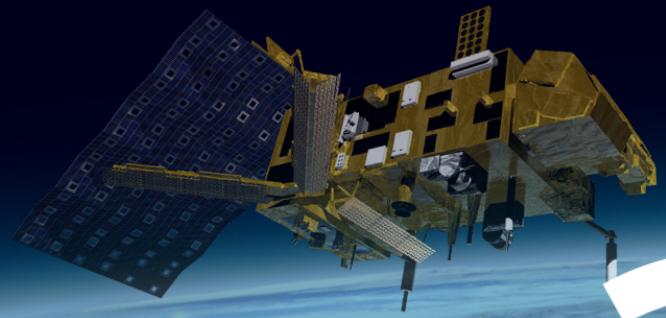


# EUMETSAT's Atmospheric Chemistry Activities: Past, Present and Future.

Rasmus Lindstrot<sup>1</sup> and the EUM ACh team  
*1: Competence Area Manager – Atmospheric Chemistry*

*ESA ATMOS 2021, 22/Nov/2021*



## Atmospheric Chemistry at EUMETSAT

### Current missions

GOME-2 on Metop A/B/C

Metop A decommissioning

### Future missions

Copernicus Sentinel-4 and Sentinel-5

Ground processor development status

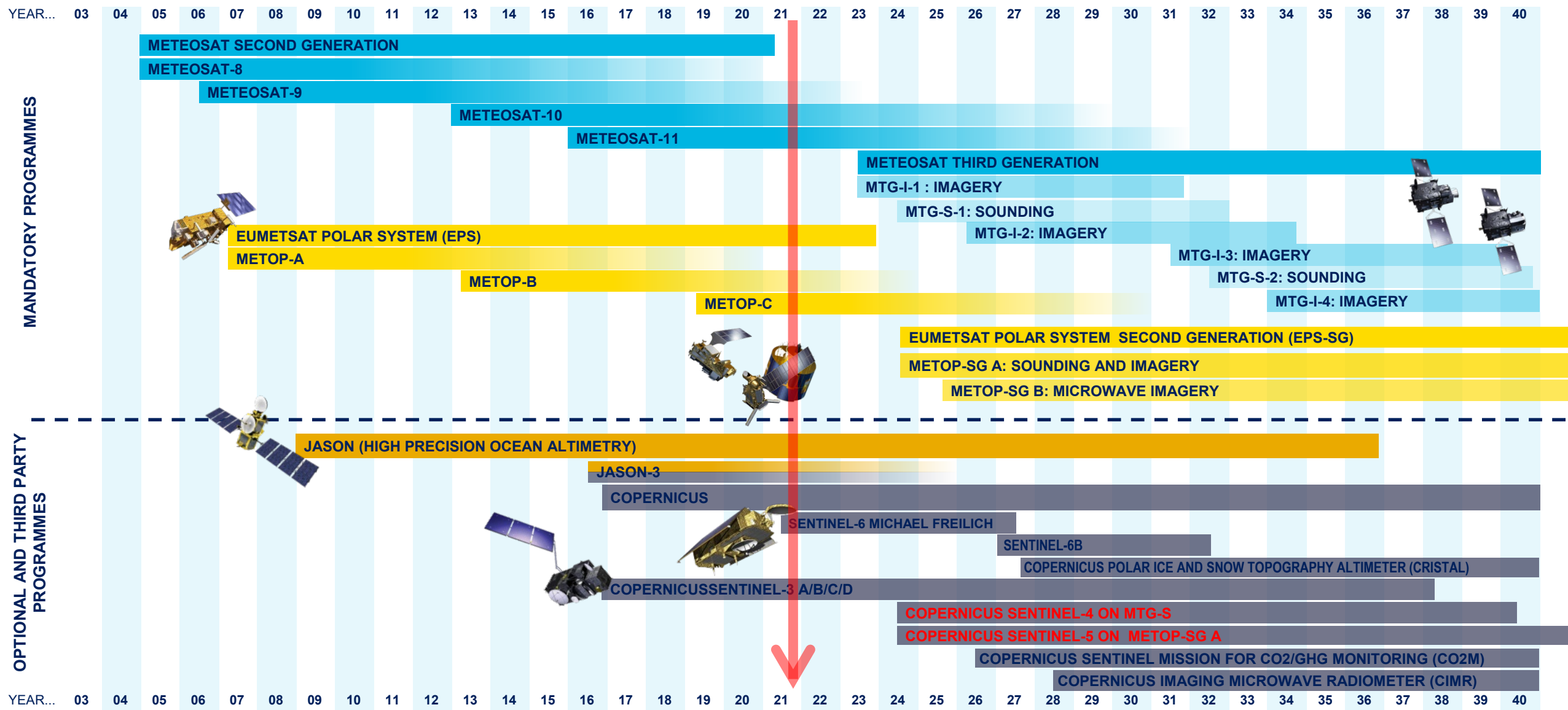
CalVal planning





# EUMETSAT mission planning

www.eumetsat.int

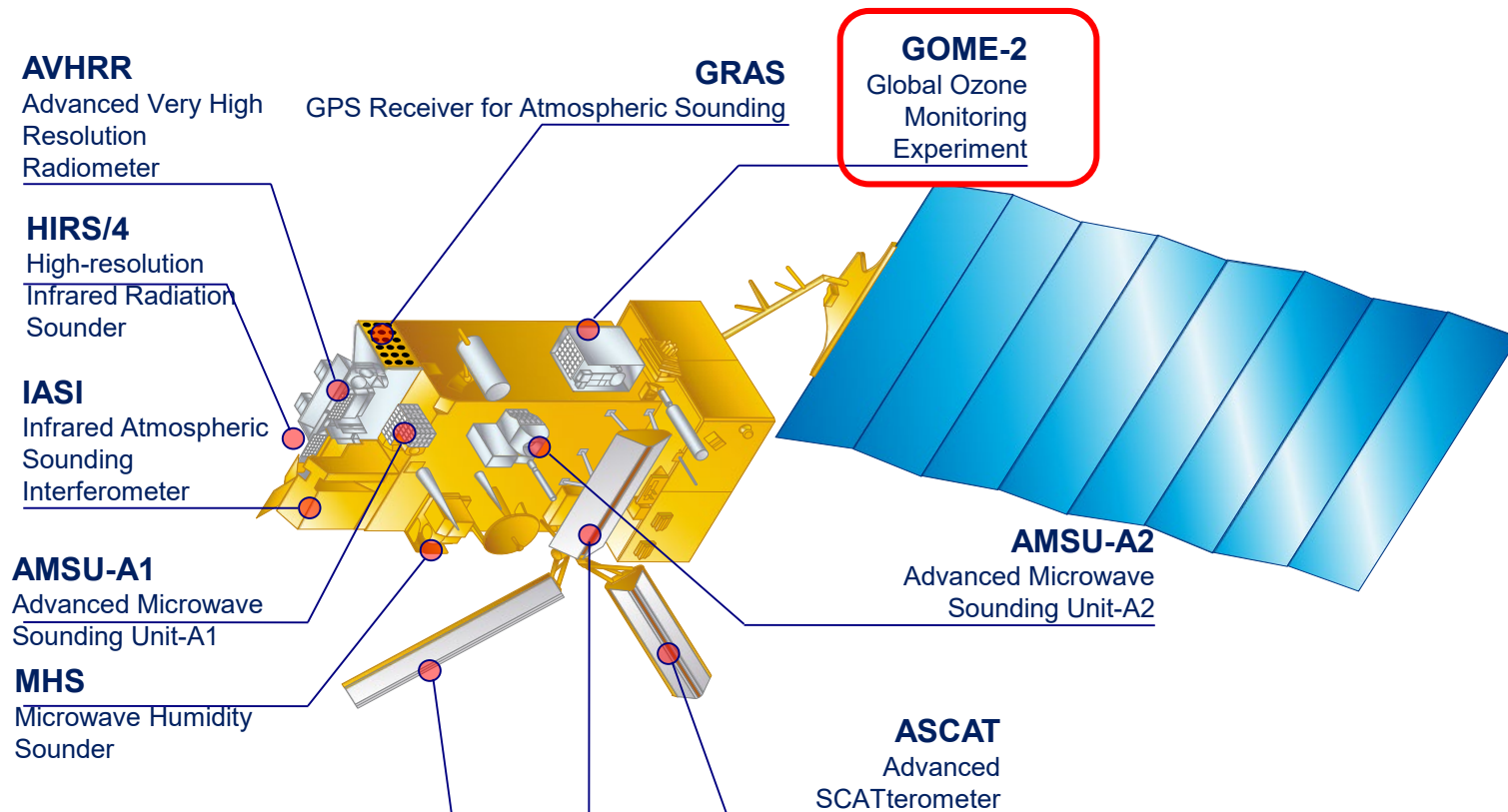




# GOME-2 on Metop-A,B,C

[www.eumetsat.int](http://www.eumetsat.int)

**Metop A**      **2006 - 2021**  
**Metop B**      **2012 -**  
**Metop C**      **2018 -**

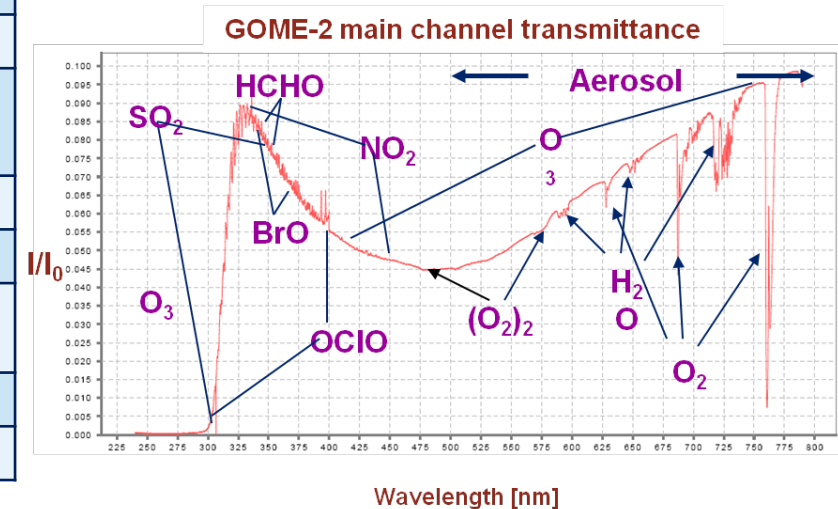
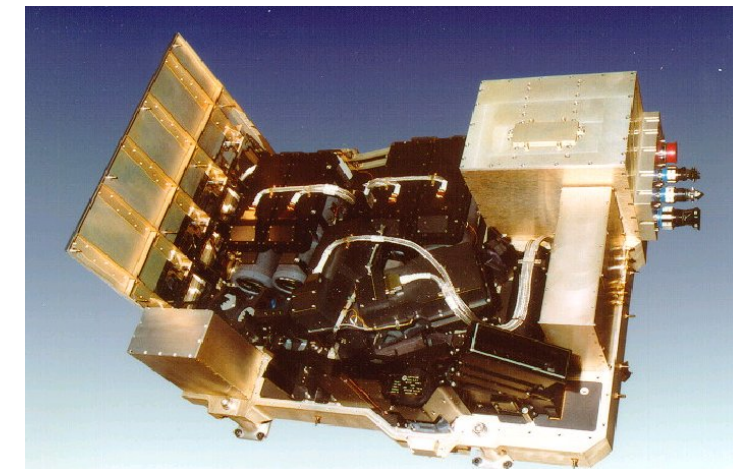




