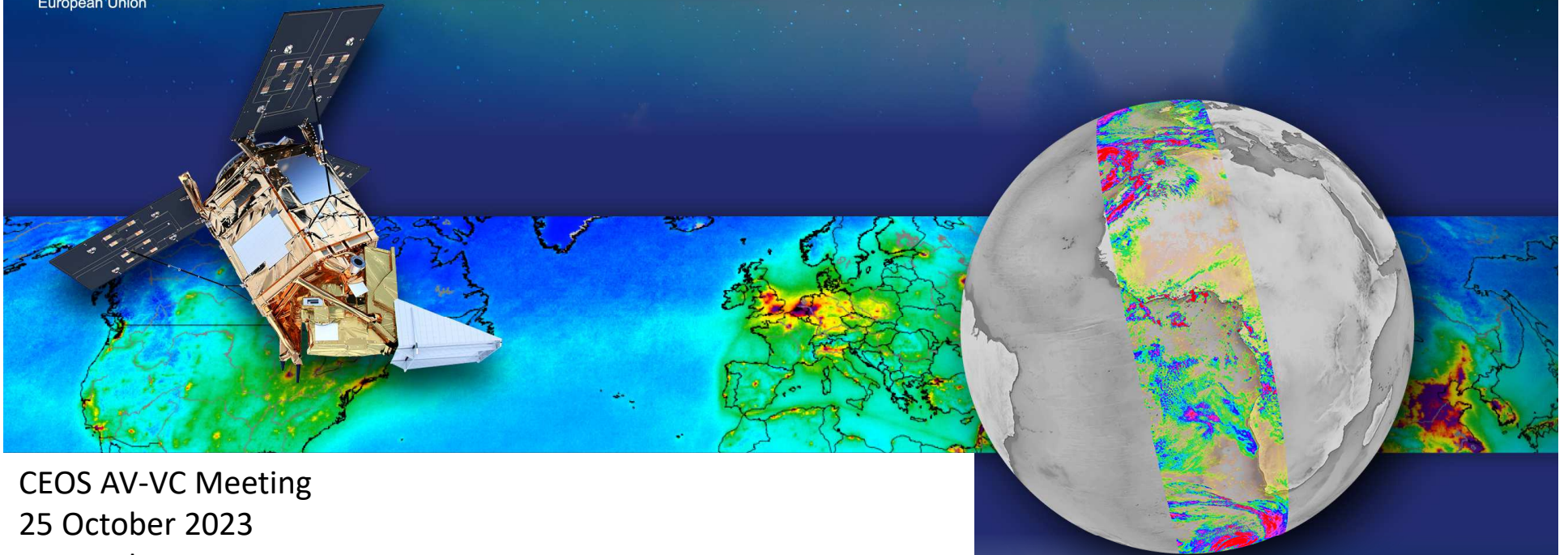




European Union

Sentinel-5P Mission Status



CEOS AV-VC Meeting

25 October 2023

Bruussels

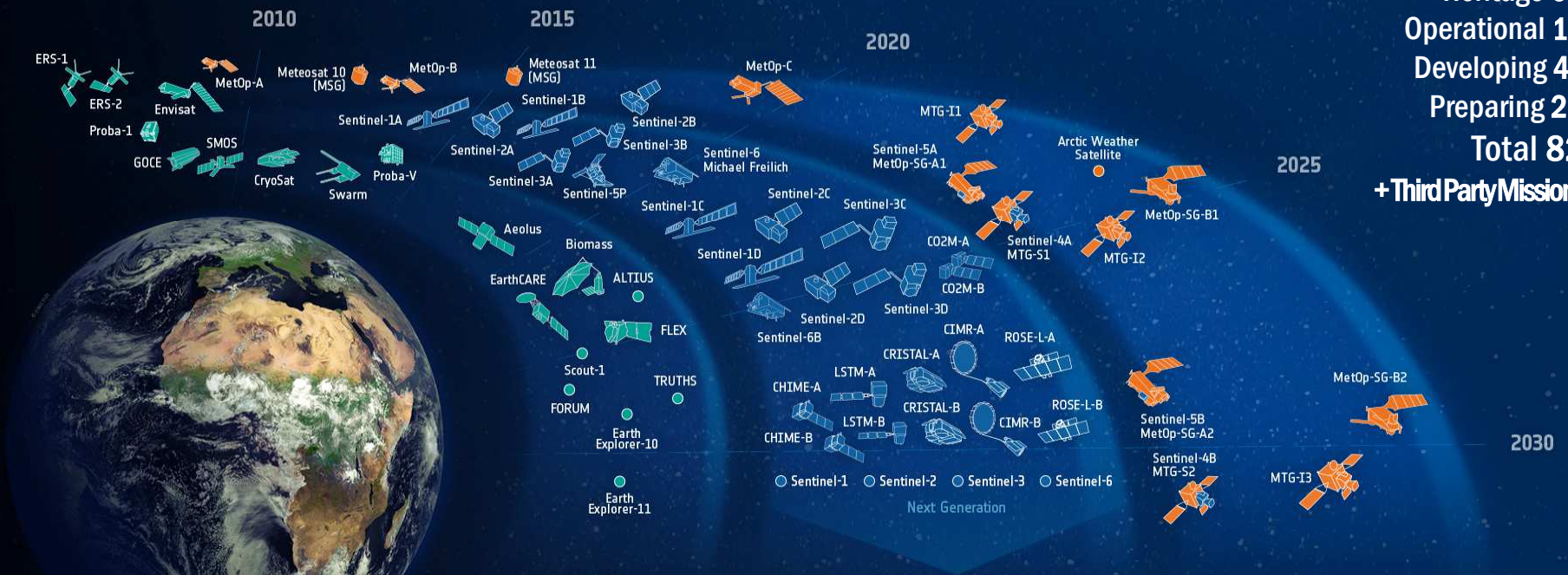
C. Retscher on behalf of C. Zehner (ESA)





ESA-DEVELOPED EARTH OBSERVATION MISSIONS

Satellites
Heritage 04
Operational 15
Developing 41
Preparing 22
Total 82
+ **Third Party Missions**



