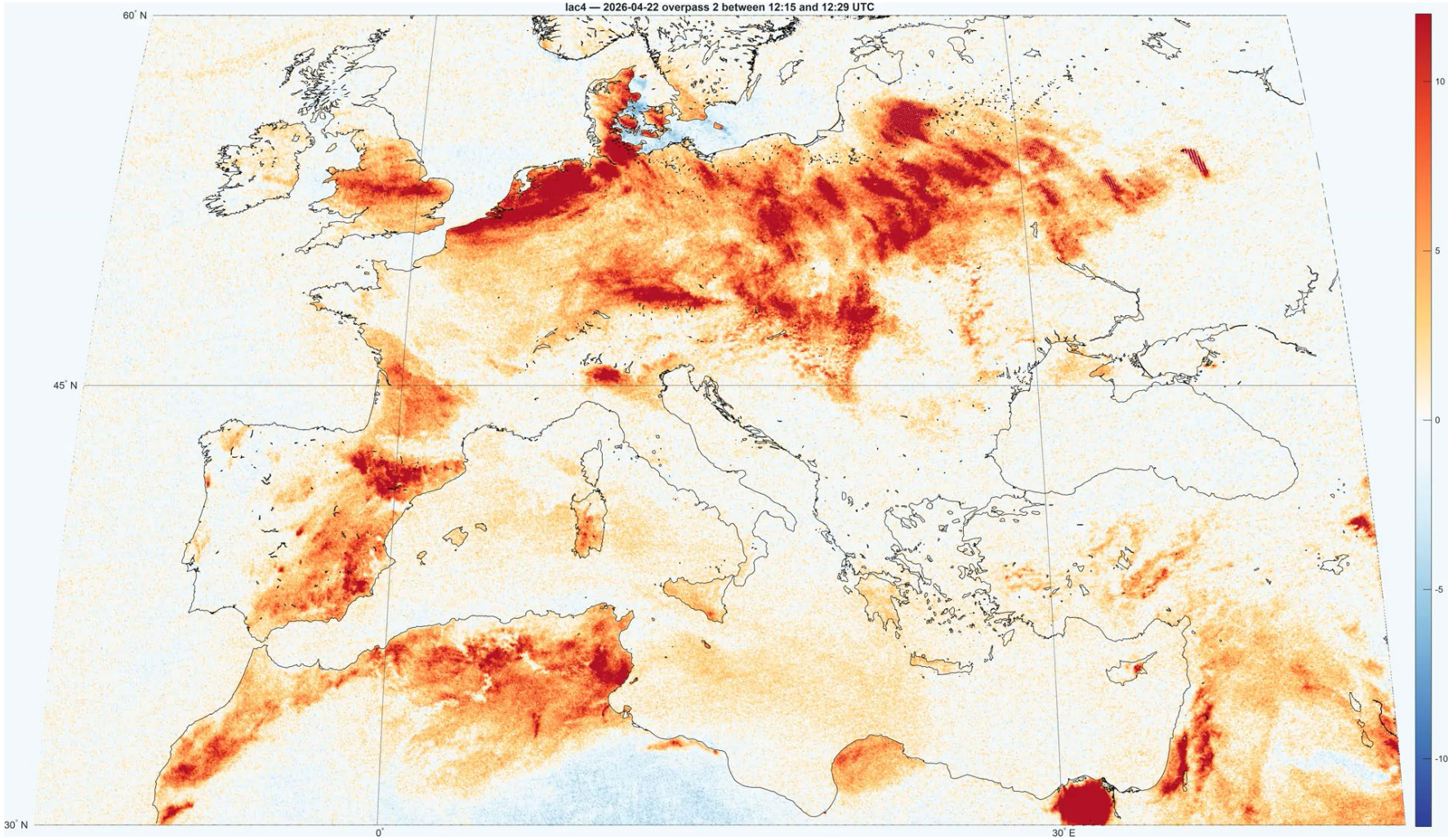
- optimized for coverage and calibration needs (fully configurable)

6-hour repeat cycle **x4 for full day**



Example of user feedback - *ammonia (ULB)*

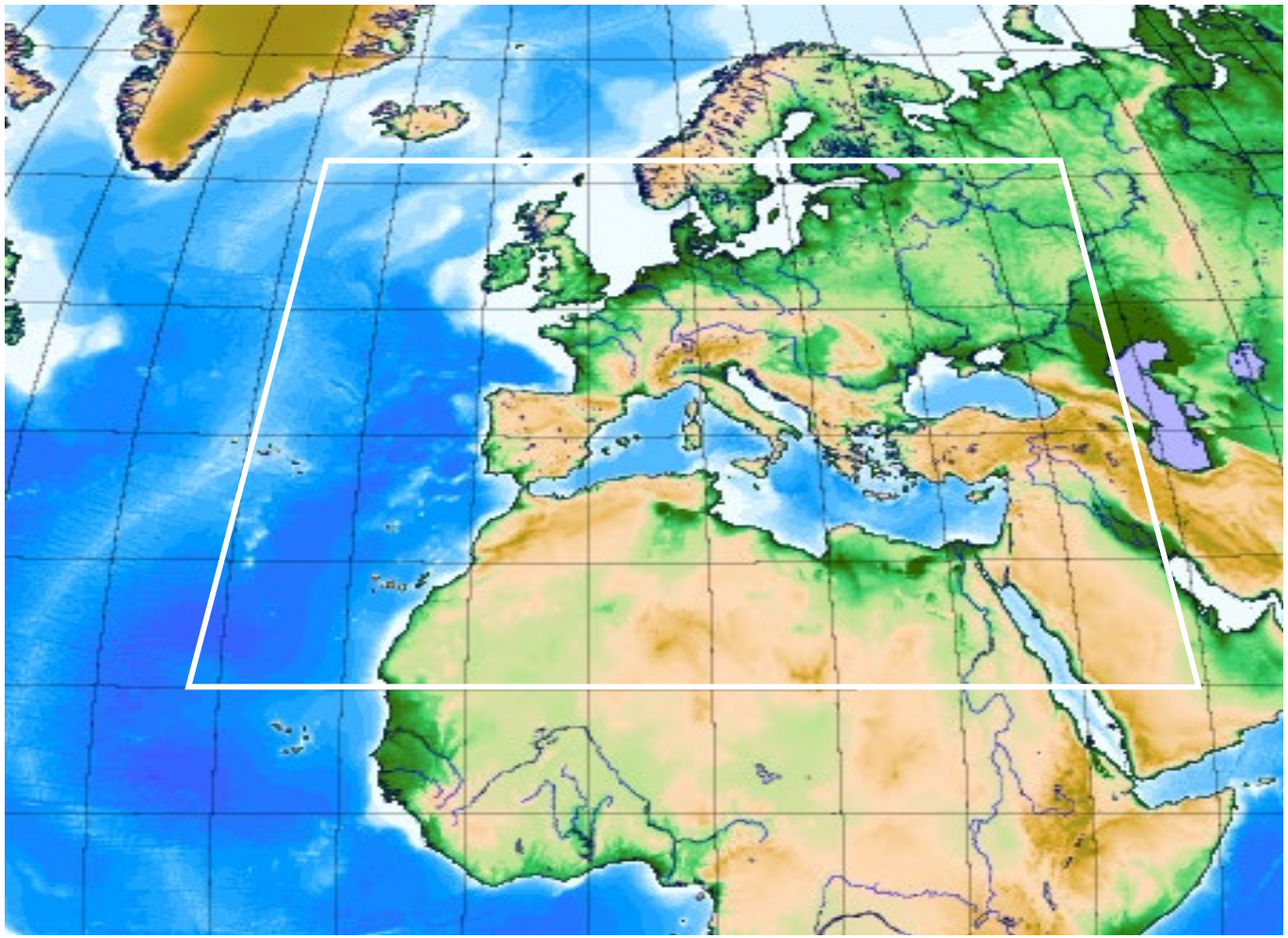
A sneak peek at global NH_3 distributions from IRS (early dissemination)



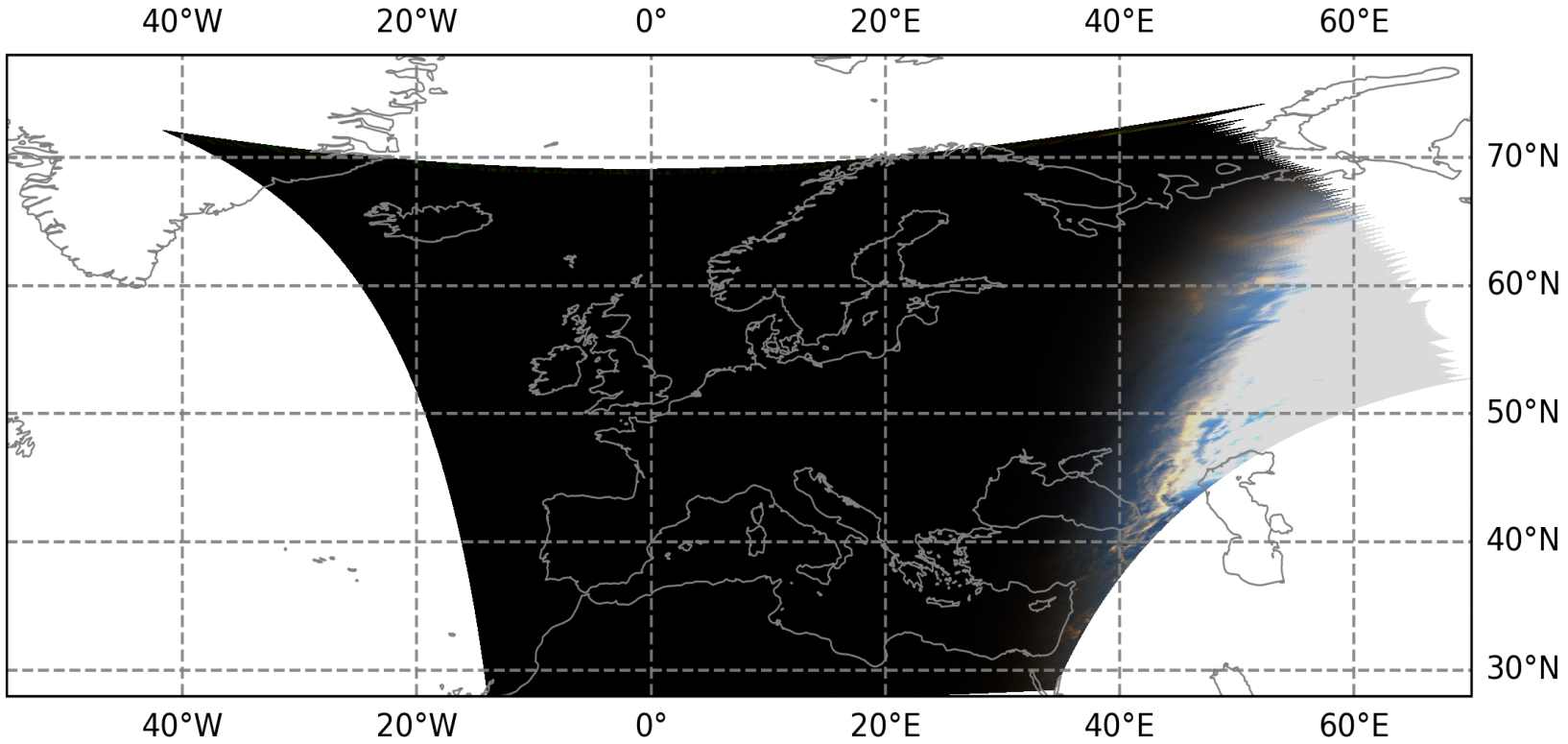
Credit: Pierre Coheur and Lieven Clarisse (ULB)

MTG: the Infrared Sounder and Copernicus Sentinel-4 synergy

MTG-S	
Infrared Sounder	**S4-UVN**
O_3	
CO	NO_2
NH_3	SO_2
	VOC (H_2CO, CHOCHO)
	Aerosol / PM



Sentinel-4/UVN scan pattern



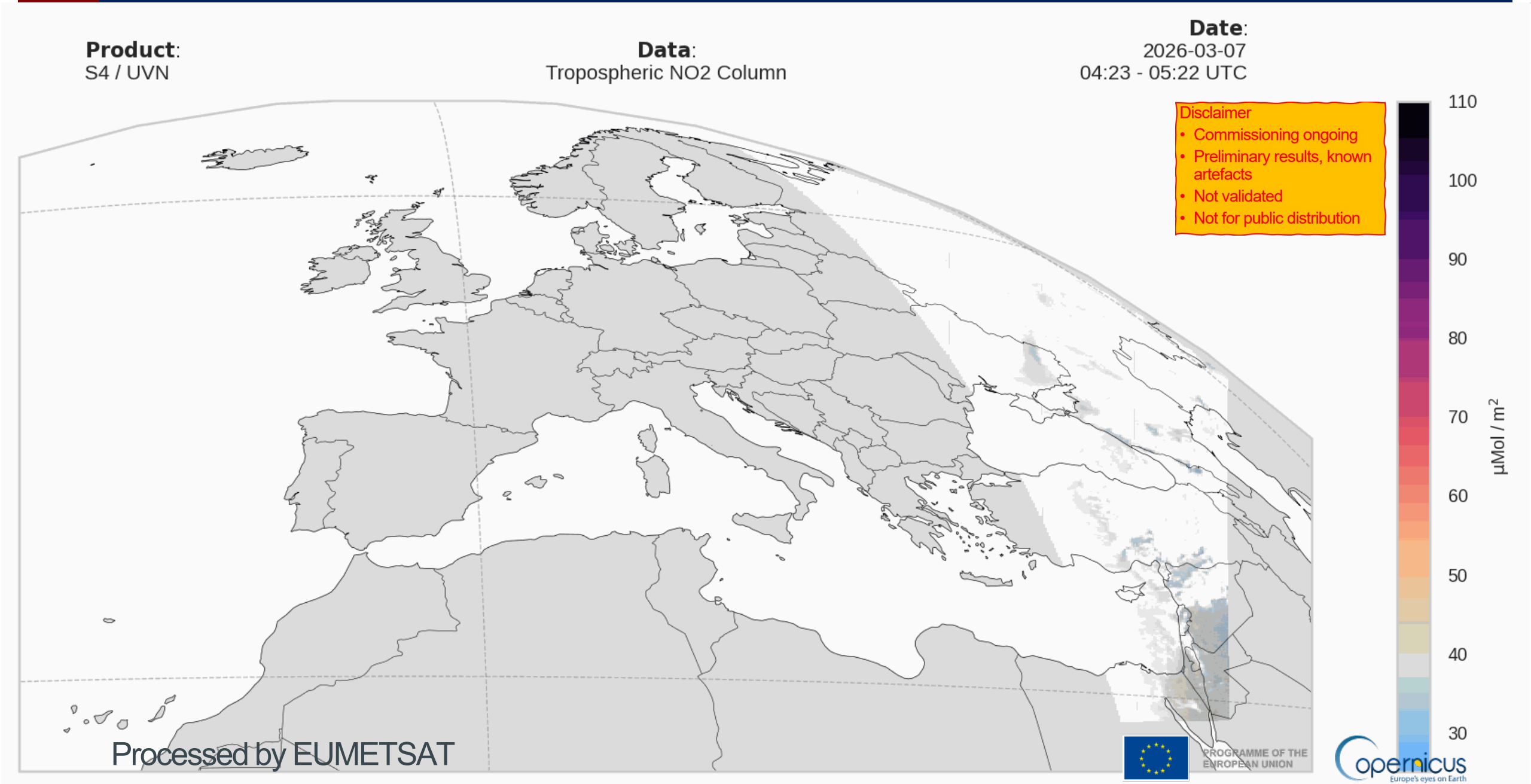
Processed by EUMETSAT

- Overall daily Earth observation pattern consists of a series of 1 hour-long East-to-West scans (“repeat cycles”) with a fast West-to-East retrace in-between.
- Blue: total area to be covered every day.
- Green: Size of a 1-hour repeat cycle (shifting throughout the day).
- Depending on the seasonally varying duration of Earth illumination by the Sun, the daily Earth observation scan series consists of 16 (winter) to 20 (summer) 1h-scans.