# GOME-2 on Metop-A,B,C

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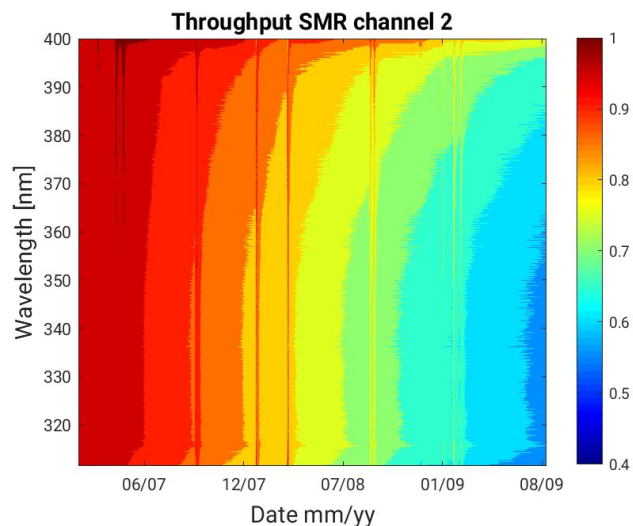
Item	Specification
Spectral range (nm)	240-790
Spectral resolution (nm)	0.26-0.51
Spatial resolution (km <sup>2</sup> )	80 × 40 (main channels) 80 × 10 (PMD)
Swath width (km)	120-1920
Spectral channels	4096 (in four separated optical channels)
Polarization channels	30 (in two separated optical channels)
Calibration system	Spectral lamp, white lamp, solar diffuser LED
Dimensions	600 mm × 800 mm × 500 mm
Weight	68 kg
Main bus voltage	22-37 V
Power consumption	50 W
Data rate interface	400 kbit



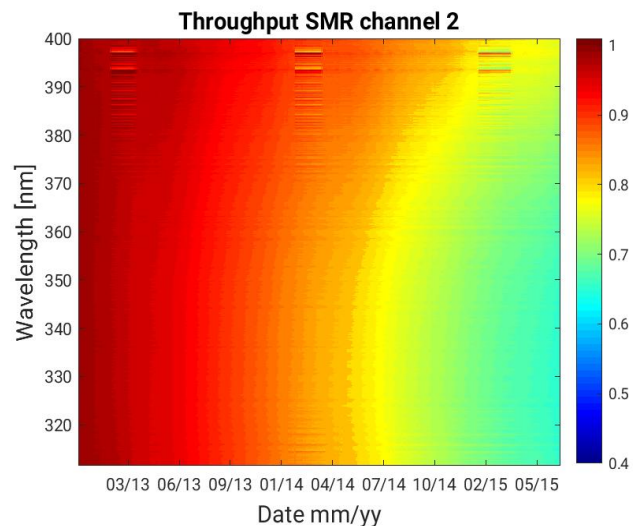
- L1 products are being generated centrally at EUMETSAT
- AC SAF is generating the long list of L2 NRT, offline products and data records derived from these