ESA UNCLASSIFIED – For Official Use



Science

Copernicus

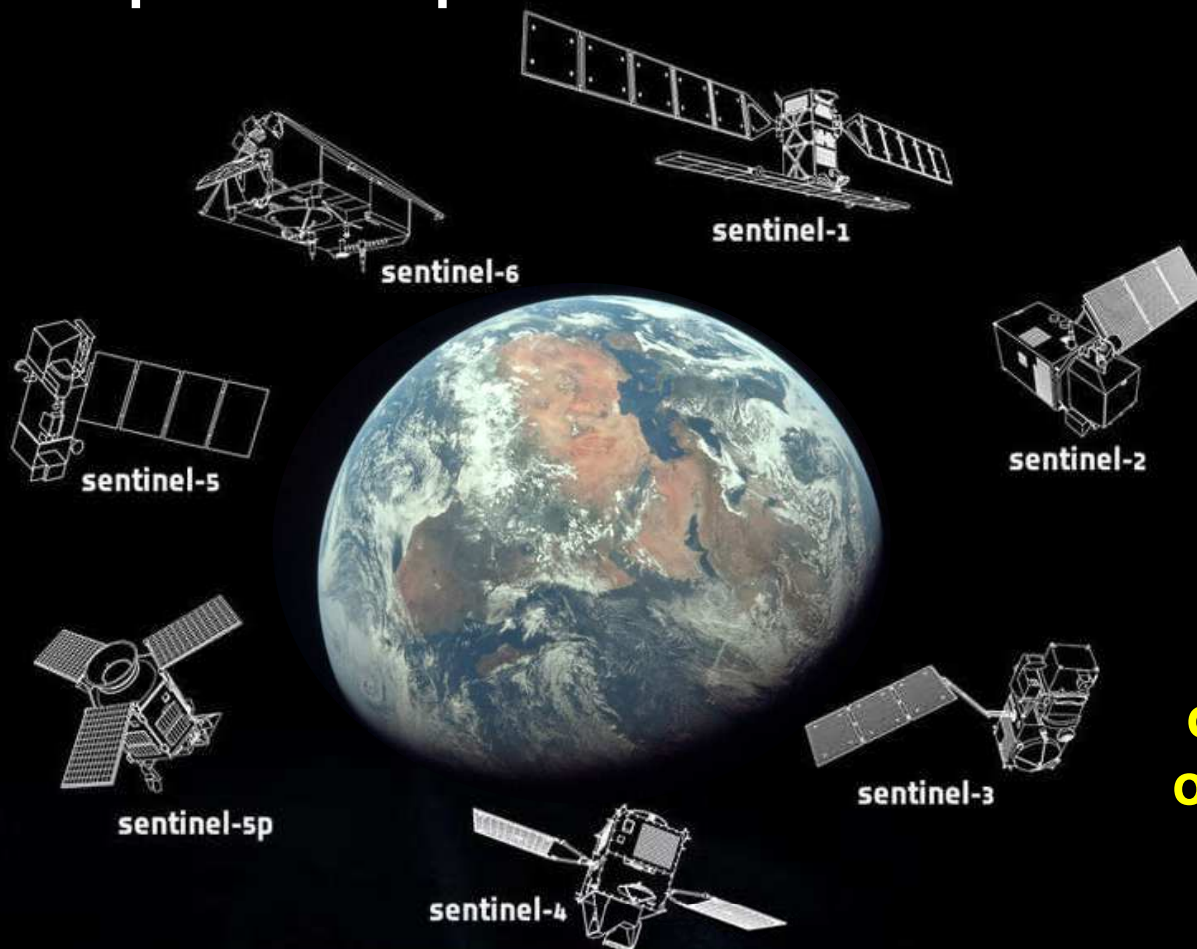
Meteorology

European Space Agency