PROGRAMME OF THE EUROPEAN UNION Copernicus Europe's eyes on Earth IMPLEMENTED BY EUMETSAT

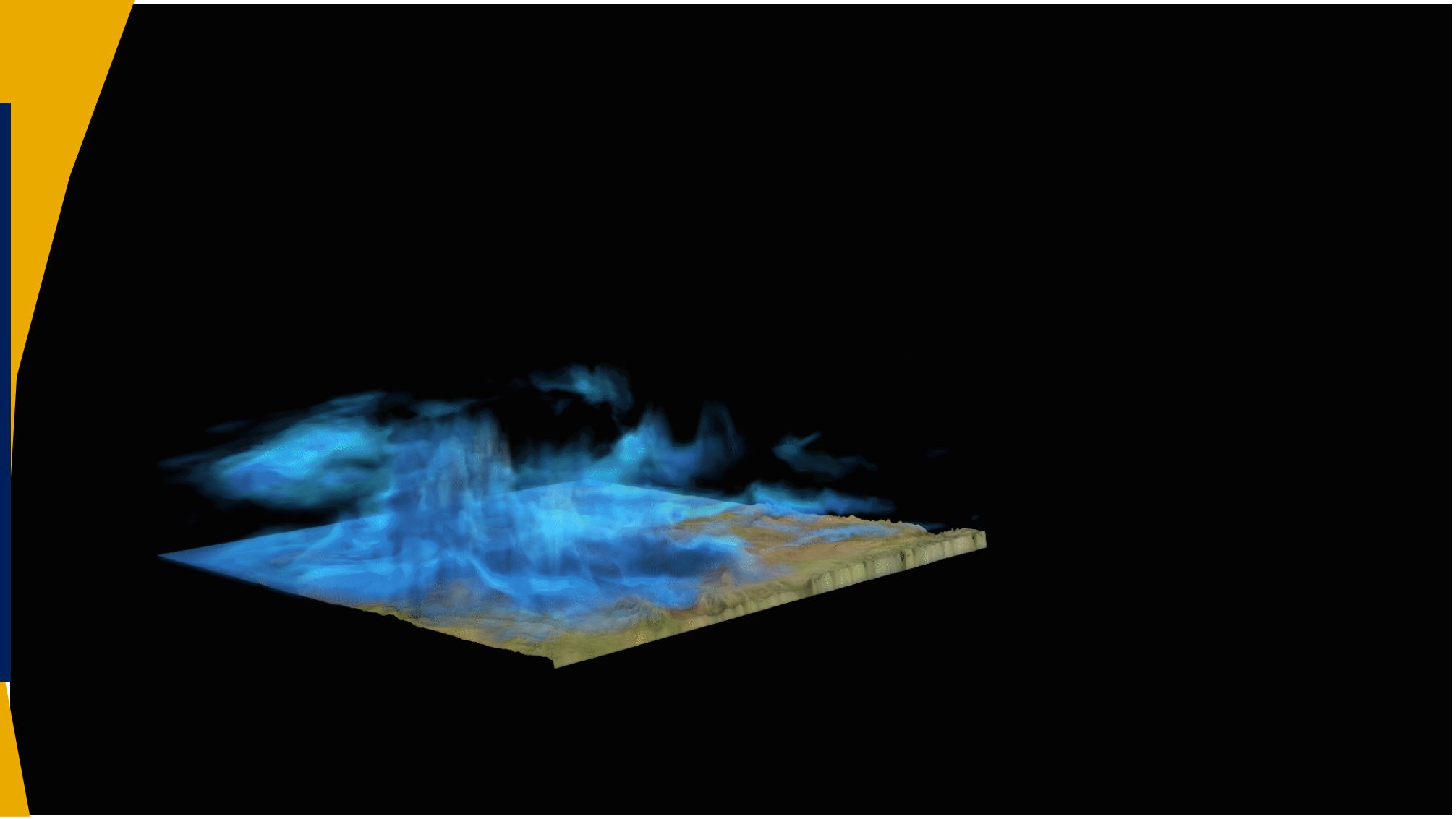
PROGRAMME OF THE EUROPEAN UNION Copernicus Europe's eyes on Earth

Sentinel-4/UVN: Some early impressions

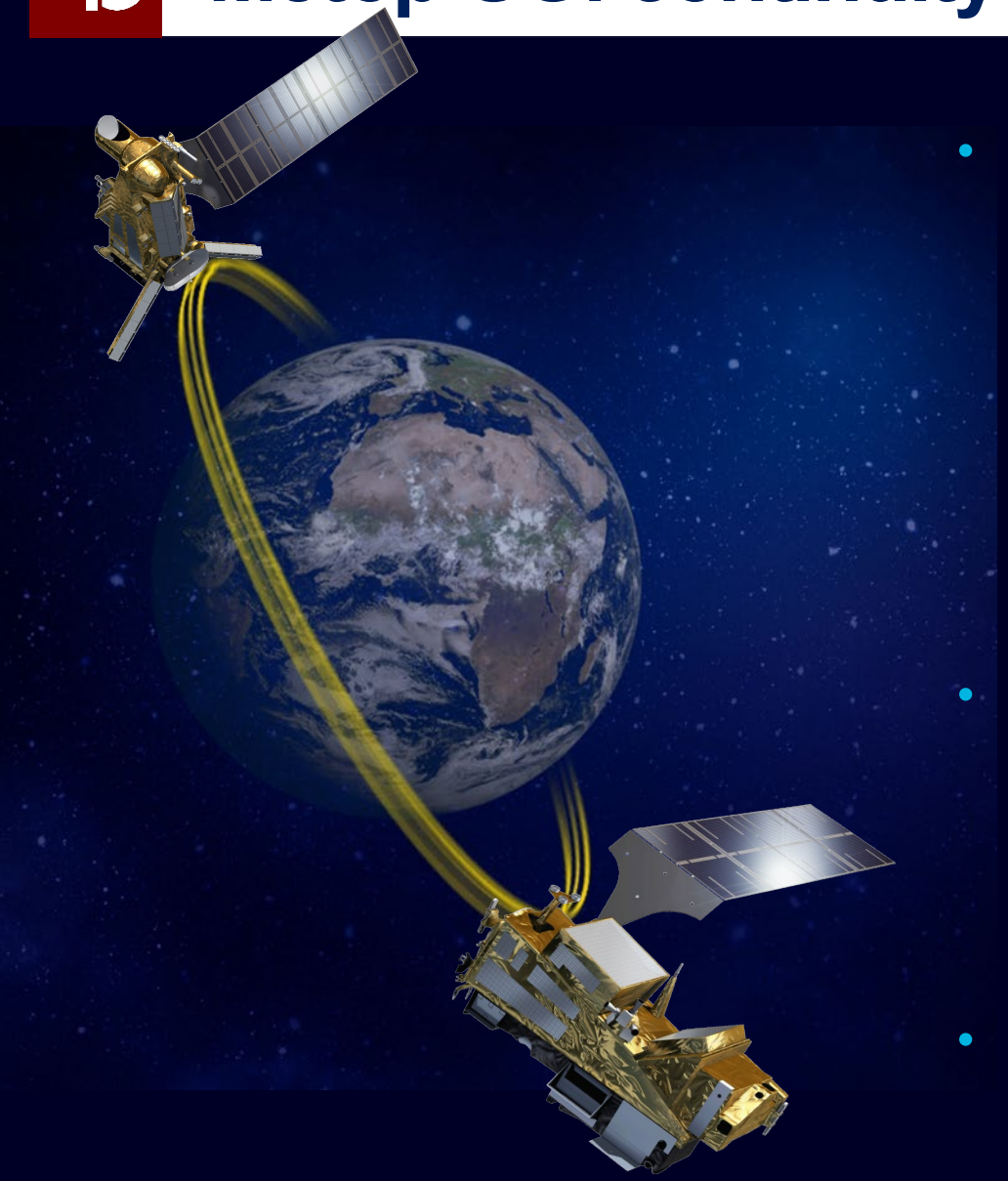


4D weather cube with MTG-I and MTG-S

The “4D weather cube”, enabled by MTG instruments, will for the first time allow forecasters to simultaneously track meteorological phenomena, such as convection, winds and lightning, to more accurately detect and forecast rapidly developing, high-impact weather.



Metop-SG: continuity beyond 2040

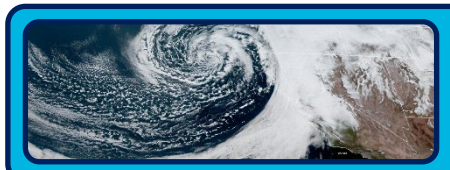


- Major improvements to all Metop observation missions:
  - Infrared and microwave sounding (IASI-NG by CNES, MWS by ESA)
  - Optical imagery (METImage, developed by DLR)
  - Scatterometer (SCA, ESA)
  - Radio occultation (RO, ESA)
  - UVN Spectrometer (Copernicus Sentinel-5)
- New imaging missions:
  - 3MI: first operational imaging polarimeter (ESA and CNES)
  - MWI: microwave imagery of precipitation (ESA)
  - ICI: Ice Cloud imagery (ESA)
- Two satellite system:
  - Metop-SGA: Sounding and imaging (launched Aug. 13, 2025)
  - Metop-SGB: Microwave imaging and scatterometry (end-2026)

Instrument Capabilities

3MI	• Aerosol – optical thickness, particle size, type, height, absorption; volcanic ash; cloud phase, height, optical depth; surface albedo
IASI-NG	• Temperature/humidity profile at high vertical resolution in clear air, clouds, trace gases (O_3, CO, CH_4, CO_2,…), sea/land/ice surface temperature, aerosols, volcanic ash
METimage	• Hi-resolution cloud products, incl. microphysics; aerosols; polar AMVs; vegetation, snow, fire; sea/ice/land surface temperature; support to sounding missions
MWS	• Temperature/humidity profiles in clear and cloudy air; cloud liquid water total column; imagery: precipitation
RO	• Refractivity profiles at high vert. resolution; temperature / humidity profiles; PBL top and tropopause height; ionospheric electron content
Sentinel-5	• Ozone profile and column; columns of CO_2, SO_2, NO_2, H_2O, CO, CH_4, aerosol optical depth; columns of BrO, HCHO, OCHCHO; volcanic plumes
SCA	• Ocean surface wind vectors; soil moisture; snow equivalent water; sea-ice type
MWI	• Precipitation and cloud products; water vapour imagery; sea-ice, snow, sea surface wind
ICI	• Cloud products, in particular ice clouds; snowfall detection and quantification; water-vapour profiles and imagery

Mapping Instruments to Applications



Numerical Weather Prediction

- IASI-NG, METimage, MWS, RO, SCA, MWI, ICI, 3MI



Nowcasting

- 3MI, IASI-NG, METimage, MWS, SCA, MWI, ICI



Oceanography

- METimage, SCA, MWI, ICI



Hydrology

- METimage, SCA, MWI, ICI



Atmospheric Composition and Air Quality

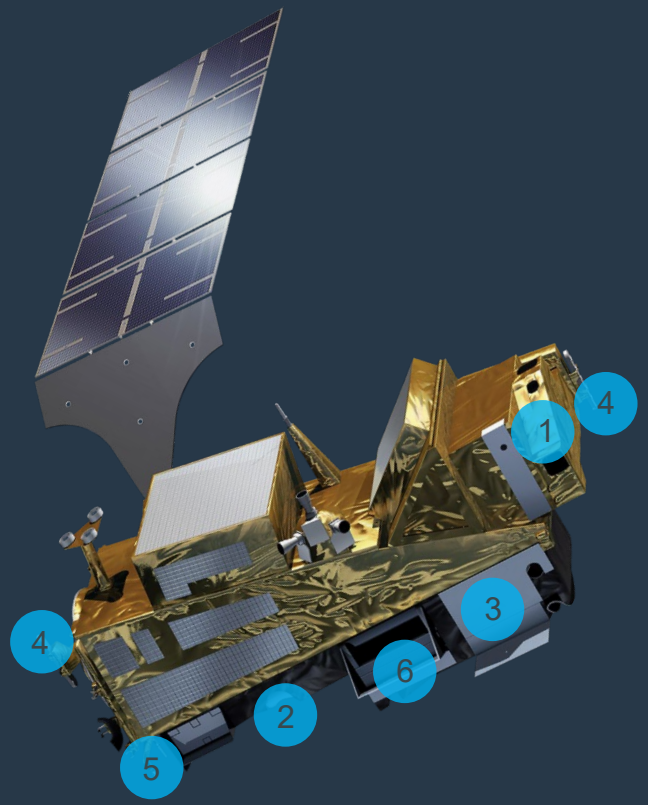
- 3MI, IASI-NG, Sentinel-5



Climate Monitoring

- 3MI, IASI-NG, METimage, MWS, RO, Sentinel-5, SCA, MWI, ICI

Metop-SGA sounding and imaging mission



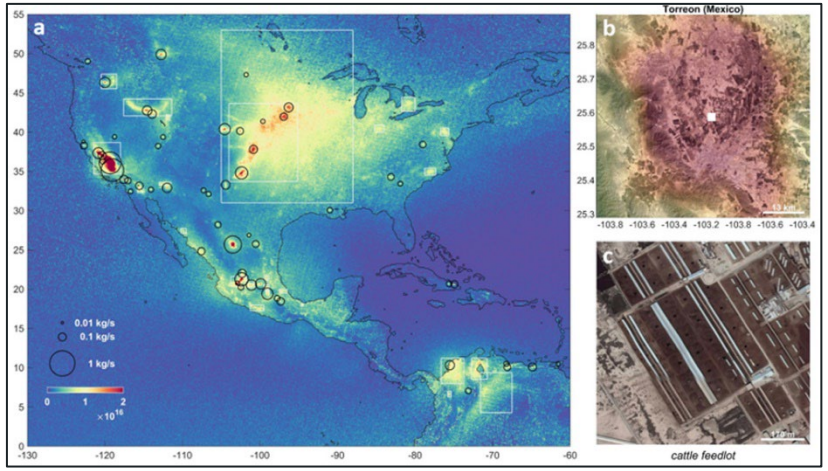
1. Infrared Atmospheric Sounding Interferometer – New Generation (IASI-NG)
2. Microwave Sounder (MWS)
3. METimage Visible-infrared imaging
4. Radio Occultation (RO)
5. 3MI (Multi-viewing, -channel, -polarisation Imager)
6. Copernicus Sentinel-5 (UV/VIS/NIR/SWIR sounder)

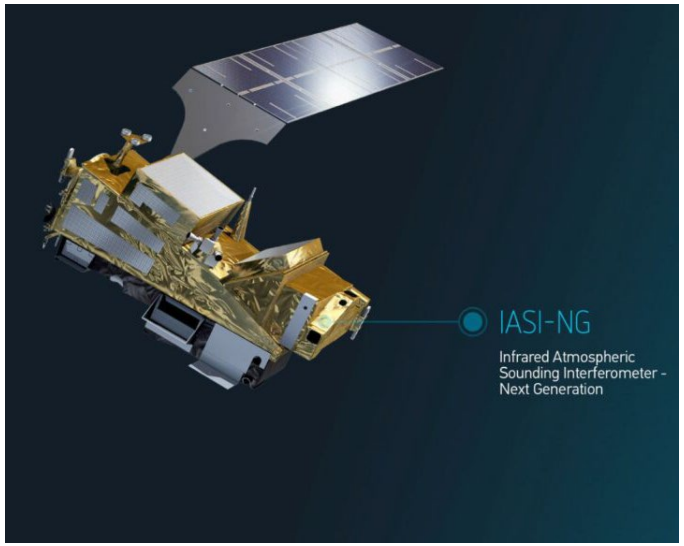
IASI-NG: continuing and surpassing the IASI legacy

For almost 20 years, IASI has been:

- ✓ One of the most important sources of observations for weather forecasting;
- ✓ The worldwide reference instrument for intercalibration.

IASI also contributes to the monitoring of currently 33 atmospheric species including greenhouse gases (CO_2, CH_4…), pollutants (CO, NH_3…) and ozone depleting molecules (CFCs)





IASI-NG will:

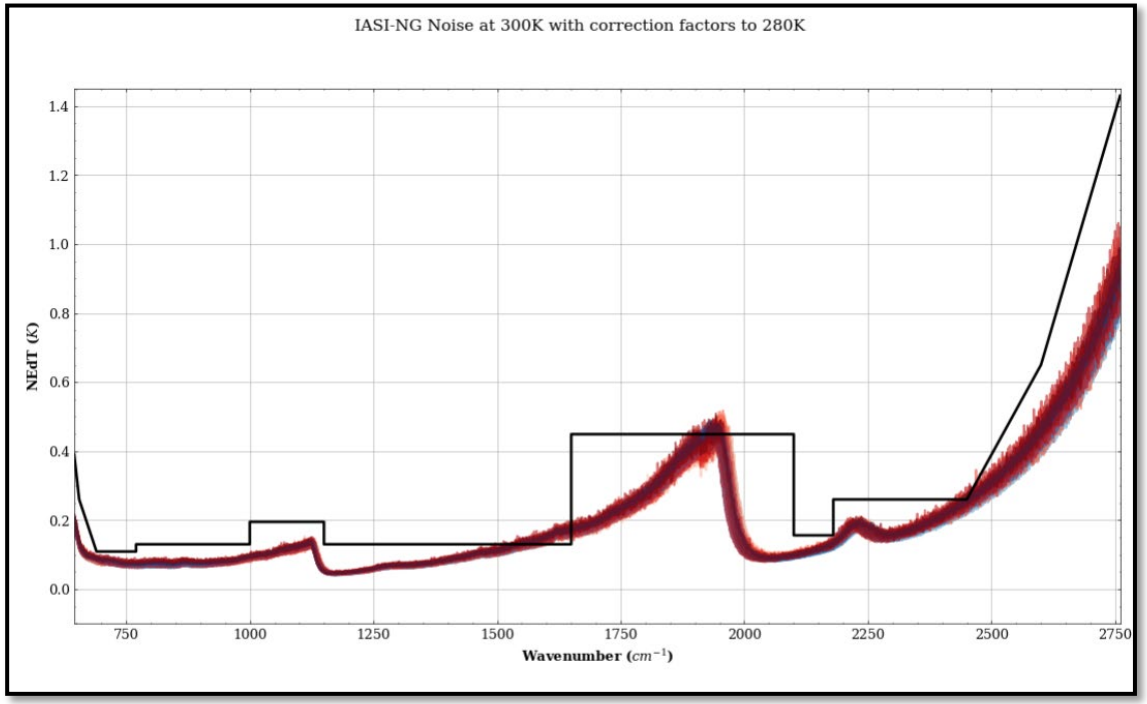
→ Continue the extraordinary legacy of IASI for another 20 years for numerical prediction and climate monitoring;

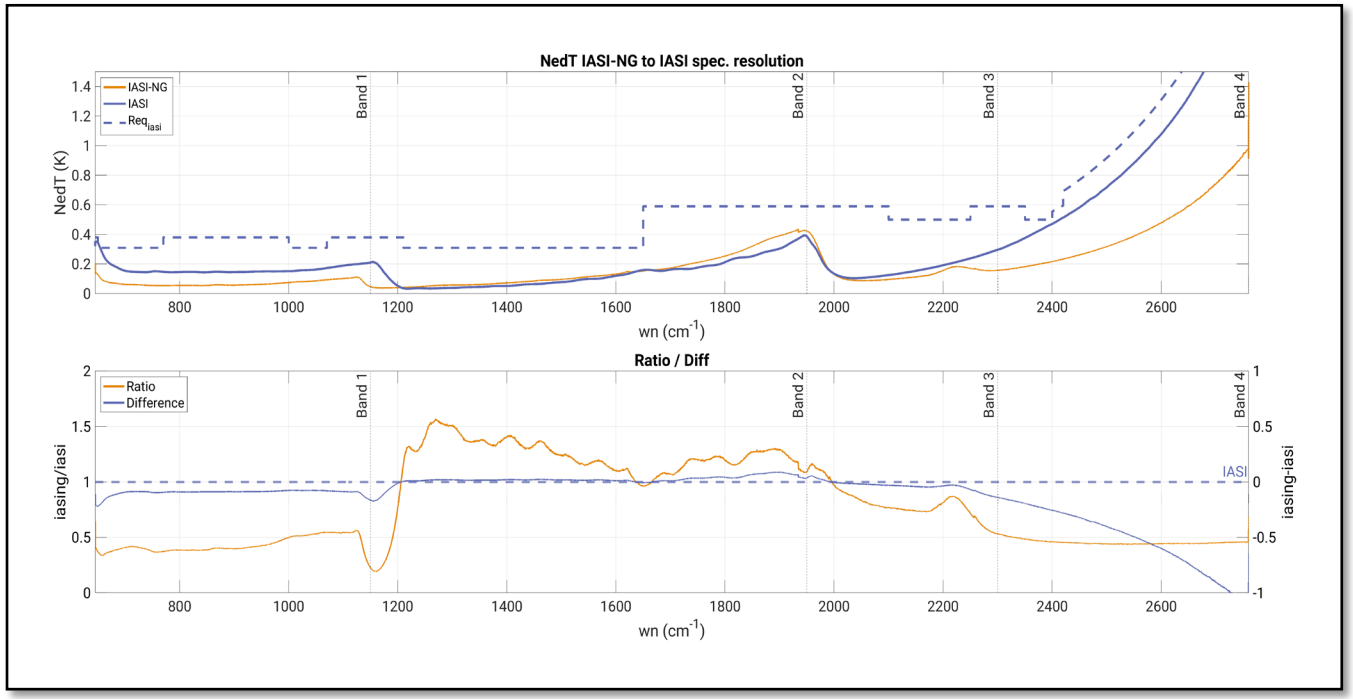
→ Improve the detection of pollution sources, such as the detection of local industrial pollution, thanks to its fine spectral resolution and low noise;

→ Provide the opportunity to detect new species which cannot be detected with IASI

IASI-NG Performances - NedT

The NedT is estimated on internal Blackbody measurements at 300K – converted to equivalent 280K.