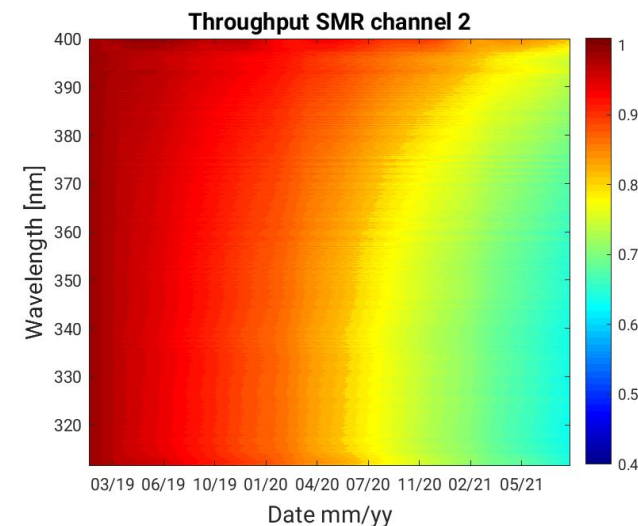
**GOME-2 Metop-A**



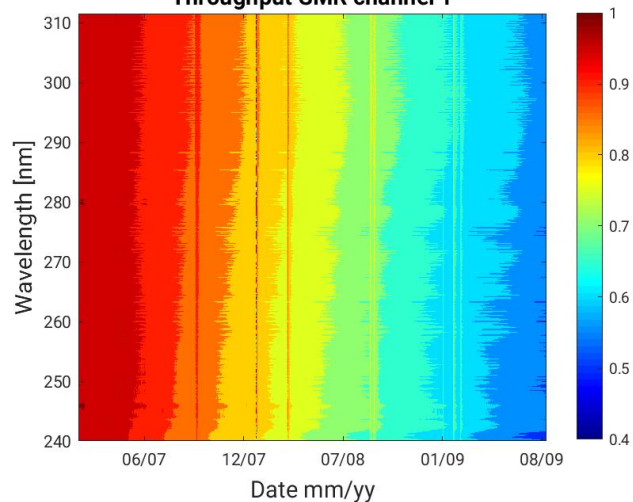
**GOME-2 Metop-B**



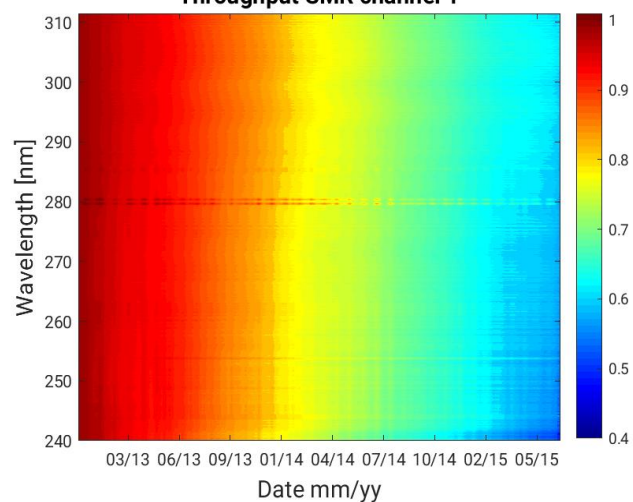
**GOME-2 Metop-C**



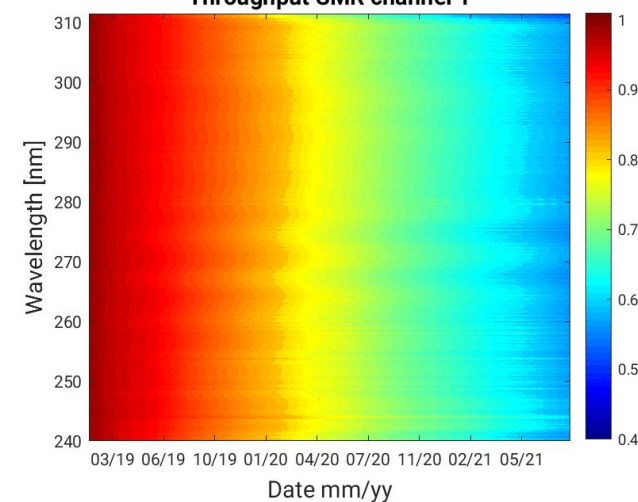
**Throughput SMR channel 1**



**Throughput SMR channel 1**



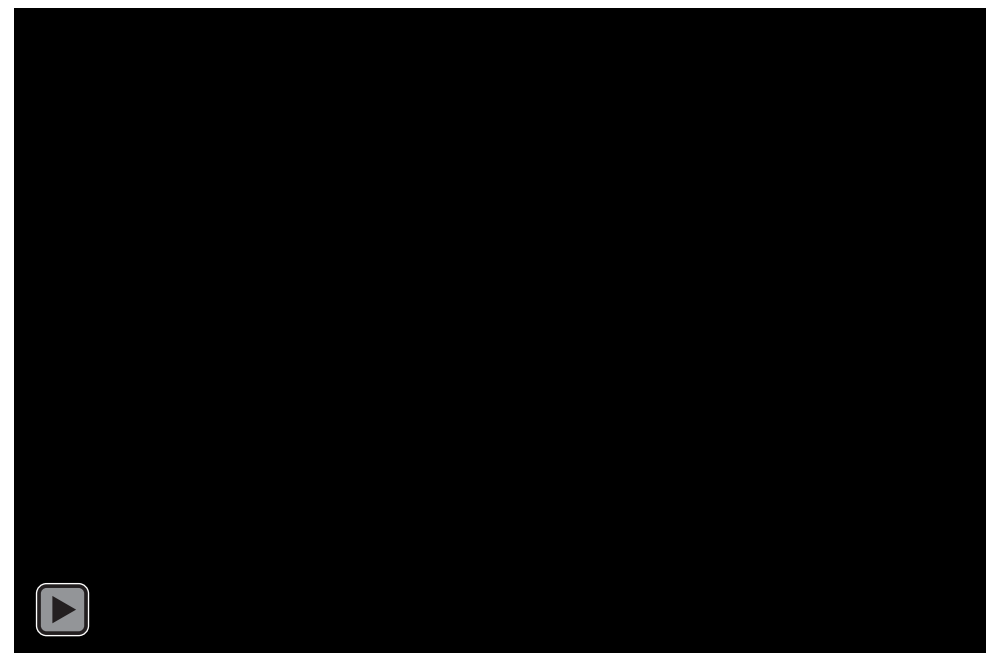
**Throughput SMR channel 1**



GOME-2 throughput for FM3, FM2, FM1 after similar time in orbit



- Metop-A has been providing meteorological data to global users for fifteen years, three times longer than expected. De-orbiting currently ongoing.
- Orbit has been lowered so that its point of orbit closest to the Earth has decreased from 817km to 580km. There are Simultaneous Nadir Observations with both Metop B and C.
- EOL campaign is used for several instrument tests, such as a long SLS measurement without temperature stabilization.
- **27 November 2021:** Metop-A payload module is switched off.
- **1 December 2021:** Metop-A deorbiting campaign is completed.