An ESA Built Copernicus Space Component



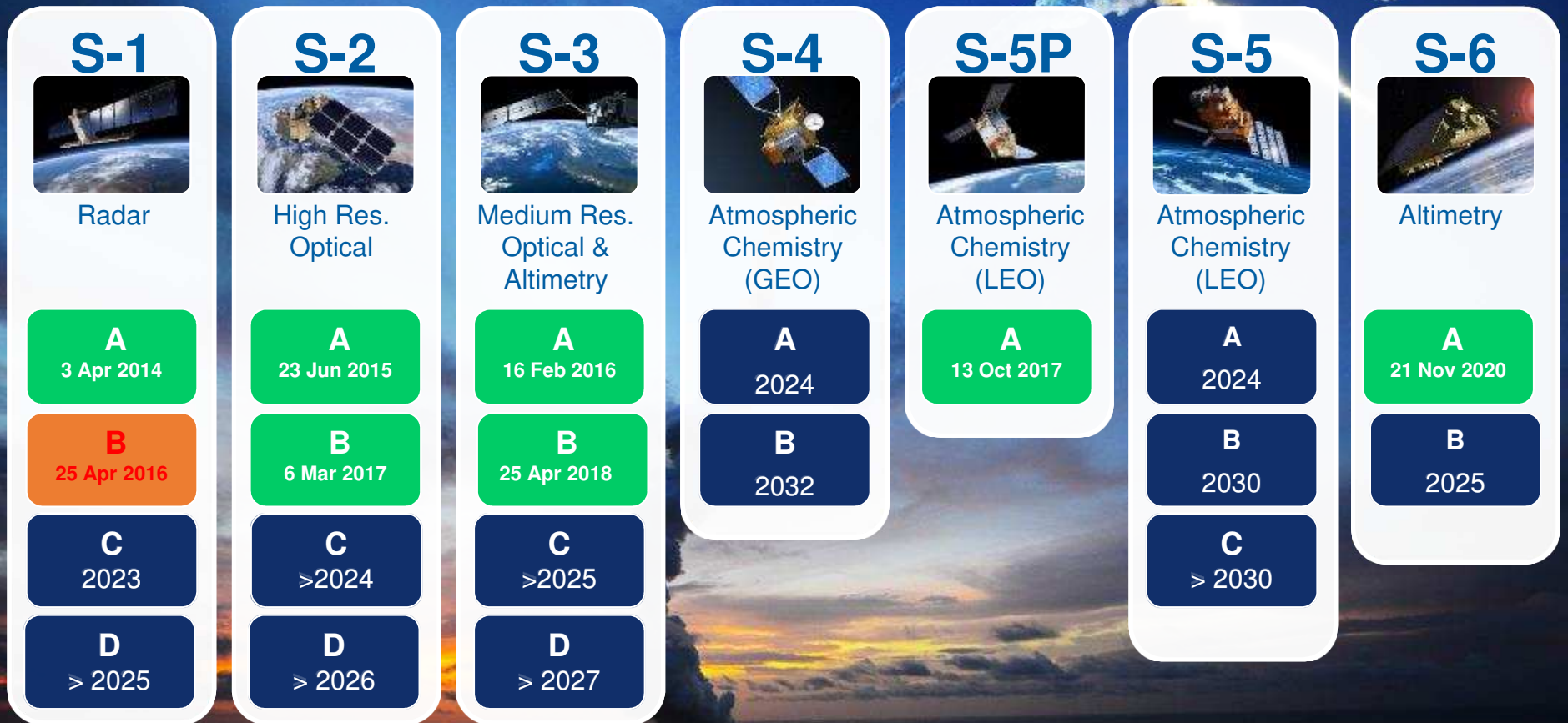
The first generation of ESA developed Sentinel satellites 1 to 6