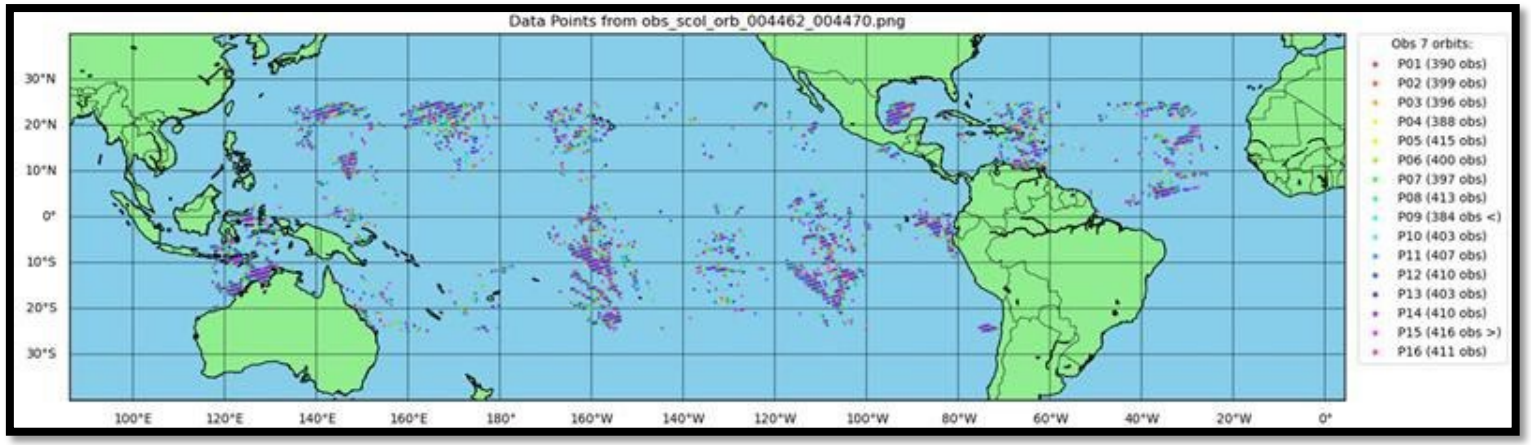


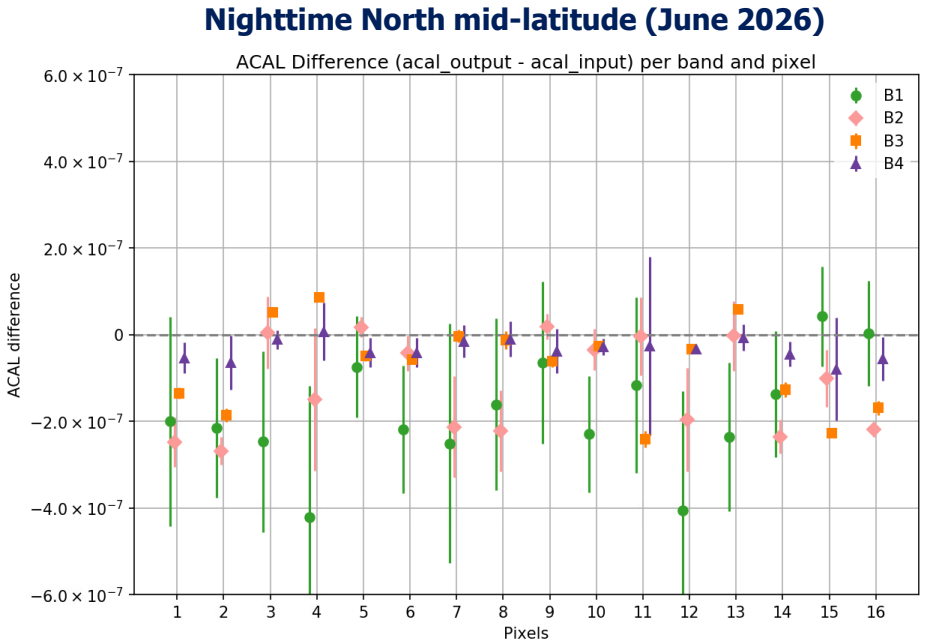


➔ TVAC (red) vs Flight (blue) NedTs are **very close and within requirements**

➔ Significant improvement with respect to IASI at the same resolution in Bands 1,3, and 4

IASI-NG Spectral Performance





✓Spectral calibration shows **residuals lower than** 0.5×10^{-6} $(< 0.5ppm)$ for all bands and pixels

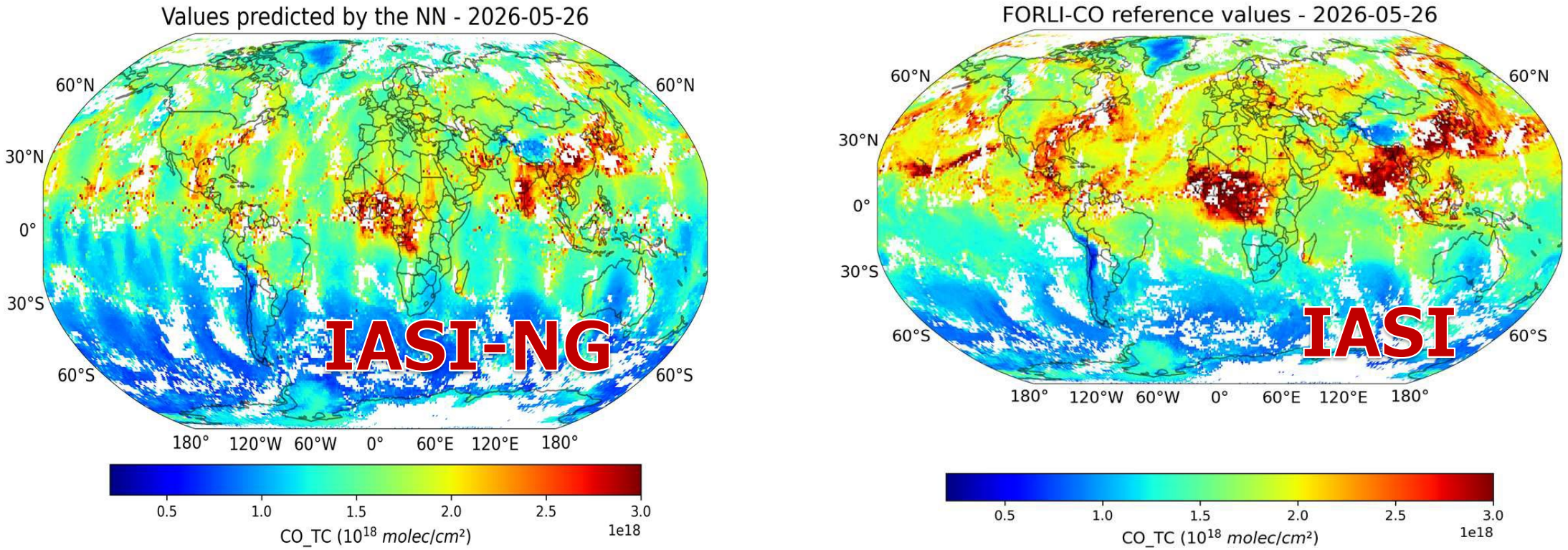
✓ Regular estimates of the spectral shift since December 2025 have shown **no seasonal, no orbital evolution, no drift** of the spectral shift.

✓ Small effects (below performance specifications) are observed:
- Prism movement direction dependency in B1/B2 < 0.3 10^{-6}
- Residual variability (few tenth of 10^{-6}) in B1 under investigation

➔ Spectral performances are reached and very stable

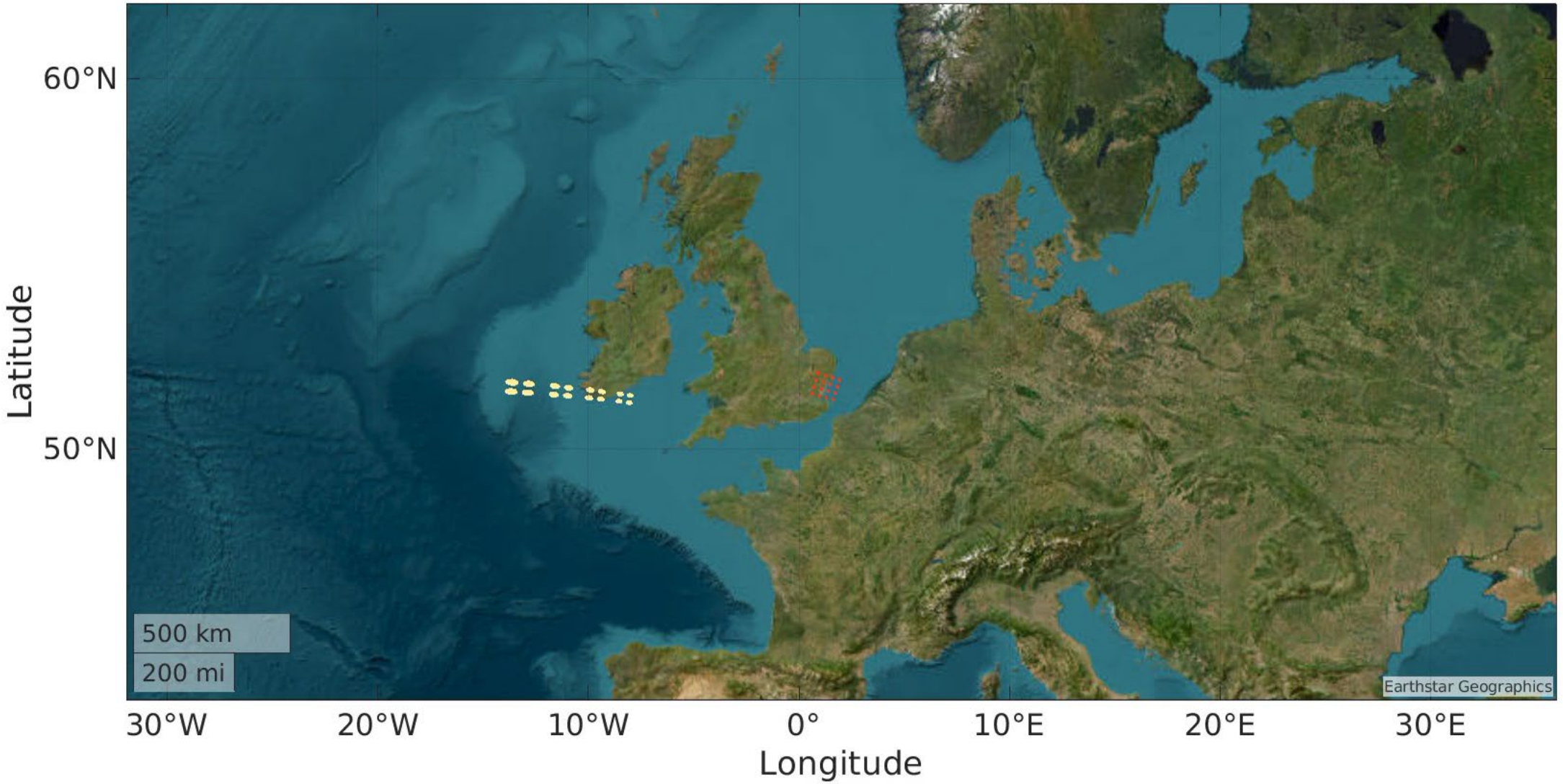
1- Highlight of the IASI-NG L1 Commissioning – User feedback

First CO estimation (LATMOS)



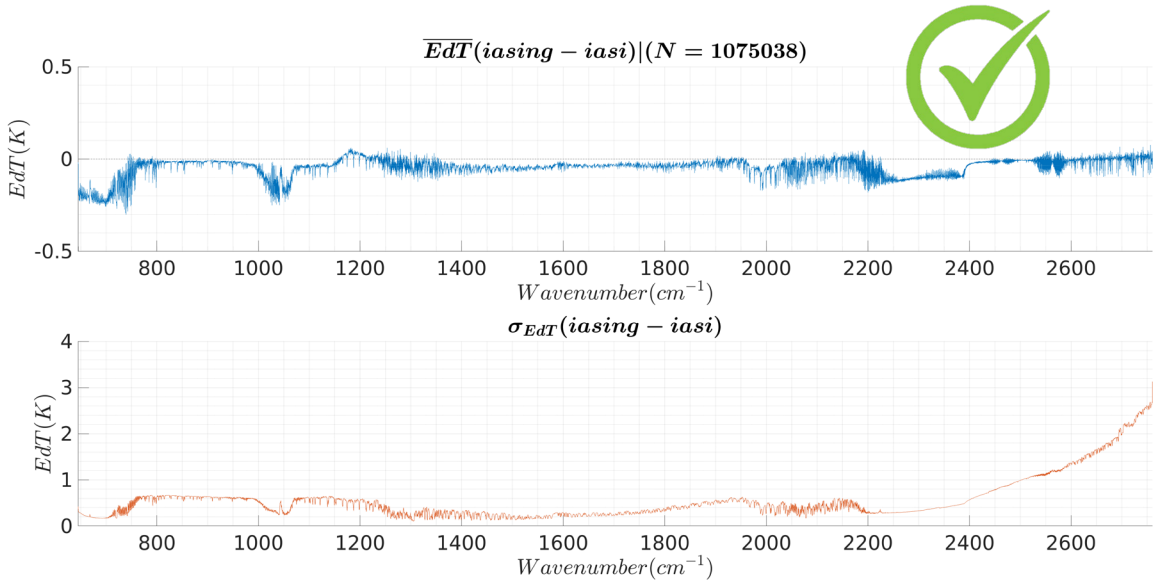
- The patterns are similar, the differences linked to different temperatures dataset used.
- At the edge of the swath, there are higher COTC values (because the IASI-NG FOV is different from the IASI FOV).
- Limitation: the model has been trained for IASI.

2- Tandem flight

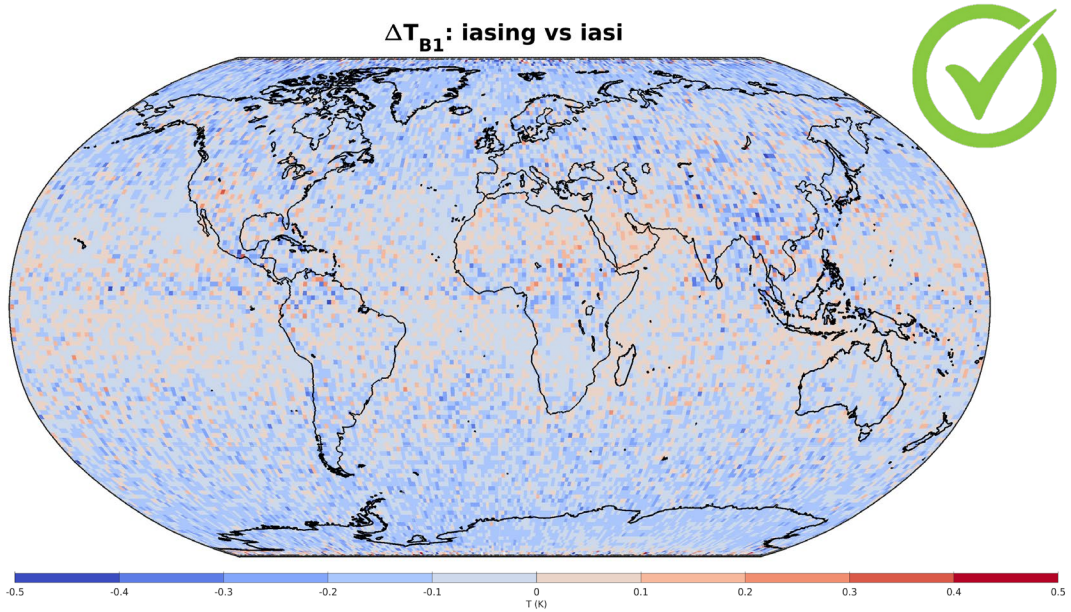


Tandem Flight Results (EUM)