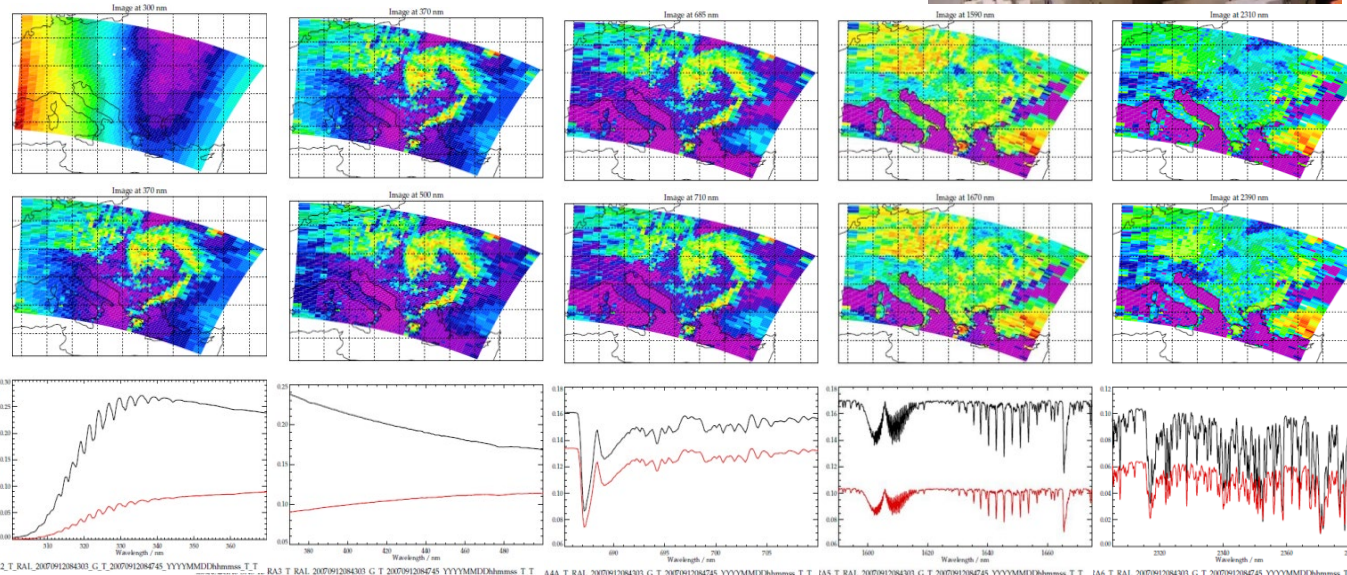
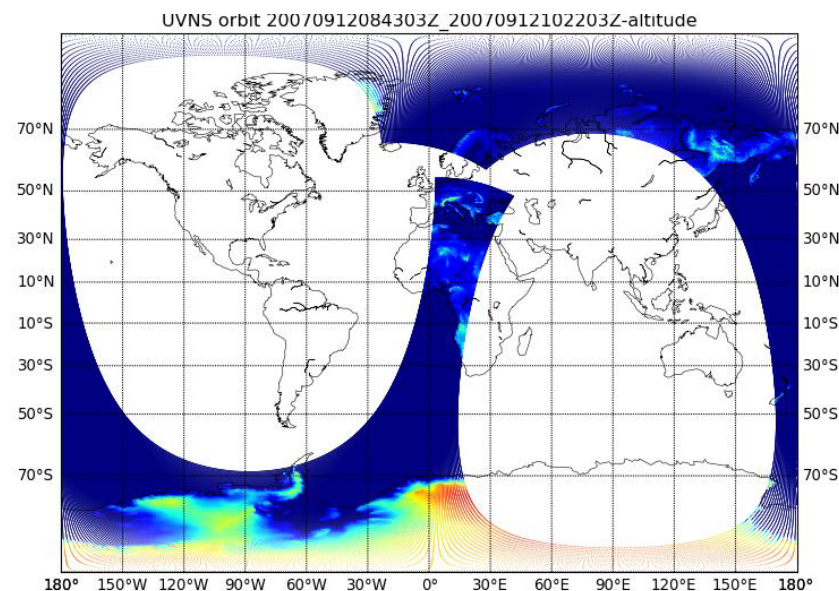




# EUMETSAT Polar System – SG A / Copernicus Sentinel-5

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Parameters	
Clouds	Effective Optical Depth (cirrus only)
	Effective Height
	Fraction/Mask from VII
Aerosol	UV Absorbing Index
	Layer Height
Surface Albedo	Surface Albedo
Ozone O3	Stratospheric Vertical Profile
	Tropospheric Column
	Total Column
Nitrogen dioxide NO2	Total Column
	Tropospheric Column
Sulfur dioxide SO2	Total Column and Height
Formaldehyde HCHO	Total Column
Methane CH4	Total Column
Carbon monoxide CO	Total Column
UV	Spectrally Resolved Irradiance at Surface and UV Index
Glyoxal CHOCHO	Total Column
Scene heterogeneity from VII	Scene heterogeneity from VII



Metop-SG A PFM  
Credits: ESA





# Meteosat Third Generation – Sounder / Copernicus Sentinel-4

- The Meteosat Third Generation – Sounder platform will carry the Copernicus Sentinel-4 payload.
- Currently scheduled for launch in Q1 2024
- First European Air Quality mission in a geostationary orbit