Providing systematic observations of land, water and atmosphere worldwide



Copernicus – Sentinels Status





PROGRAMME OF THE
EUROPEAN UNION

PROGRAMME OF THE
EUROPEAN UNION



co-funded with



Combating
Climate Change

Food Security and
Water Management

Monitoring Land
and Natural Resources

Safeguarding
the Arctic

Strengthening
Copernicus Space
with the Sentinel
Expansion
Missions

CO2M

LSTM

CHIME

ROSE-L

CIMR

CRISTAL



Sentinel-5 Precursor: first atmospheric Sentinel Mission



PROGRAMME OF THE
EUROPEAN UNION



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- **Launched:** 13 October 2017, Plesetks
- **Launcher:** Rockot
- **Main Payload:** TROPOMI (co-funded by The Netherlands and ESA) - Hyper-spectral push-broom imaging spectrometer, 4 spectrometers with 2D detectors with 4000 spectral channels
- **Orbit:** Altitude of 820 km, 227 orbit repeat cycle
- **Daily Global Coverage:** 13:30 ascending node crossing time
- **Spatial Sampling:** 5.5 x 3.5 km (mission requirement: 7 x 7 km)
- **Mission Control:** ESOC
- **TROPOMI Mission Planning:** KNMI
- **Ground Stations:** Svalbard (NOR) and Inuvik (Canada)
- **Operational Data Processing:** DLR (on behalf of ESA)
- **Mission Design Life Time:** ~7 years
- **National co-funding during Routine Operations** (e.g. on Algorithm Development/QA Monitoring): Belgium, Germany, and The Netherlands
- **Key User:** Copernicus Atmospheric Monitoring Service (ECMWF)





PROGRAMME OF THE
EUROPEAN UNION



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Sentinel-5P 5 years Anniversary Conference Italy, Taormina, 10-14 October 2022

**140 Participants in Person
(20-30 on-line)**

84 oral presentations

50 posters

Social Event: Etna Excursion

Sentinel-5 Precursor

Mission Objectives

1. Ozone, Air Quality, and Climate Monitoring and Forecasting
2. Extending the time series of GOME, SCIAMACHY, OMI, GOME2 measurements
3. Precursor of the Copernicus Sentinel-4 and Sentinel-5 missions



Sentinel-5P Products



European Union



Sentinel-5 Precursor mission operations → in operations since April 2018 and in routine operations since March 2019

Sentinel-5P TROPOMI
NO₂ tropospheric column
April 2018 - March 2019

Ozone Profile (O₃ Profile) – November 2021

Aerosol Layer Height (ALH) - September 2019

Methane (CH₄)

Tropospheric Ozone Column (trop. O₃) - March 2019

Sulfur Dioxide (SO₂)

Formaldehyde (OCHO) - October 2018

Total Columns of Ozone (O₃)