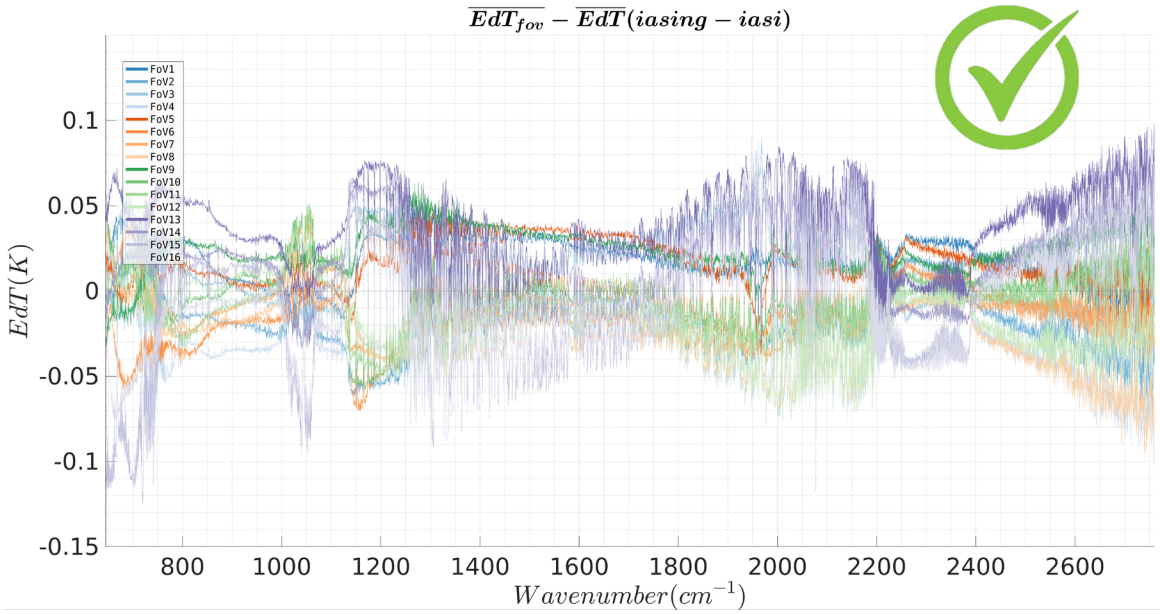
Avg diff



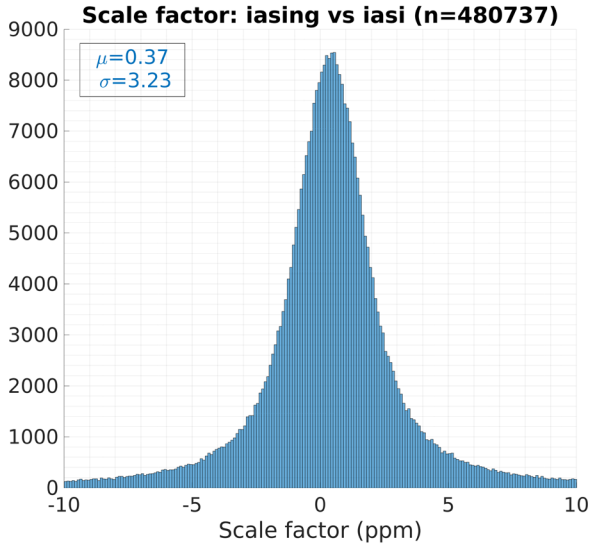
Map diff

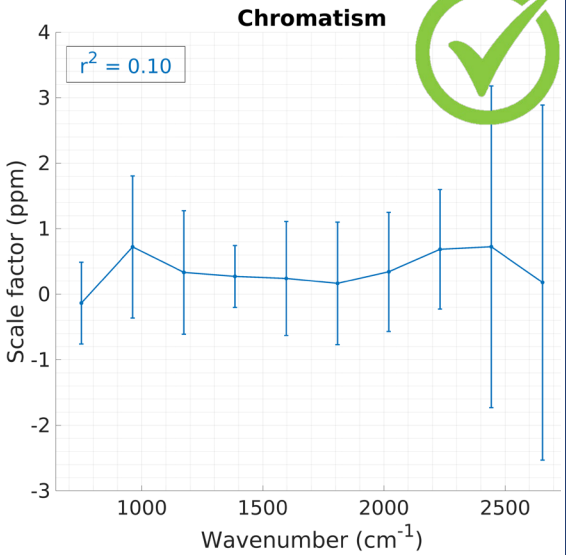


Inter-pixel diff

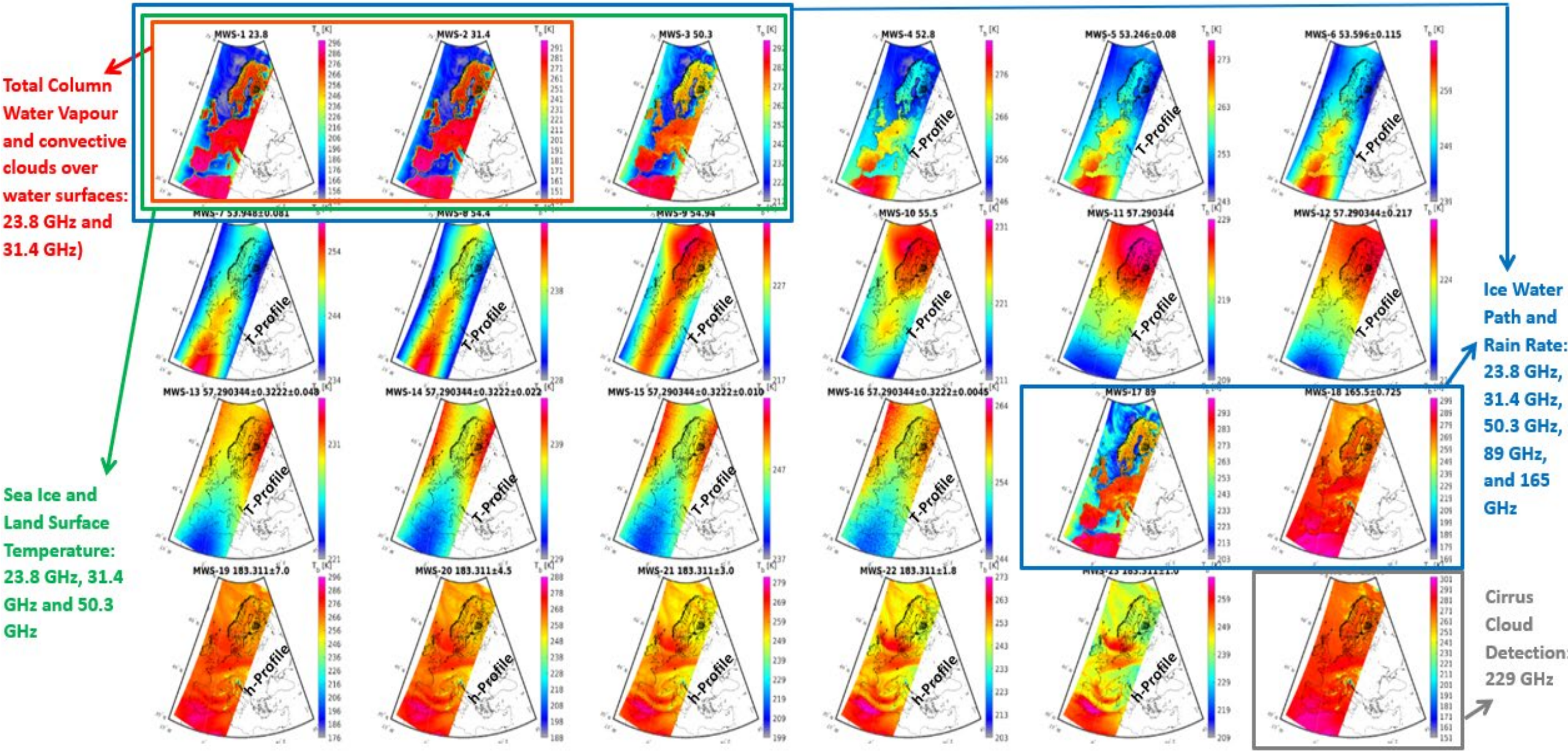


Spectral calibration





MWS Level 1B geolocated brightness temperatures: main applications



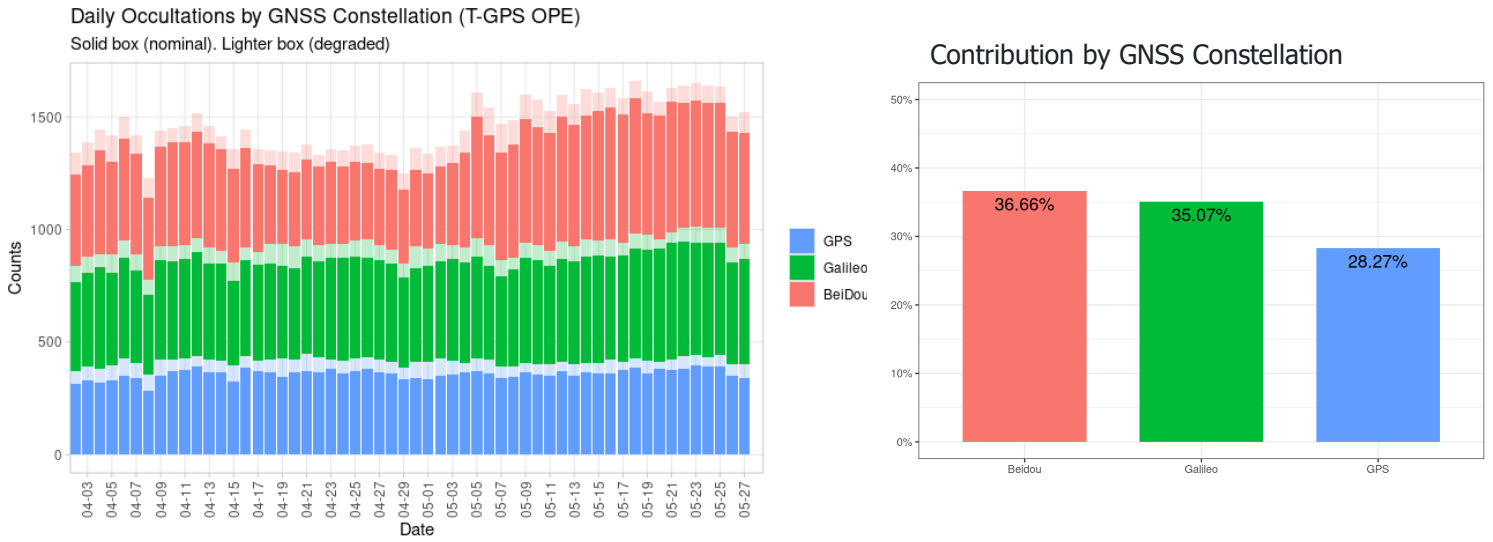
T: Temperature h: humidity

MWS Recap and status

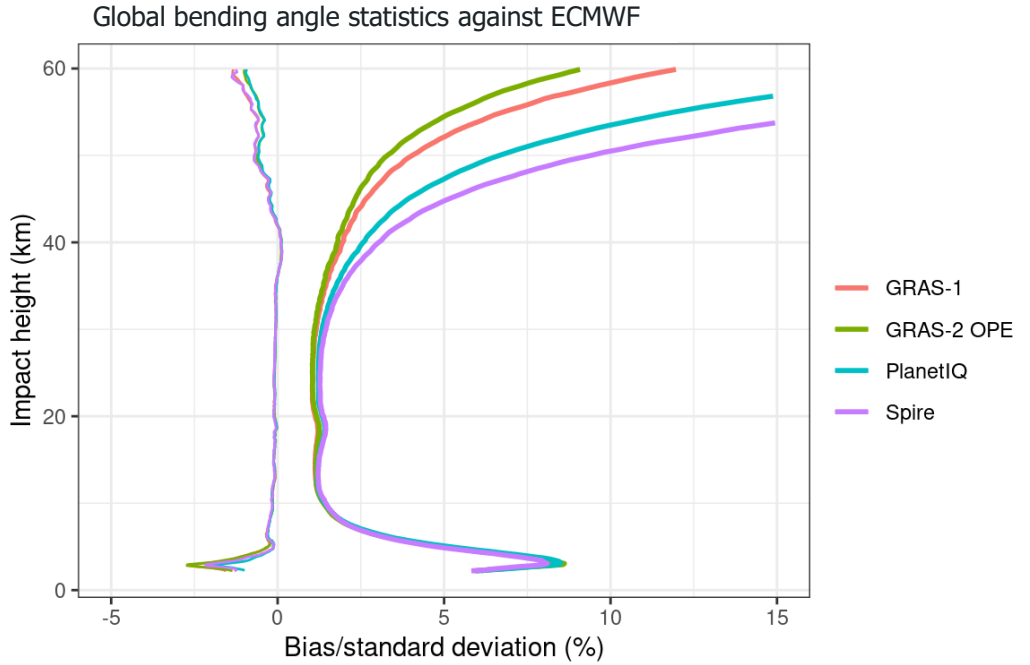
- **The MWS L1B global products were declared operational on 27 August 2026.**
- On 11 March 2026, 15:32 UTC, a sudden increase of the radiometric noise was observed for channels 19 to 23 of MWS PFM onboard Metop-SGA1;
- Since then, the radiometric noise levels of these channels exceed specifications by a factor of 4 to 6;
- The anomaly led to an increase of both, white noise and pink noise (striping). No significant changes on global average temperature biases are observed;
- Compared to humidity sounding channels of other currently operated microwave sounders, MWS PFM exhibits currently a significantly higher noise level;
- Channels 1 to 18 and channel 24 of MWS PFM are not affected by the anomaly.
- For global NWP, channels 19 to 23 are still considered usable while using all-sky assimilation schemes (after adapting the observational error and applying low pass filtering procedures)

GRAS-2 RO Global Mission: overview

- Metop-SGA1 GRAS-2 radio occultation mission **declared operational on 5 May 2026**.
- Following the operational declaration, the increasing contribution from BeiDou occultations has stabilized the production at approximately **1,500** occultations per day.

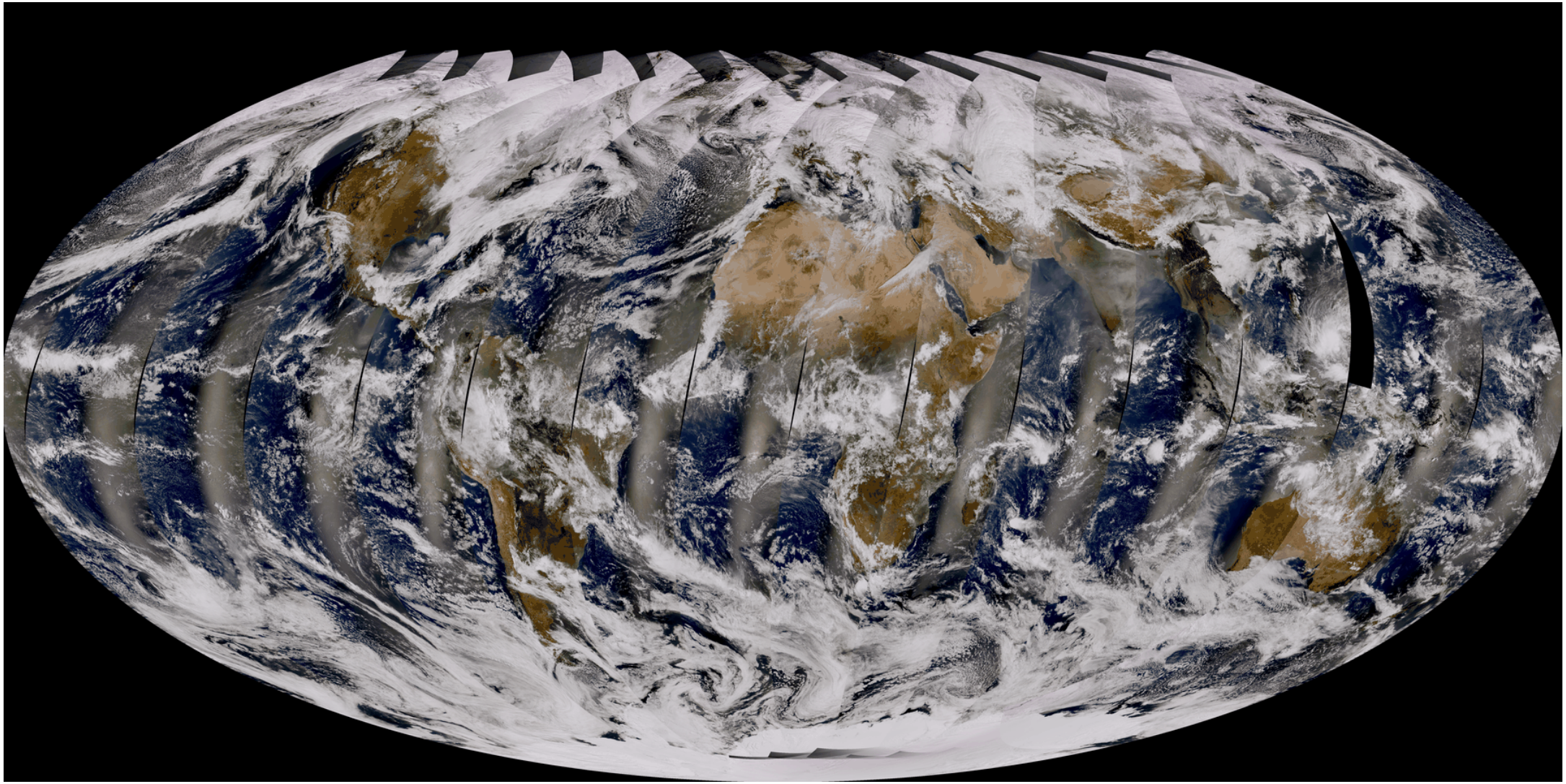


- GRAS-2 exhibits a consistent vertical systematic error (bias) relative to the other operational RO missions.
- Above 35 km, GRAS-2 delivers lower random error (standard deviation) than GRAS-1 and the other operational RO missions, establishing itself as the **new reference mission** in this altitude range.