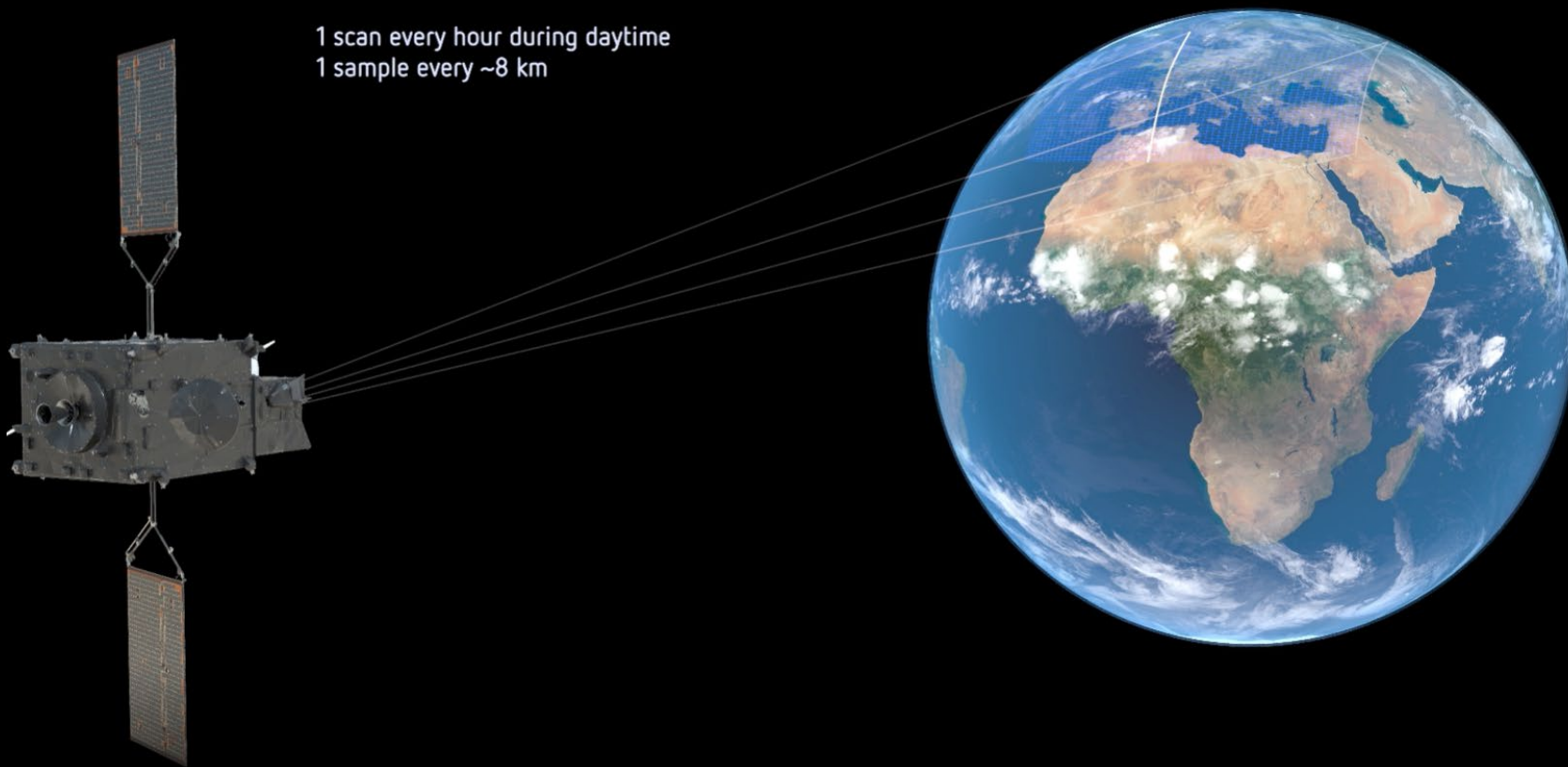
## Copernicus Sentinel-4

UVN Sounder (Ultraviolet – Visible – Near-infrared)