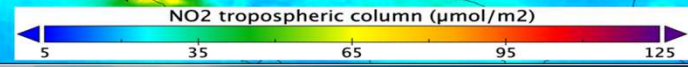
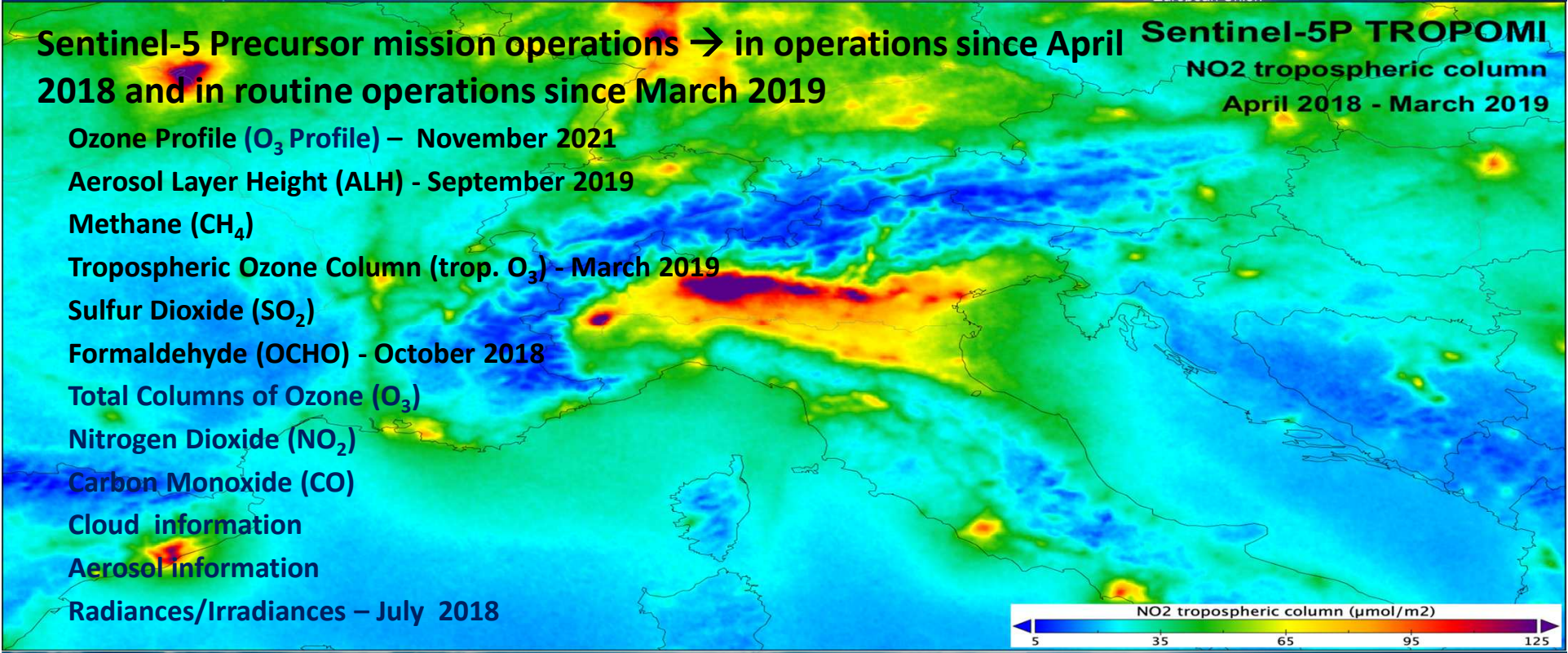
Nitrogen Dioxide (NO₂)

Carbon Monoxide (CO)

Cloud information

Aerosol information

Radiances/Irradiances – July 2018



Copyright: Contains modified Copernicus Sentinel data (2018-2019) / processed by KNMI