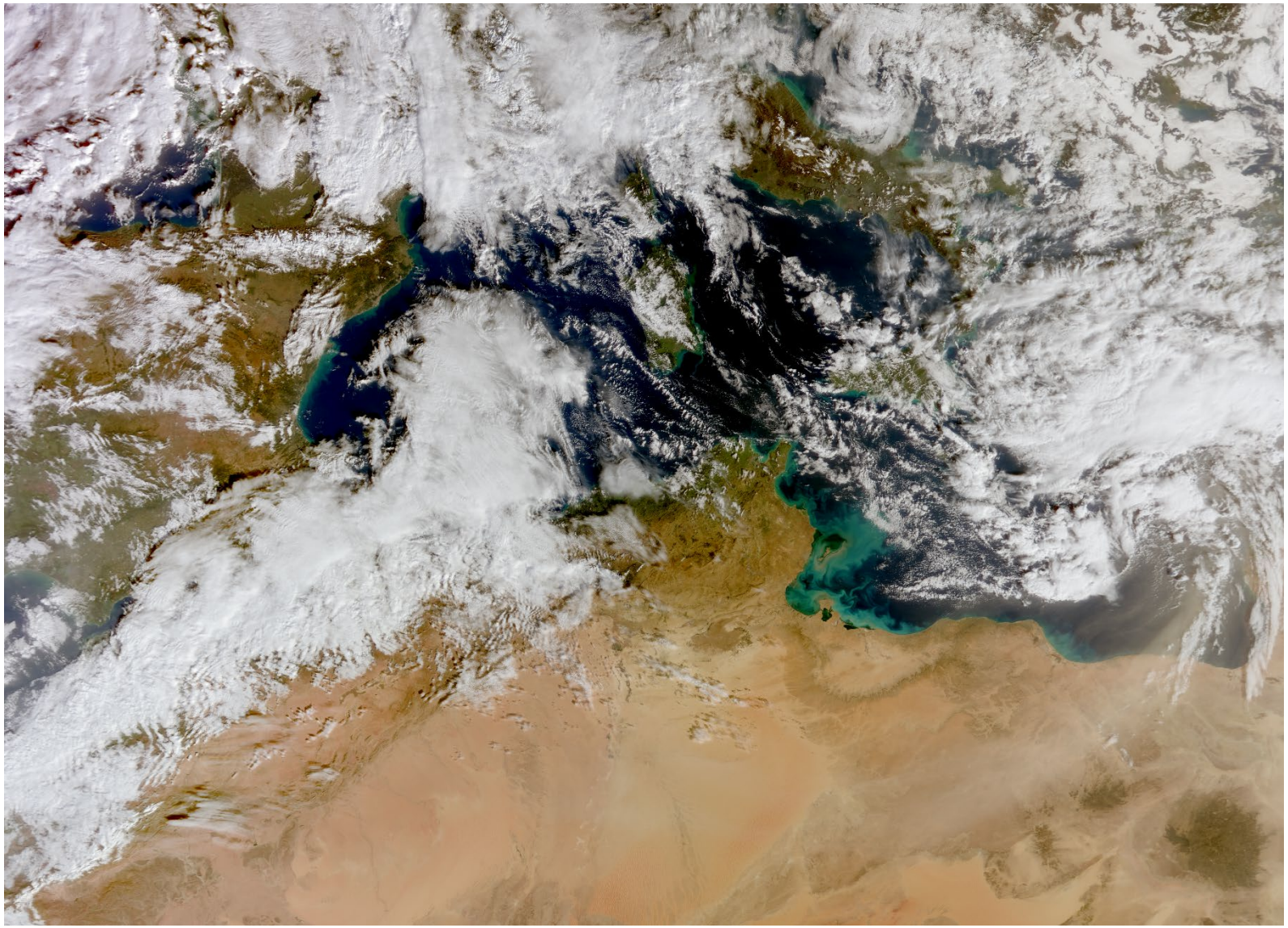
Metop-SGA1 METimage

108 days of METimage Imagery (03/2026 – 06/2026)



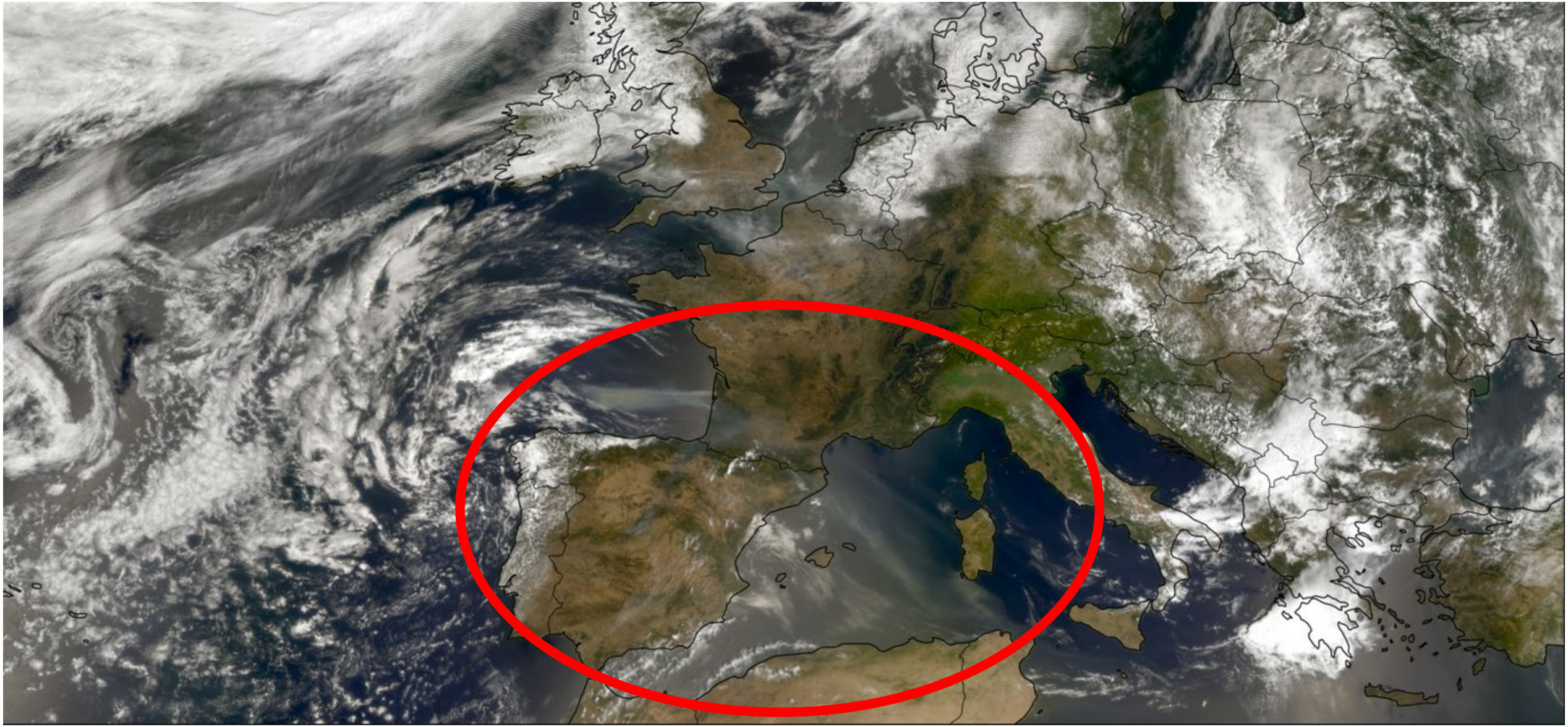
METimage Imagery (23/01/2026)

Mediterranean Sea after Cyclone Harry



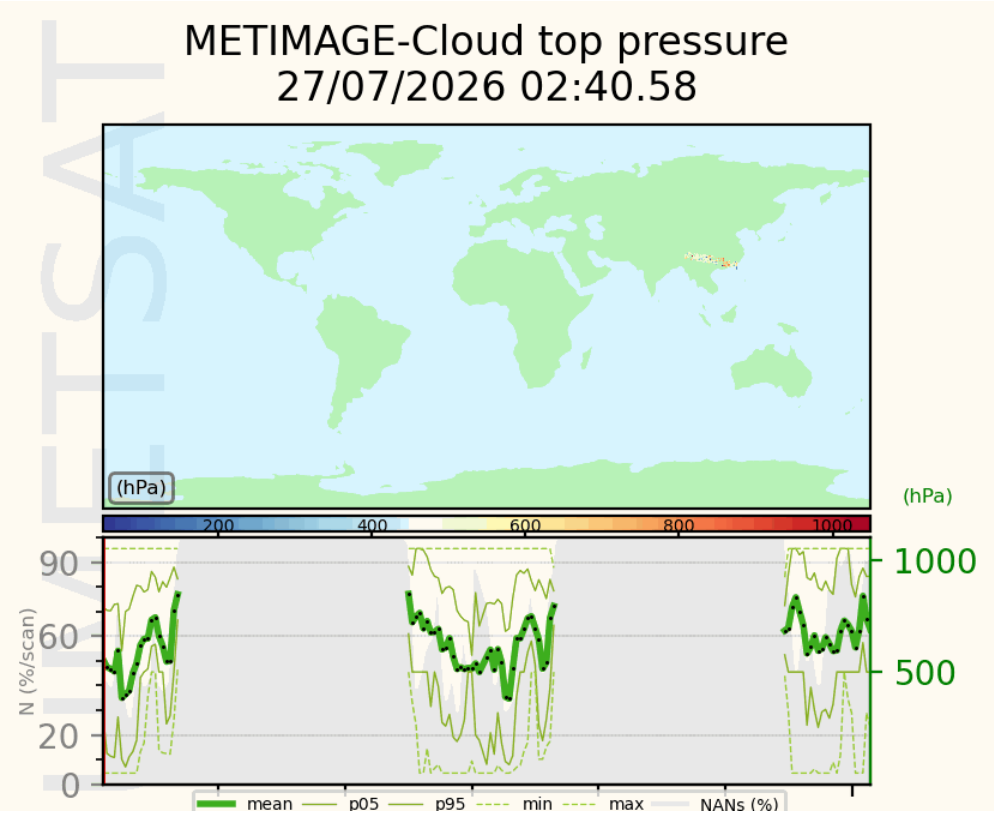
A true colour image of Europe from METimage - *with wildfires visible*

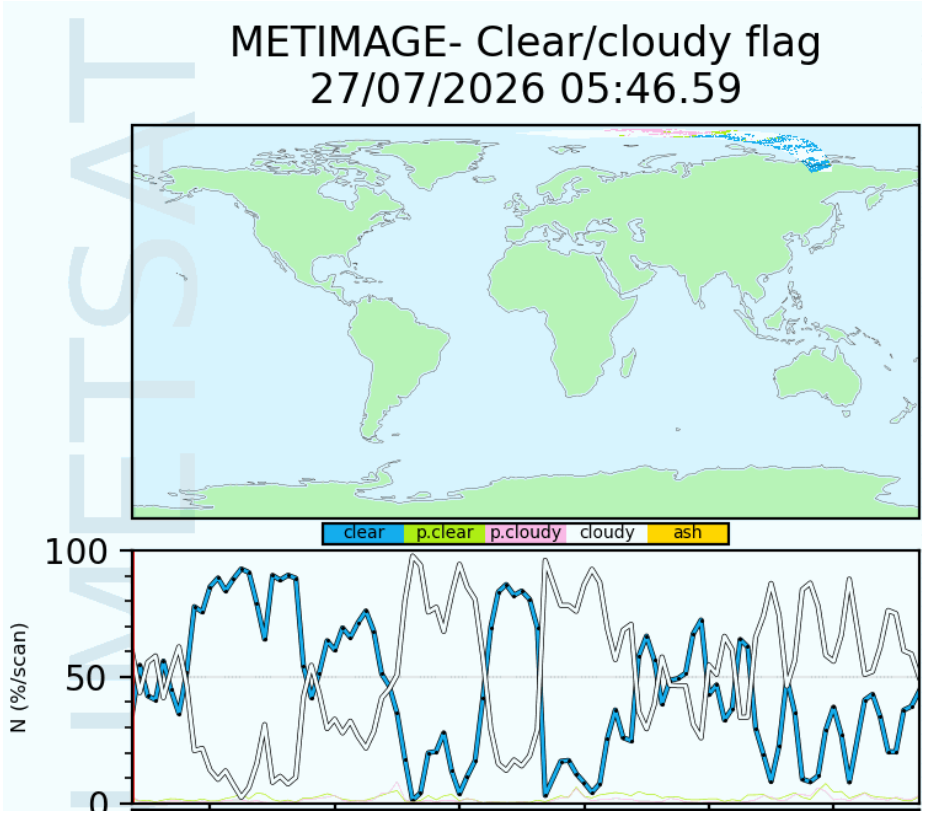
www.eumetsat.int



METimage L2 product status

- Pre-operational status reached for cloud mask (CLD) and cloud top pressure from O_2 bands (CTP).
- Production stable and all major gaps resolved

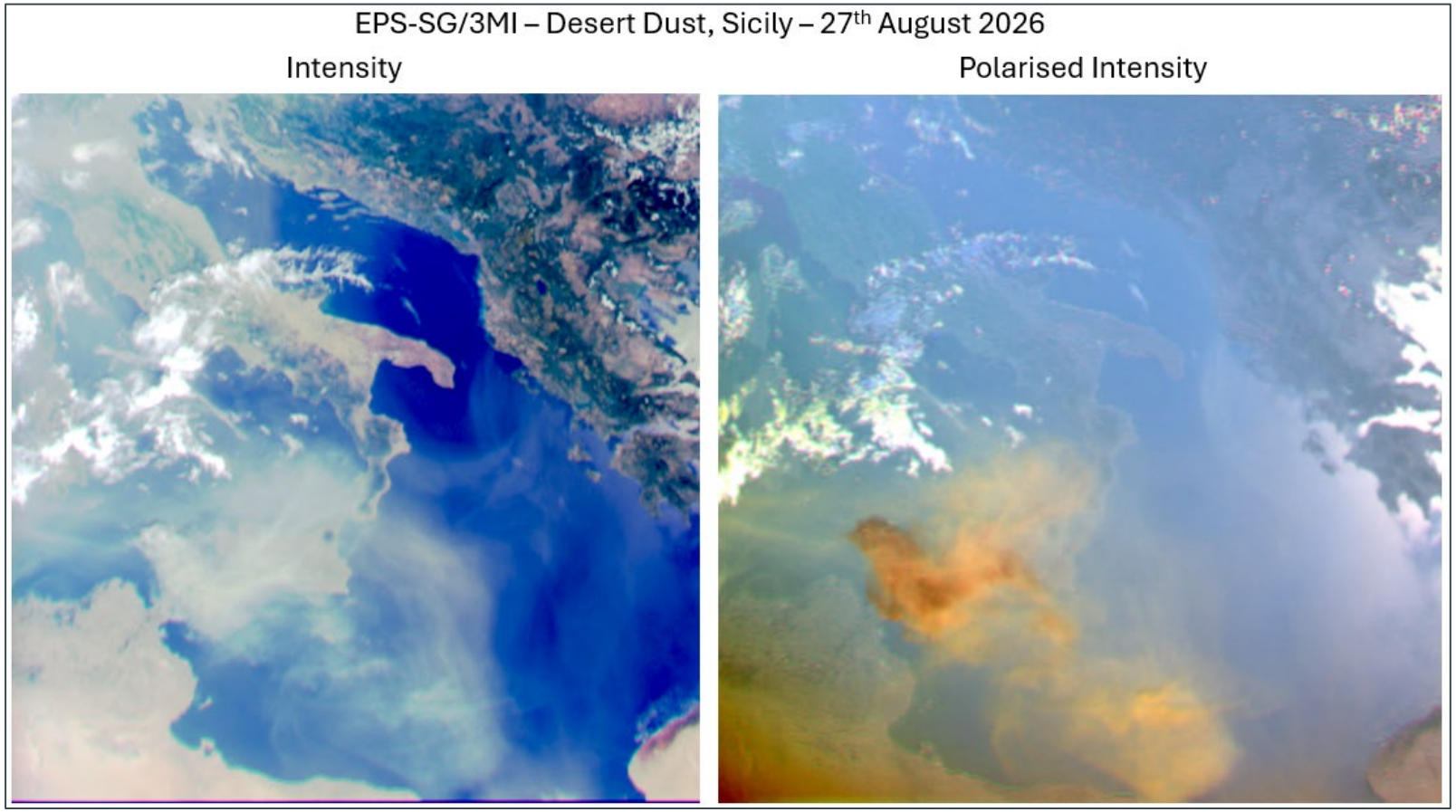




3MI polarimeter



- 3MI first operational polarimeter (2025-2045)



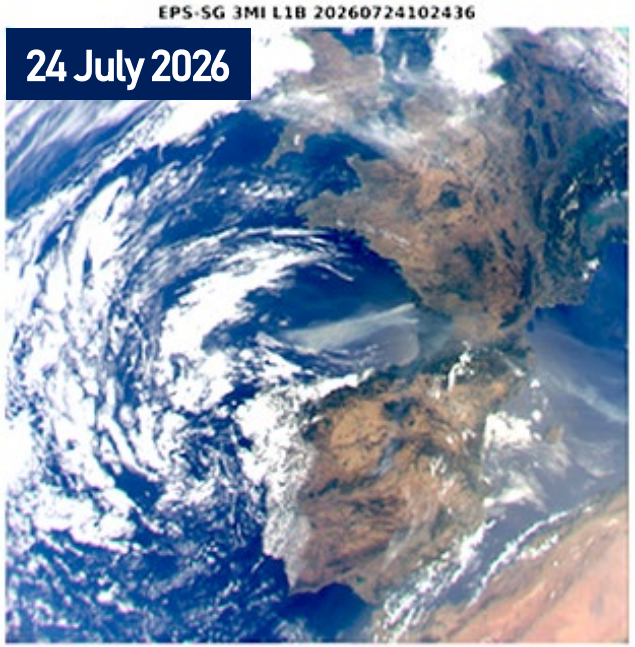
3MI Acquisitions – Forest fires in France and central Spain