1 scan every hour during daytime

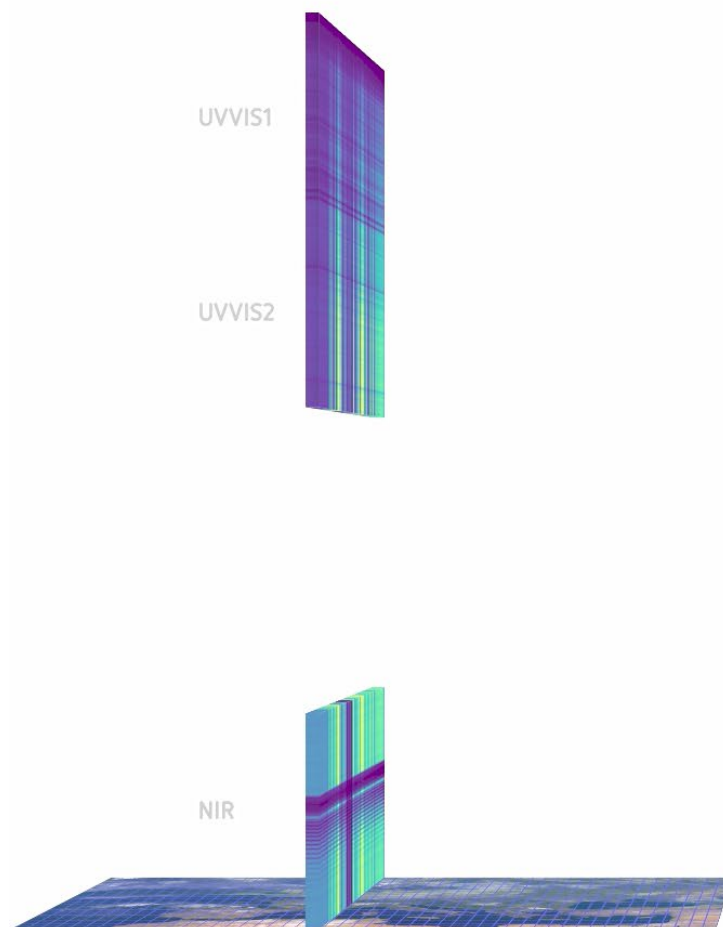
1 sample every ~8 km

## Meteosat Third Generation – Sounder





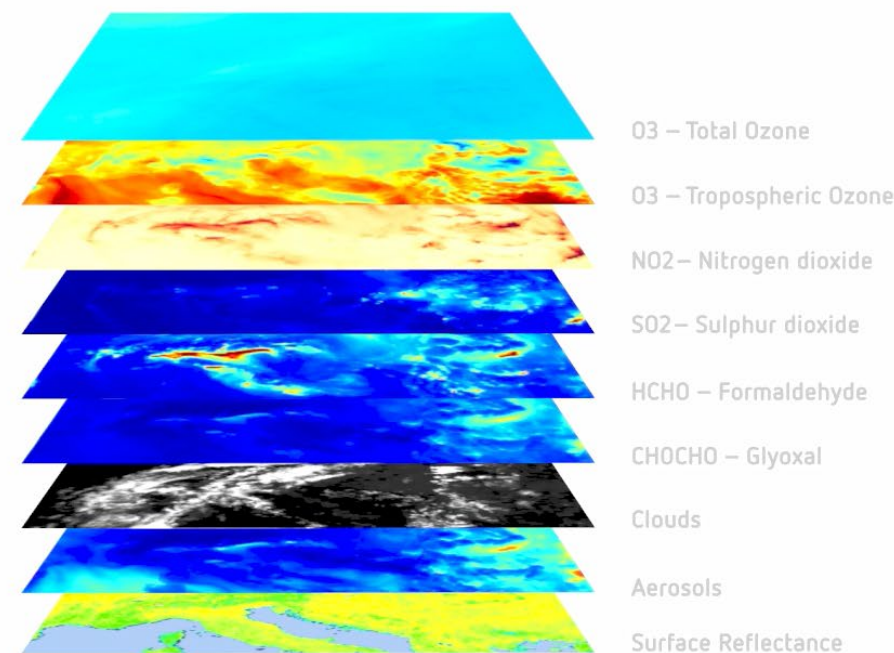
Parameter
Total O <sub>3</sub> column
Tropospheric O <sub>3</sub> sub-column
NO <sub>2</sub> total column, tropospheric sub-column
SO <sub>2</sub> total column
CH <sub>2</sub> O total column
CHOCHO total column
Aerosol absorbing index
Aerosol layer height
Cloud optical thickness, fraction, altitude
Surface reflectance (Lambertian equivalent albedo and bi-directional reflectance factor), aerosol optical thickness
Cloud and scene characteristics from FCI re-sampled to S4 L1b spatial grid
Aerosol column optical thickness, type, layer height, absorbing index
Cloud optical thickness, fraction, altitude
O <sub>3</sub> with enhanced separation of the lower troposphere



## Meteosat Third Generation – Sounder

Copernicus Sentinel-4 UVN

Geophysical products (Level-2)





- High resolution spectrometer systems with very demanding radiometric/spectral/geometrical requirements.
- Throughout mission lifetime, L0-to-L1B processors need to have access to accurate Calibration Key Data (CKD) in order to generate compliant L1B products.
- Part of the CKD is dynamic, i.e., it is subject to temporal fluctuations and drifts at different time scales. Reasons: Launch/settling effects, Optics / detector / diffuser contamination & degradation, etc.