Dissemination Timeliness



European Union



Mission dissemination

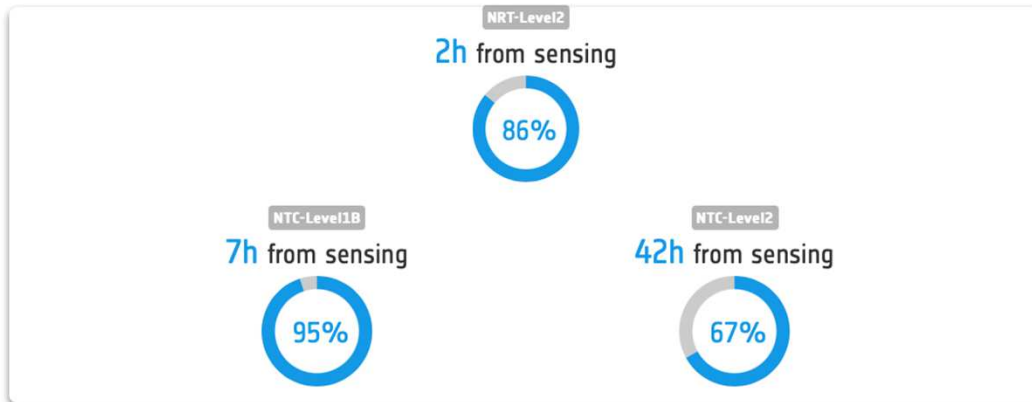
Publication timeliness



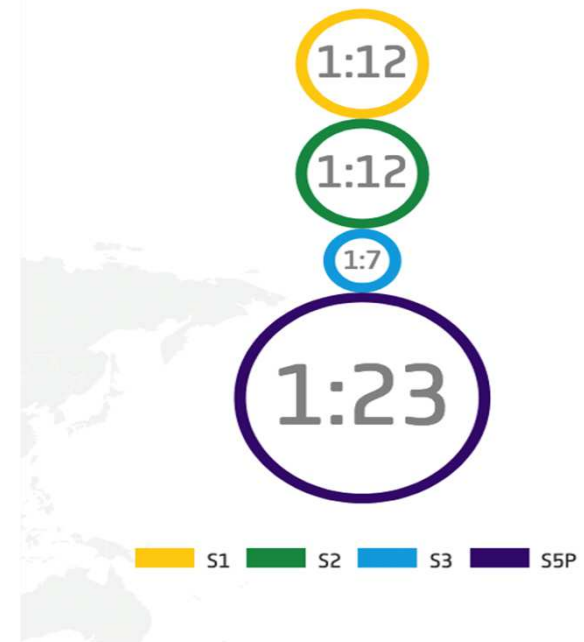
Sentinel-5P

Publication timeliness during the last month

Copernicus Open Access Hub



Overall archive exploitation ratio

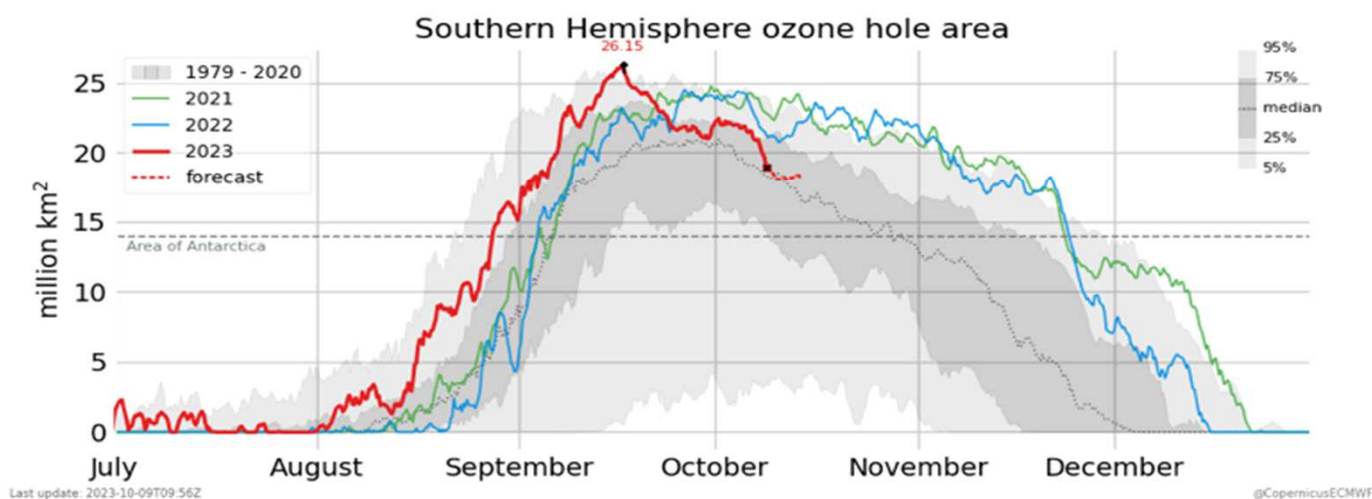


Sentinel-5P Ozone Monitoring



https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-5P/Ozone_hole_goes_large_again
Early start of 2023 ozone hole and record extension during Sep. - possible Honga Tonga eruption impact (water vapour)