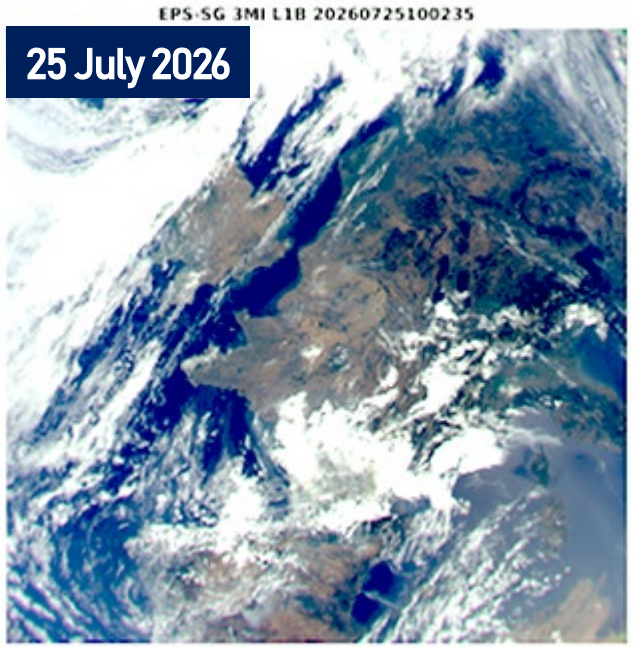
www.eumetsat.int

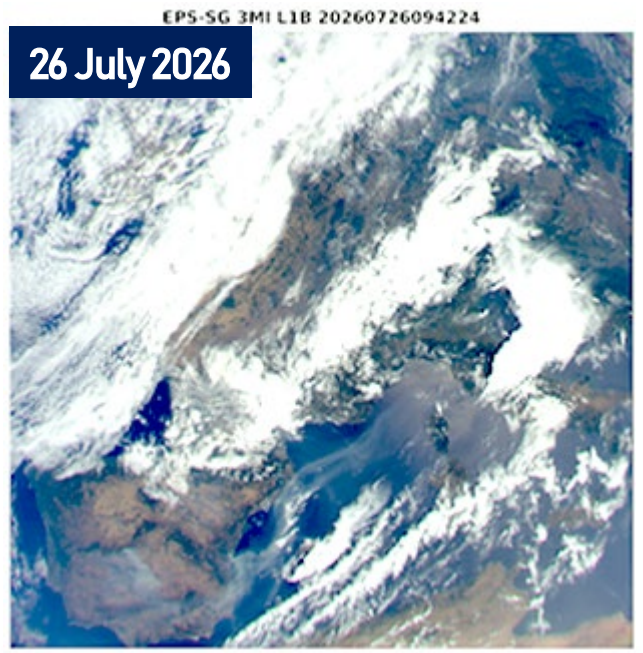
TOA RGB

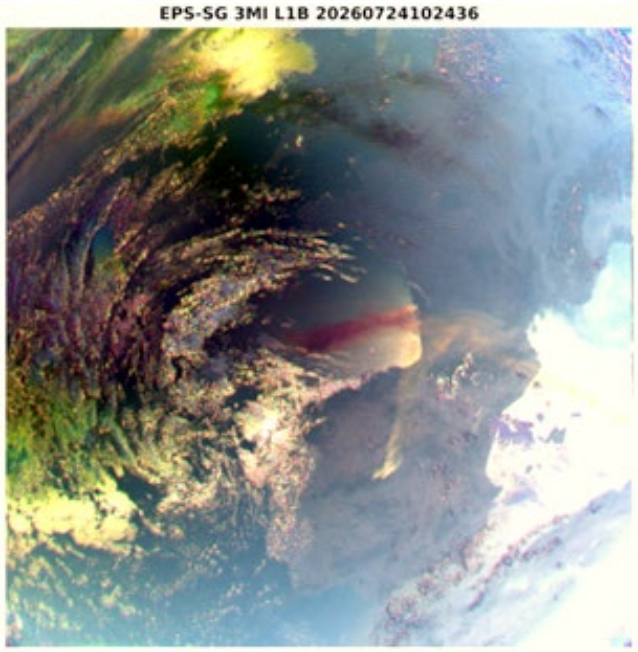
L1B

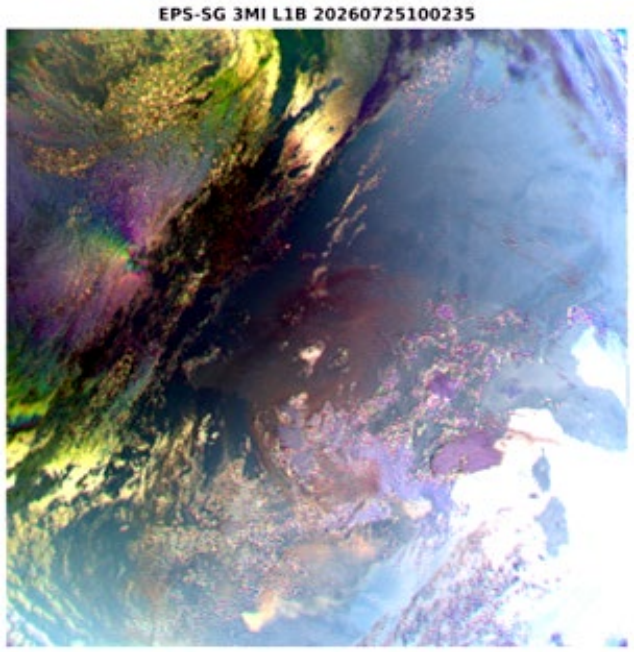
TOA Polarisation RGB

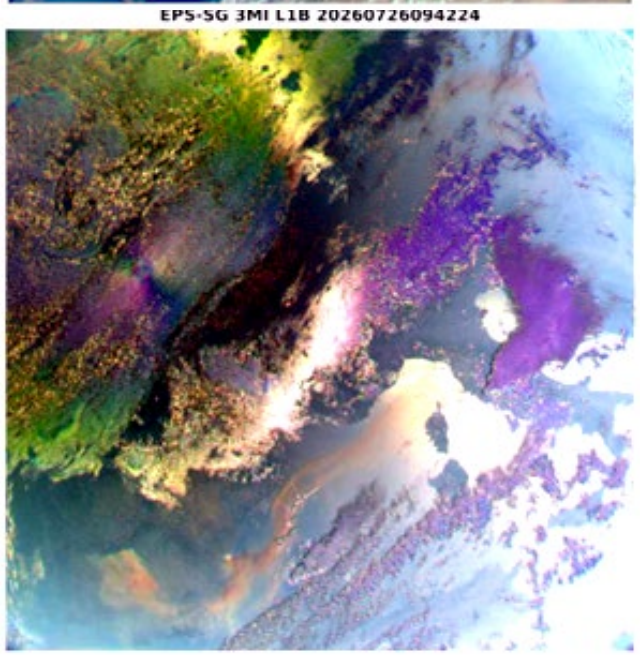






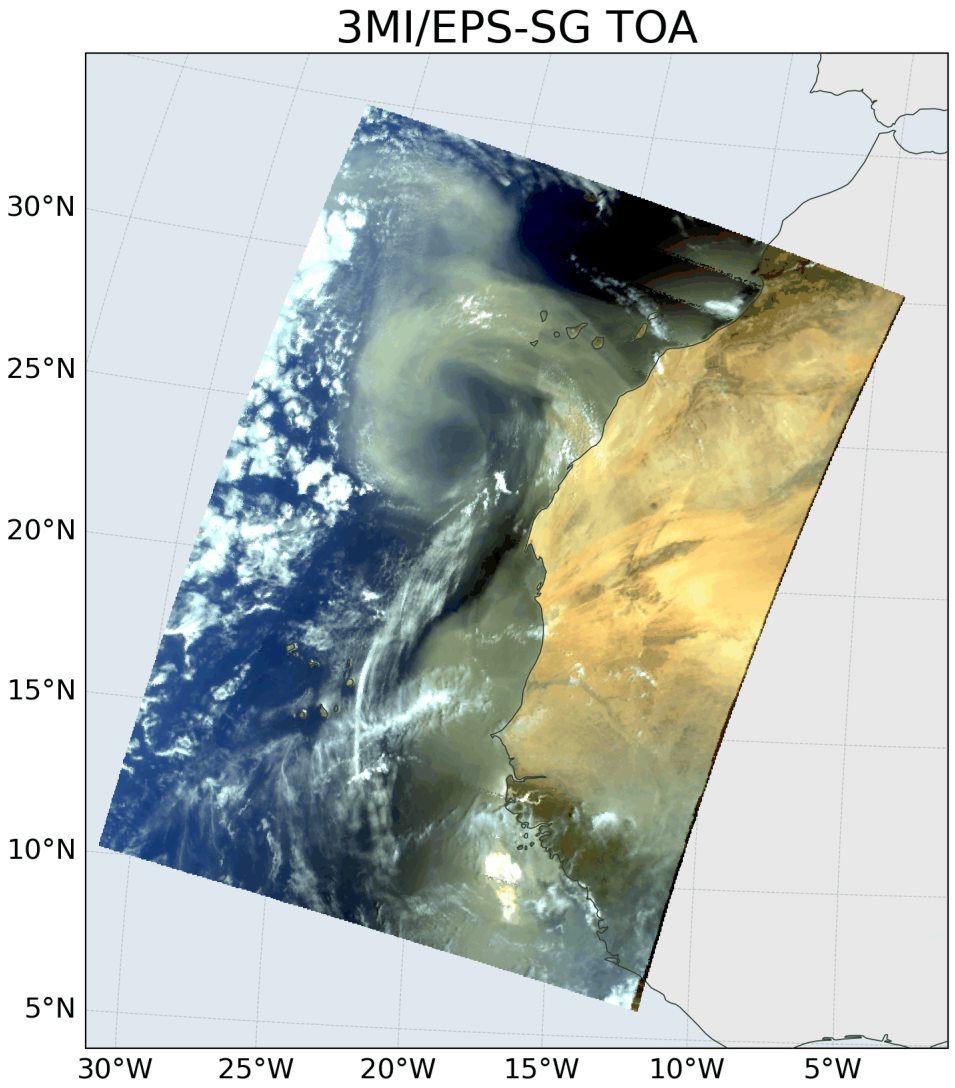






First 3MI Aerosol Characterisation

Dust over Canary islands, 1 April 2026



Latest status and ongoing updates

L2 Aerosol under testing since January 2026

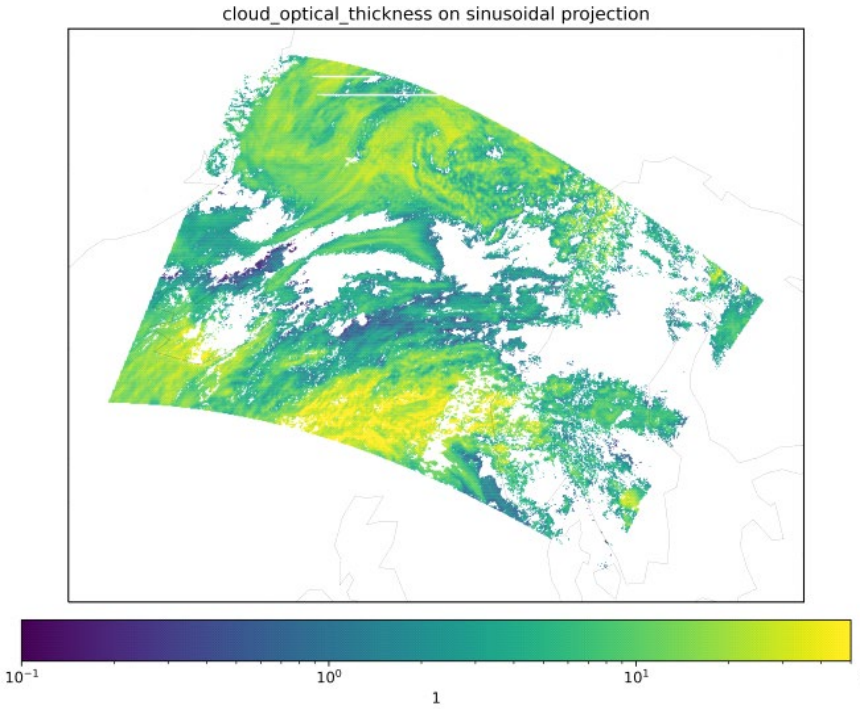
- Promising initial results despite remaining L1 limitations:
  - Minor remaining fixes in L1B.
  - Pending geometrical update in L1C.
- Plays an important role in providing feedback about quality of L1 during commissioning.
- Early validation started in August 2026.
- Full-quality global processing will follow once L1 production is fully stable and L1 Cal/Val is completed.
- Continuous improvements to further enhance processor performance.

User preparation:
Provision of sample data to operational users in Q1 2027.

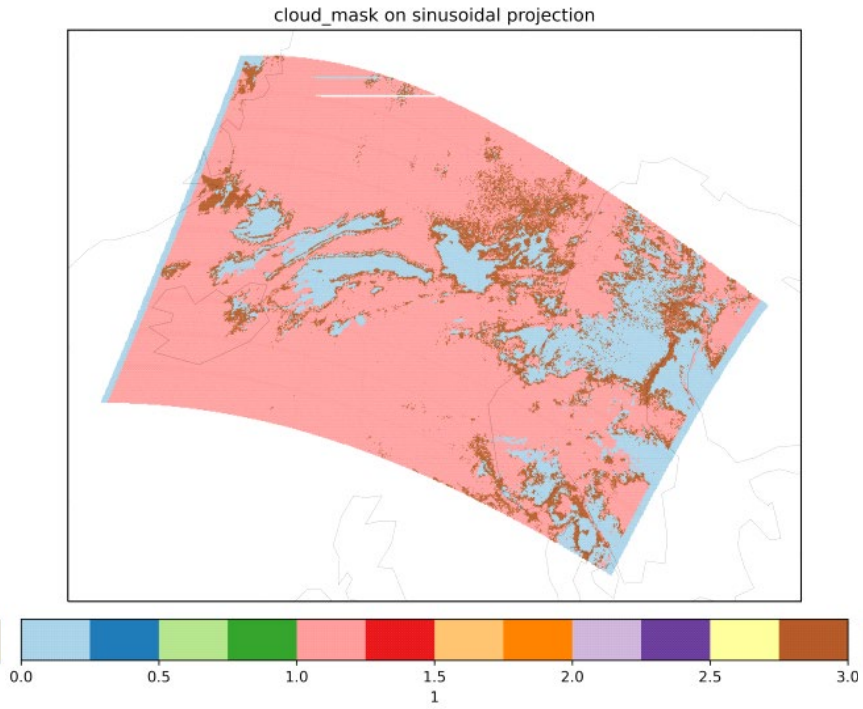
3MI L2 Cloud

- Prototype tested on preliminary Level-1C products
- “Dockerised” for future compatibility with Ground Segment
- Example:

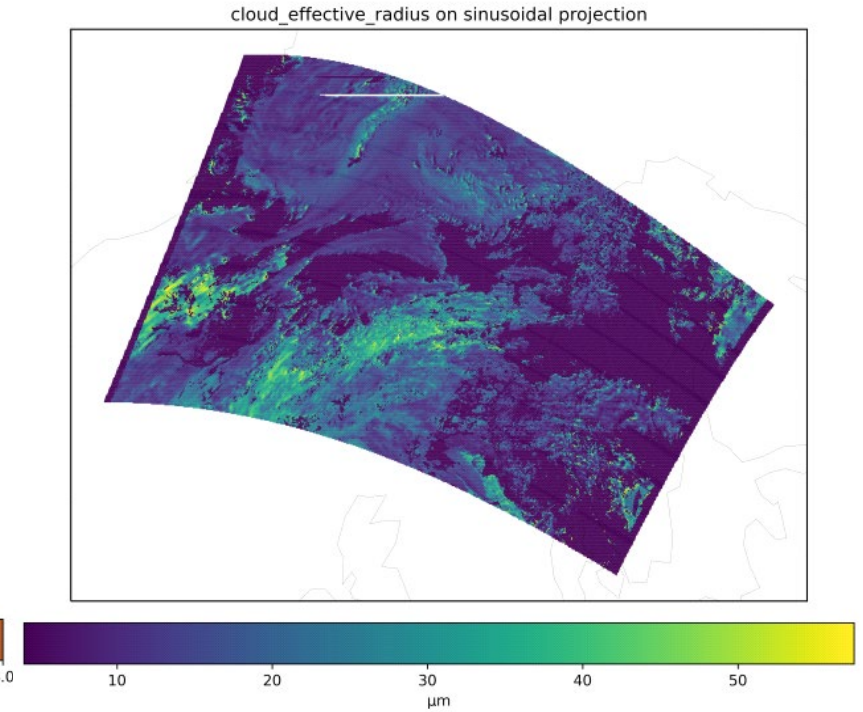
CLOUD OPTICAL THICKNESS



CLOUD MASK

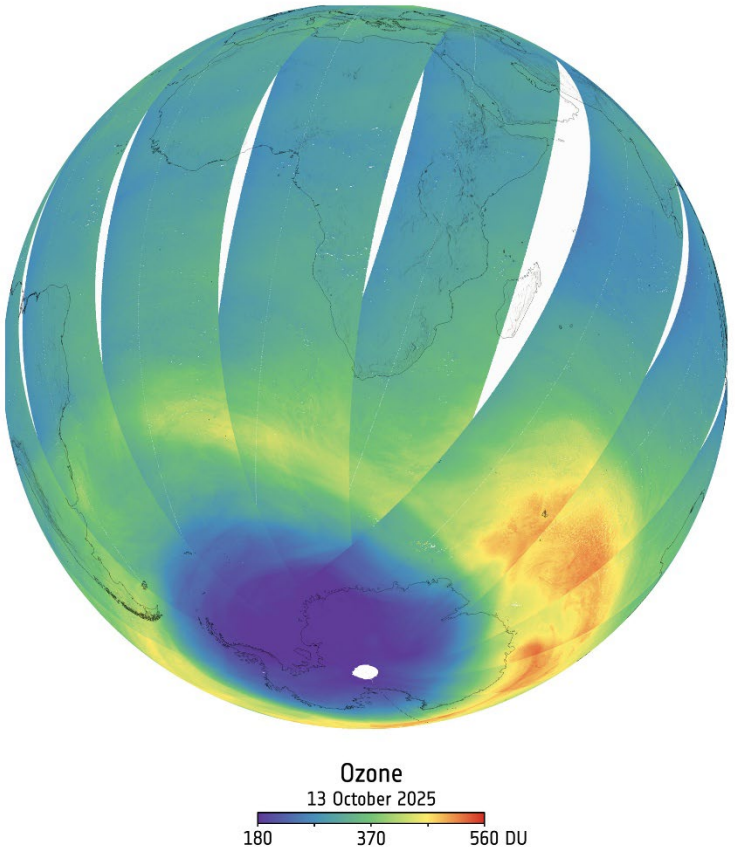


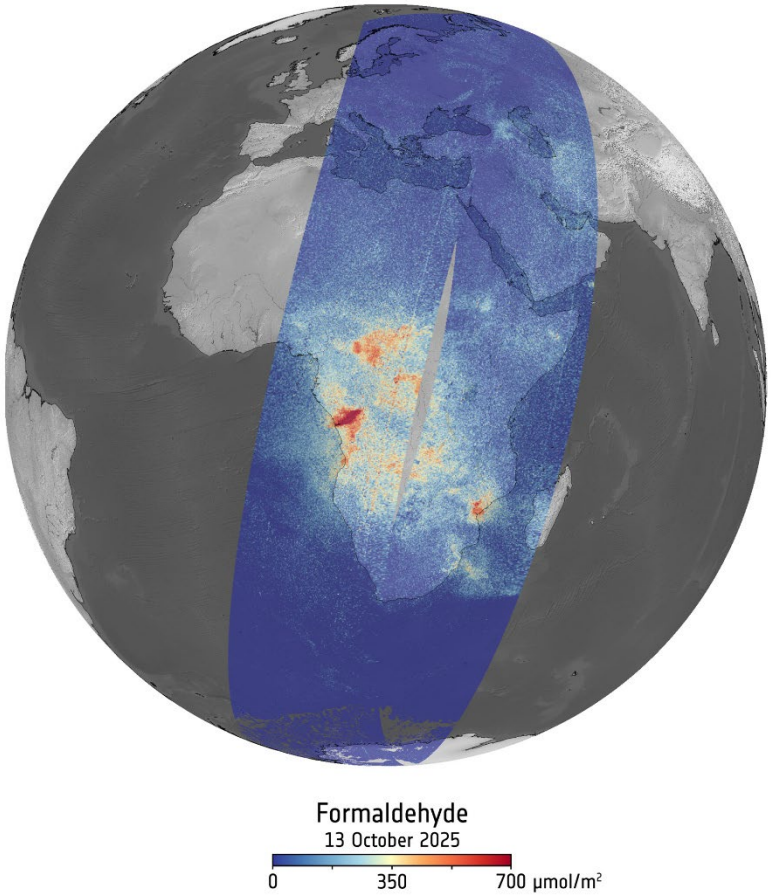
EFFECTIVE RADIUS

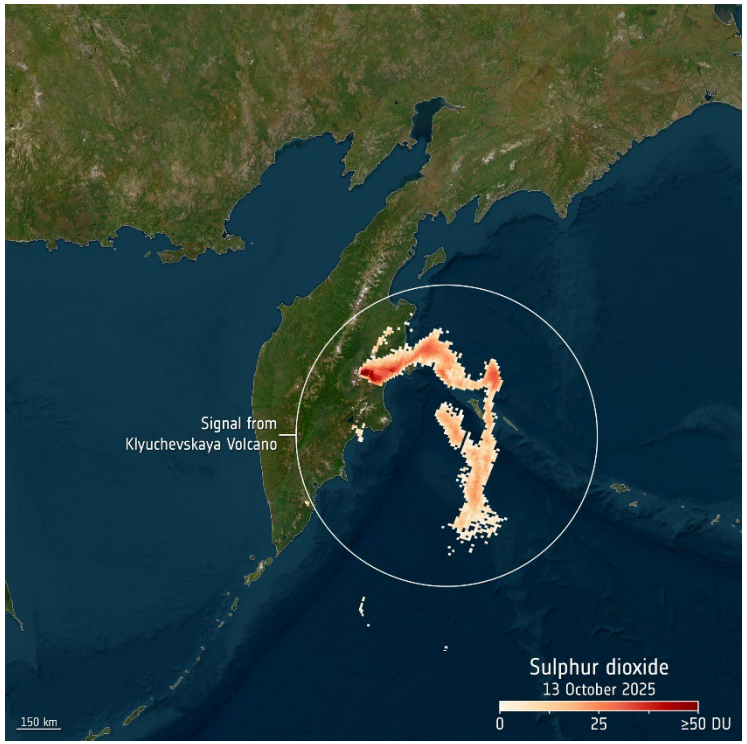


But also: spectral cloud albedo, IWP, LWP, multilayer flag, oxygen pressure, cloud phase, …