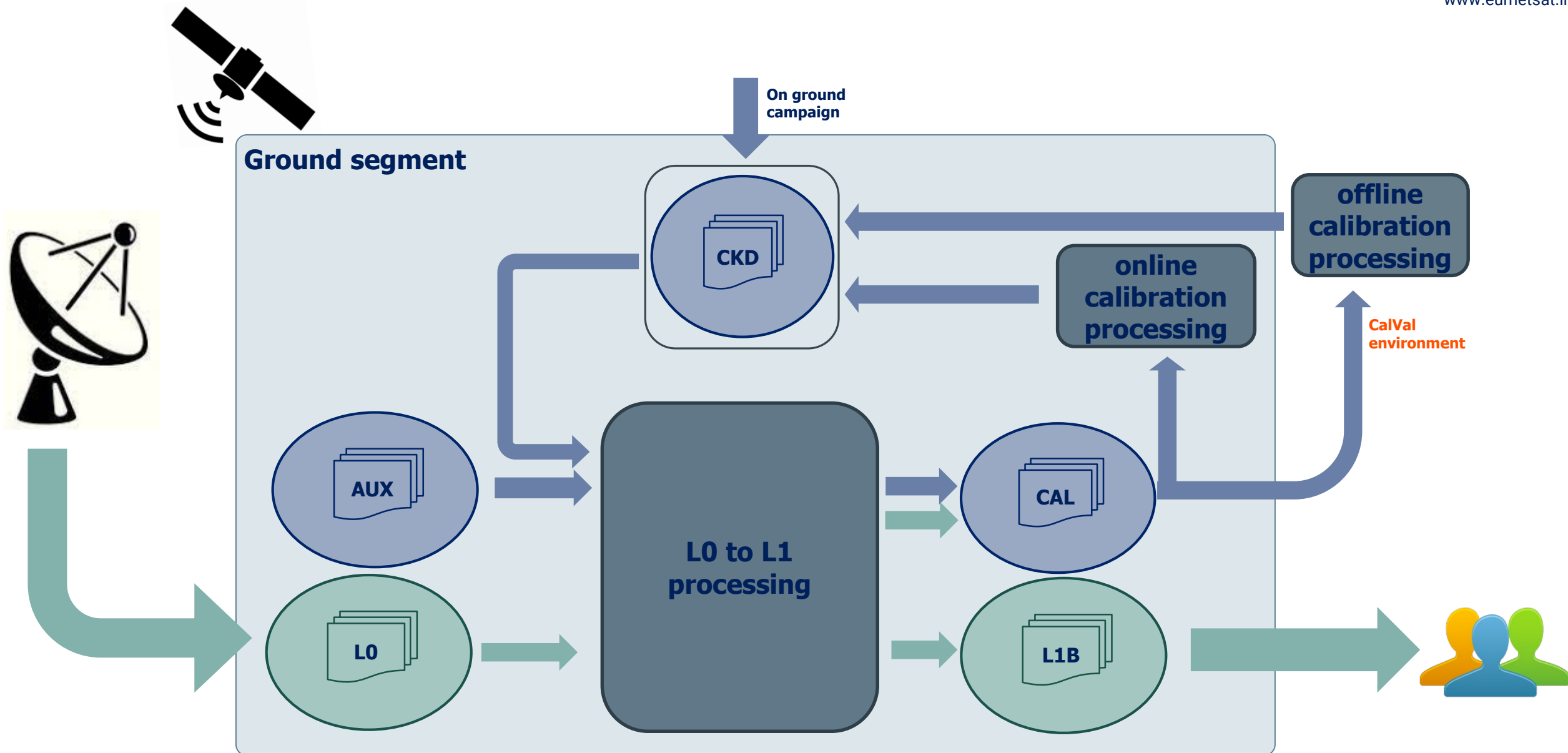


- CKD life cycle:
  1. On-ground calibration campaign (-> CKD), complemented by
  2. Commissioning phase measurements (-> CKD completion & update)
  3. Routine operations (CKD update)
- On-board calibration sources (LED, WLS, SLS) are used in addition to Sun, Dark, Deep Space and Star measurements to monitor instrument calibration.
- Operational L0-L1 processors are designed to calculate updated CKD in an autonomous way, where possible
  - spectral calibration; dark current; electronics offset; system non-linearity; defective pixel maps; pixel response non-uniformity (PRNU), ...



# Copernicus S4/S5 L1 Operational Processors

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- Ongoing development
  - Sentinel-4 L1 Operational Processor is under development as part of the MTG [Instrument Data Processing Facility - Sounder \(IDPF-S\)](#) ground segment.
  - Sentinel-4 L2 Processor (esa/DLR development) is integrated into MTG [Level-2 Processing Facility \(L2PF\)](#).
  - Sentinel-5 L1 and L2 Operational Processors are implemented in EPS-SG [Payload Data Acquisition and Processing \(PDAP\)](#) facility.
- Final ground processing baseline for launch (ATBD, prototypes, CKD) to be defined after execution & analysis of on-ground calibration campaigns, scheduled to happen during the course of 2022 for both Proto Flight Models.
- With launch dates in Q1/Q2 2024, readiness of operational processors, fully implemented and verified in EPS-SG / MTG-S ground segments, is a challenge. ESA and EUMETSAT are therefore jointly working on strategies to ensure the timely commissioning/CalVal of the instruments and products by using temporary processor solutions.

- The [Sentinel-4 and Sentinel-5 Calibration and Validation Plan](#) captures the different tasks to be fulfilled during commissioning and routine phases.
- Level-1 calibration:
  - Solar, on-board, and vicarious calibration targets
  - Other satellite data (GOME-2, Sentinel-5p, TEMPO/GEMS, ...)
  - via international partner collaboration, partner agencies, GSICS, CEOS AC/VC.
- Level-2 trace gas (and ancillary) product validation and verification:
  - Ground-based observations (NDACC, Pandonia, WOUDC, Eubrewnet, TCCON, ...)
  - Other satellite data (GOME-2, Sentinel-5p, TEMPO/GEMS, ...)
  - Dedicated campaigns
  - Model-based validation (CAMS)
- These Fiducial Reference Measurements (FRM) will form the basis of the absolute validation
  - Timeliness requirement: < 48h (NTC)
  - Data access & format (Easy access, data format, consistent and traceable processing approach, traceability to standard and/or community recognised best practices, high product quality)
  - Documentation
  - Long-term availability in order to cover the time of the missions
- Announcement of Opportunity (AO) Call to be released 18-24 months prior to launch, whereby ESA and EUMETSAT invite interested groups to participate in carrying out the activities defined in the CalVal plan.



# Thank you!

Questions are welcome.