The air quality mission on Metop-SG

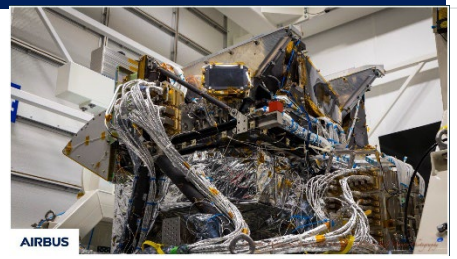


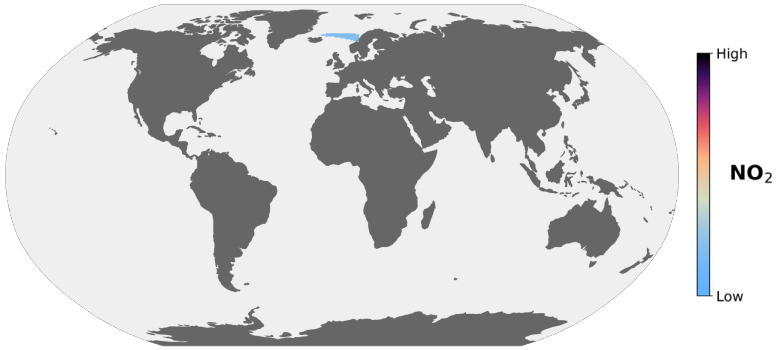




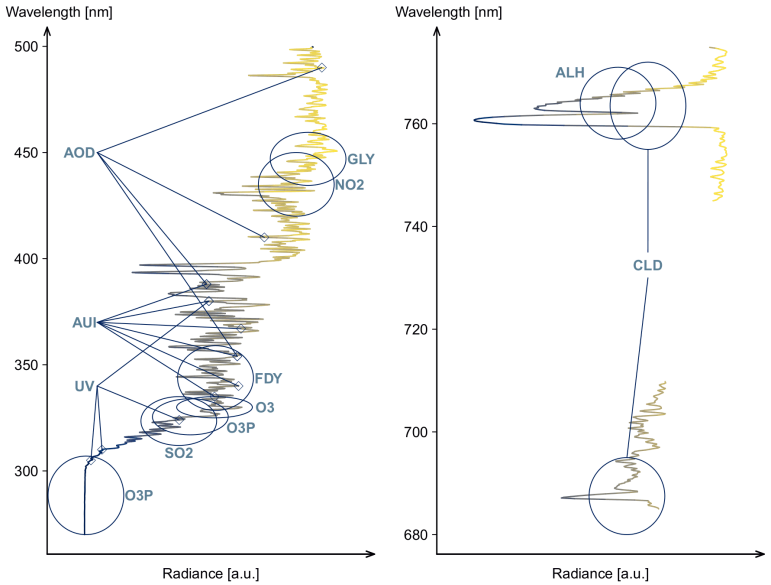
Sentinel-5 in short

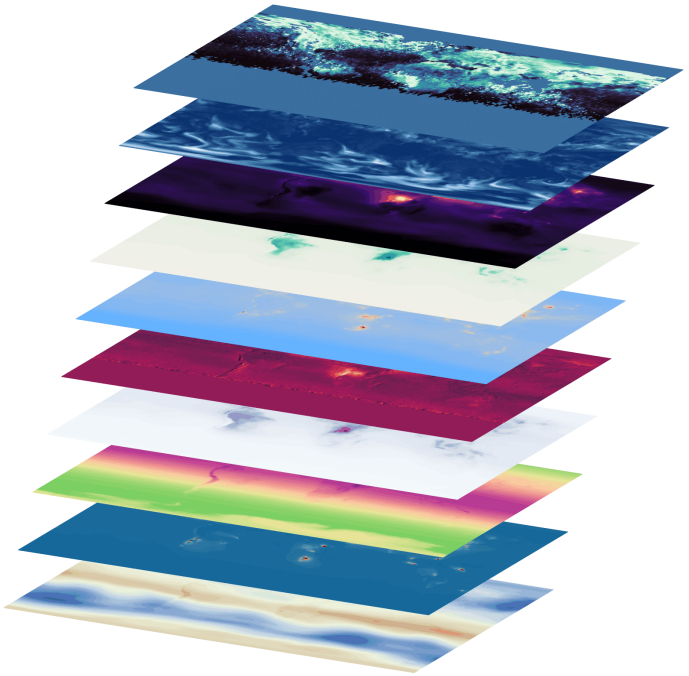
Copernicus Sentinel-5 will monitor air quality, trace gases and aerosols at high spatial resolution with near-daily global coverage





Atmospheric composition is revealed through spectral fingerprints in the UV, VIS, NIR, and SWIR spectral regions:



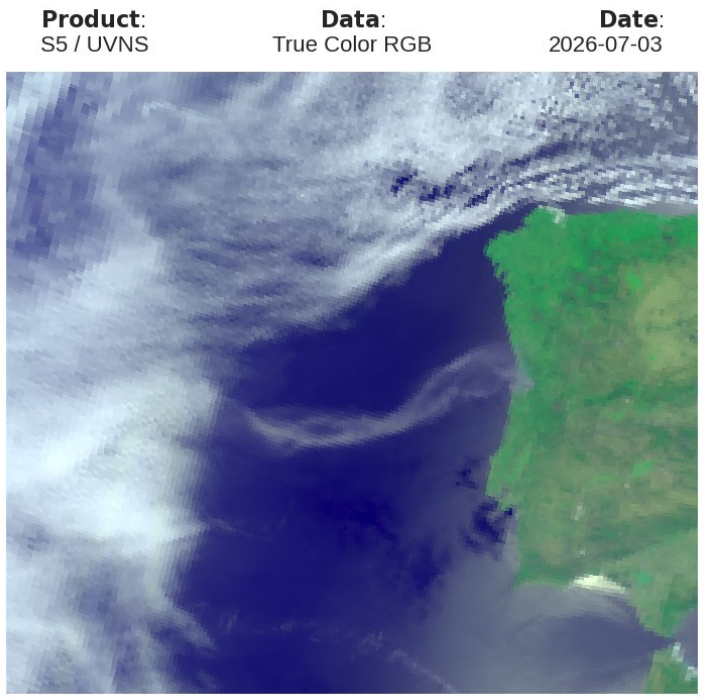


- Carbon monoxide
- Methane
- **Aerosol layer height**
- Cloud properties
- Aerosol optical depth
- Glyoxal
- Nitrogen dioxide
- Aerosol UV index
- Formaldehyde
- UV index
- Sulfur dioxide
- Ozone

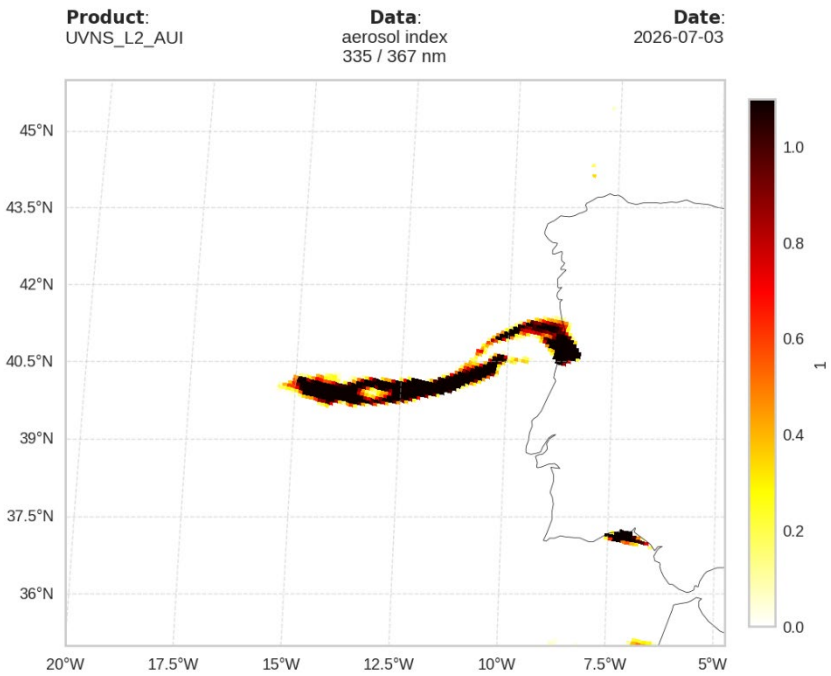
PROGRAMME OF THE EUROPEAN UNION

Copernicus Europe's eyes on Earth

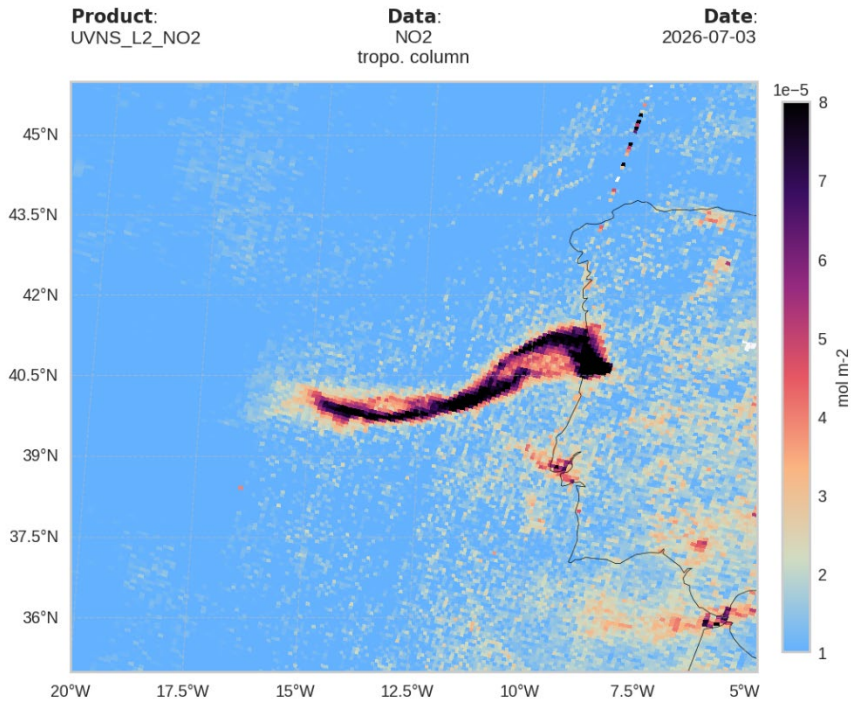
Wildfires in Porto, 17 April 2026



Aerosol UV Index



Tropospheric NO_2



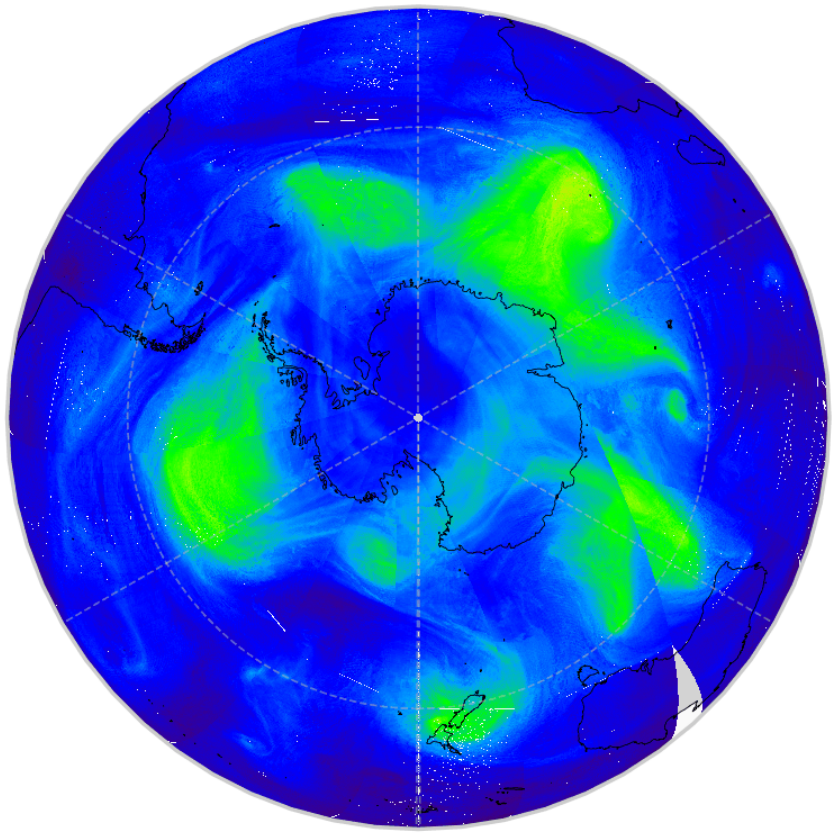
PROGRAMME OF THE EUROPEAN UNION

Copernicus Europe's eyes on Earth

Copernicus Sentinel-5: Level-2 Snapshots generated at EUMETSAT

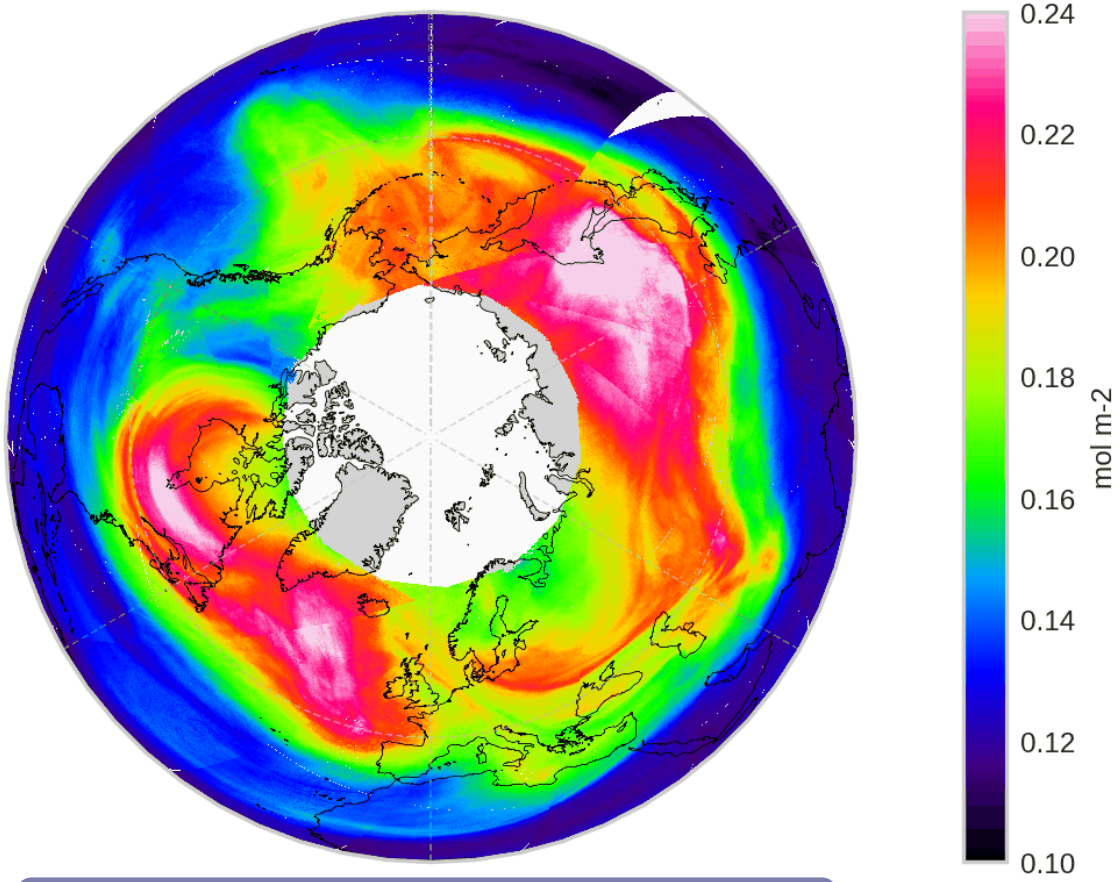
Stratospheric Polar Vortices, Jan. 2026

Product: UVNS_L2_O3 **Data**: O3 total column **Date**: 2026-01-23



Total O3 Column (South Pole)

Product: UVNS_L2_O3 **Data**: O3 total column **Date**: 2026-01-23



Total O3 Column (North Pole)

Metop-SGB microwave imaging mission



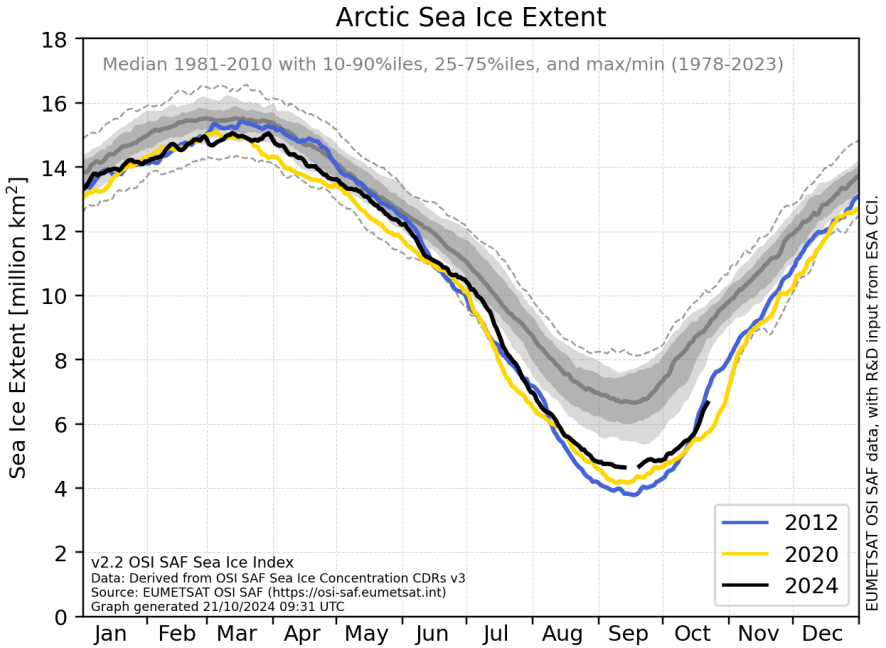
1. Scatterometer
   SCA
2. Radio Occultation
   RO
3. Microwave Imaging for Precipitation
   MWI
4. Ice Cloud Imager
   ICI
5. ARGOS-4
   Advanced data collection system

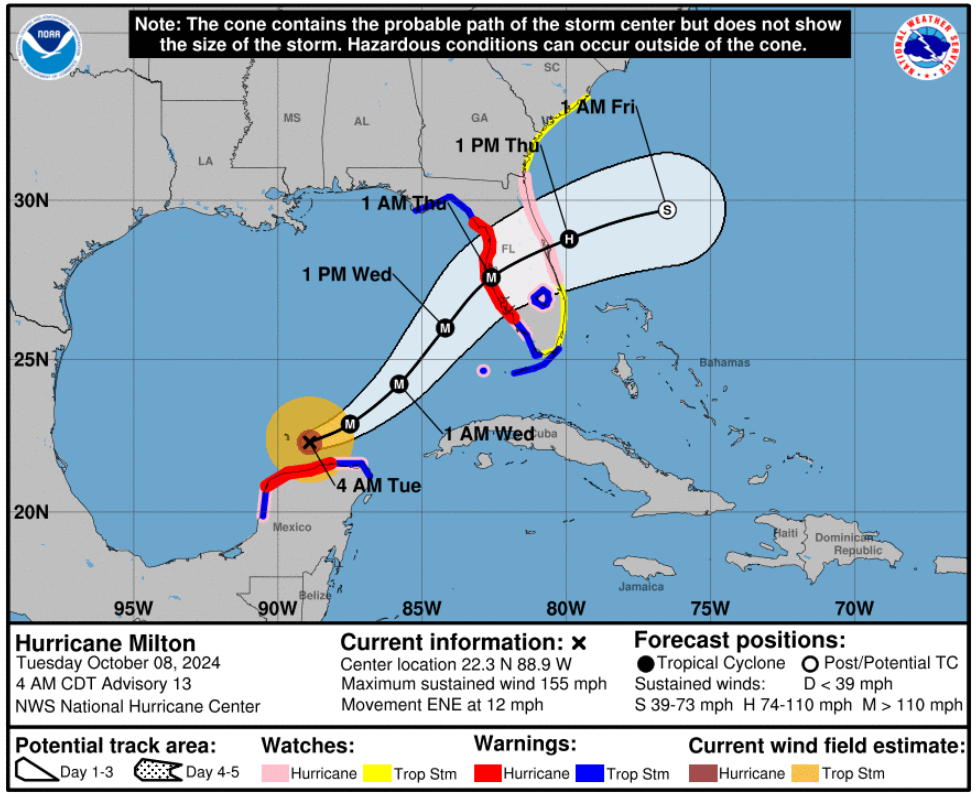
SCA – measurements and products

Scatterometer

Active real-aperture radar operating in C-Band (~5 GHz)

- Sends pulses to the ground and measures the return
- Sensitive to:
  - Scattering from capillary waves on the ocean
  - Soil dielectric properties
  - Sea ice roughness





Products

- Wind speed and direction at the ocean surface
- Surface soil moisture
- Sea ice parameters (ice edge, type, low-resolution drift)

Provides NRT data for NWP

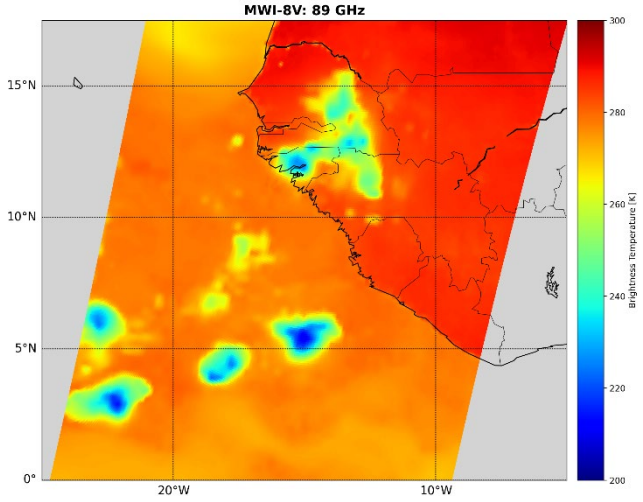
MicroWave Imager (MWI)

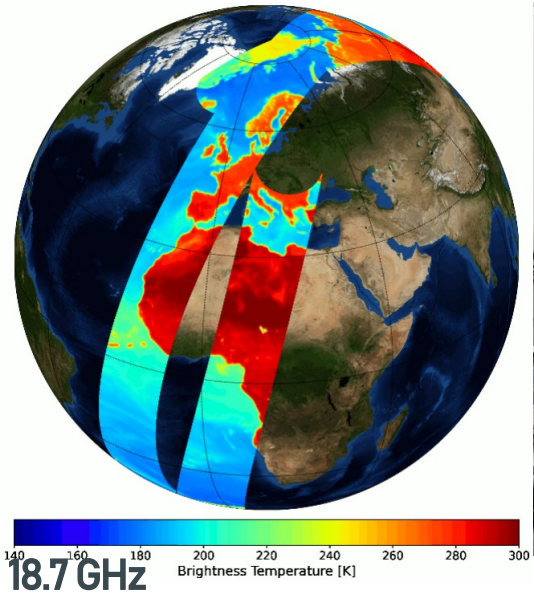
Main Applications:

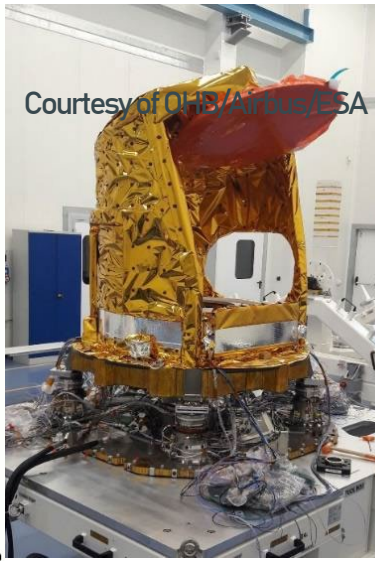
- Provision of cloud and liquid/solid precipitation products with enhanced information on light precipitation and snowfall by exploiting the 50-53 GHz and 118 GHz channels;
- Supporting Numerical Weather Prediction (NWP) at regional and global scales;
- Serving nowcasting and very short-range forecasting at regional scales;
- Supporting observations of surface parameters: sea surface temperature, sea surface wind speed, emissivity;
- Provision of sea ice and snow observations: sea ice cover/concentration, snow cover, snow water equivalent;
- Continuity of measurements of key microwave imager channels as observed by SSM/I, TMI, SSMIS, AMSR-2, GMI, in support of long-term climate records.

Satellite Application Facilities involved:

- Numerical Weather Prediction (NWP-SAF)
- Nowcasting (NWC-SAF)
- Climate Monitoring (CM-SAF)
- Hydrology (H-SAF)
- Land, ocean and sea ice surface (OSI-SAF)







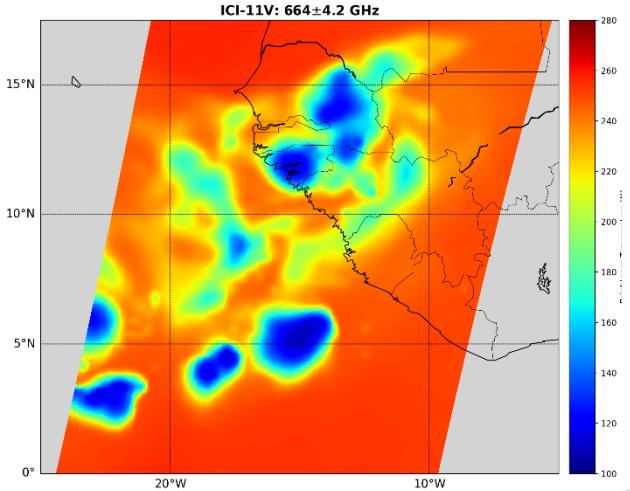
Ice Cloud Imager (ICI)

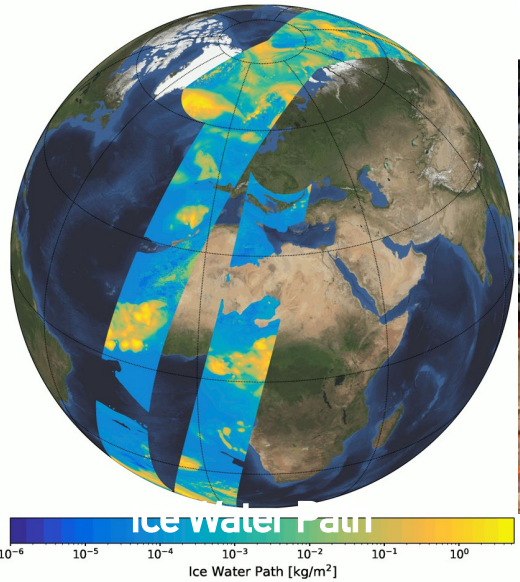
Main Applications:

- Provision of enhanced ice cloud properties and unprecedented insights (crystal size, shape, orientation) by utilizing mm and sub-mm frequencies (183–664 GHz) and its dual polarization capabilities at 243 and 664 GHz;
- Filling an observational gap by providing information on non-precipitating ice, which is not covered by either optical/infrared or mm observations;
- Supporting the validation of ice cloud models and their parameterisation in weather and climate models;
- Provision of ice cloud products for climate monitoring;
- First-ever operational sub-mm mission, extending the scope of MW assimilation in weather forecasting;
- In combination with MWI, ICI could enhance light precipitation and snowfall retrievals by addressing uncertain surface emissivity, through its sounding bands and high WV absorption.

Satellite Application Facilities involved:

- Numerical Weather Prediction (NWP-SAF)
- Climate Monitoring (CM-SAF)
- Hydrology (H-SAF)
- Nowcasting (NWC-SAF)







The EPS-Sterna Programme

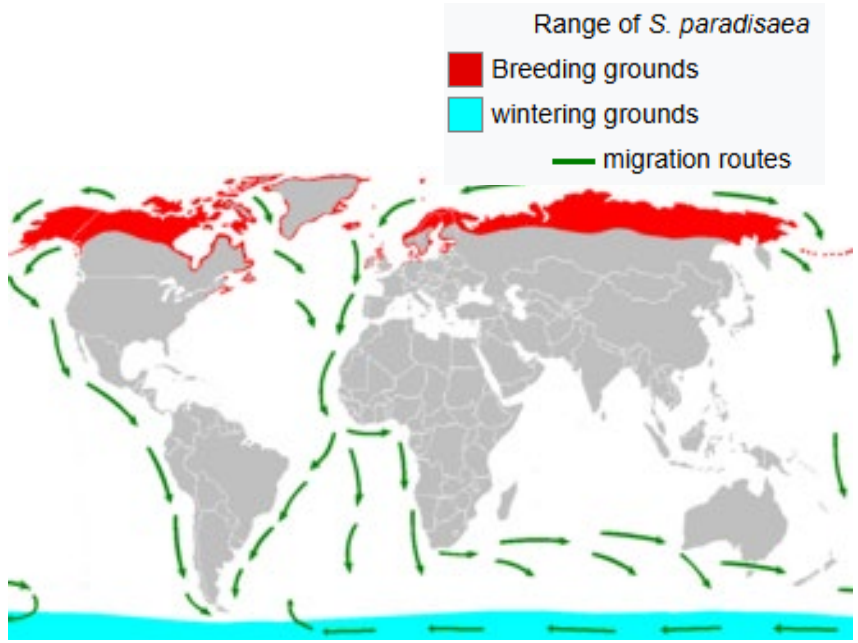
Since December 2018, EUMETSAT has identified a constellation of small microwave sounders to complement the reference EUMETSAT Polar System (EPS-SG) Microwave Sounder (MWS) mission, as an additional contribution to the realisation of Vision 2040 of the WMO Integrated Global Observing System, in line with the EUMETSAT strategic objective of Destination 2030.



EPS-Sterna Programme was approved in January 2026

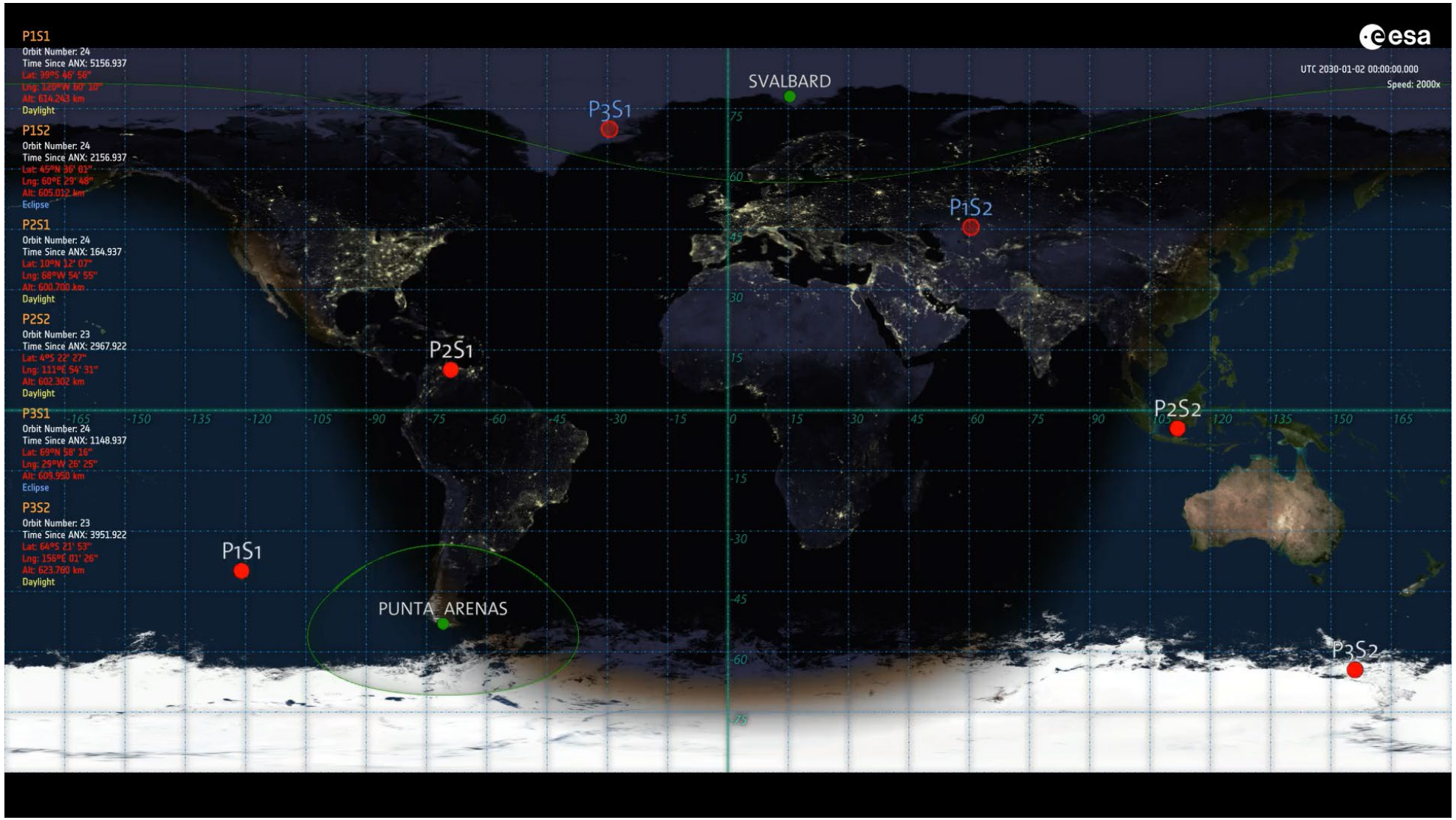
Objectives

- To expand and complement the microwave sounding observations from the EPS-SG and NOAA JPSS polar-orbiting, meteorological satellites, as well as CMA FY-3 polar-orbiting meteorological satellites;
- To improve accuracy of global Numerical Weather Prediction models by increasing the number of microwave sounding observations;
- To contribute to Nowcasting applications at high latitudes through an increase in the frequency of microwave observations;
- To contribute to climate monitoring by improving global reanalysis based on NWP models and by adding to the record of upper tropospheric humidity with increased spatiotemporal sampling.



Sterna Orbits - 2D Visualisation

EPS-Sterna (6Sats)





Thank you!

Questions are welcome.