Ozone hole area

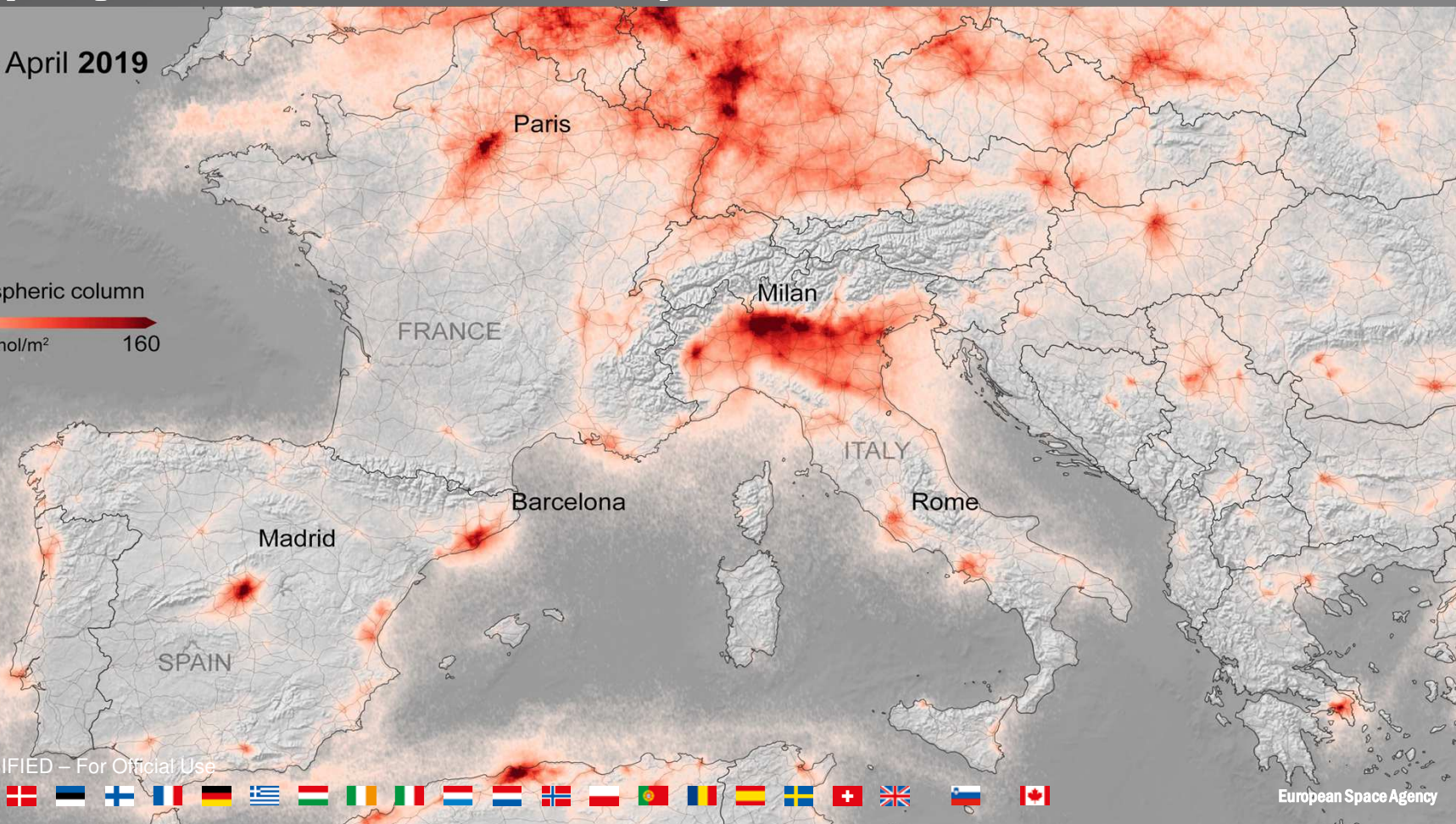


Dropping Air Pollution in Europe



March - April 2019

NO₂ tropospheric column
20 $\mu\text{mol}/\text{m}^2$ 160



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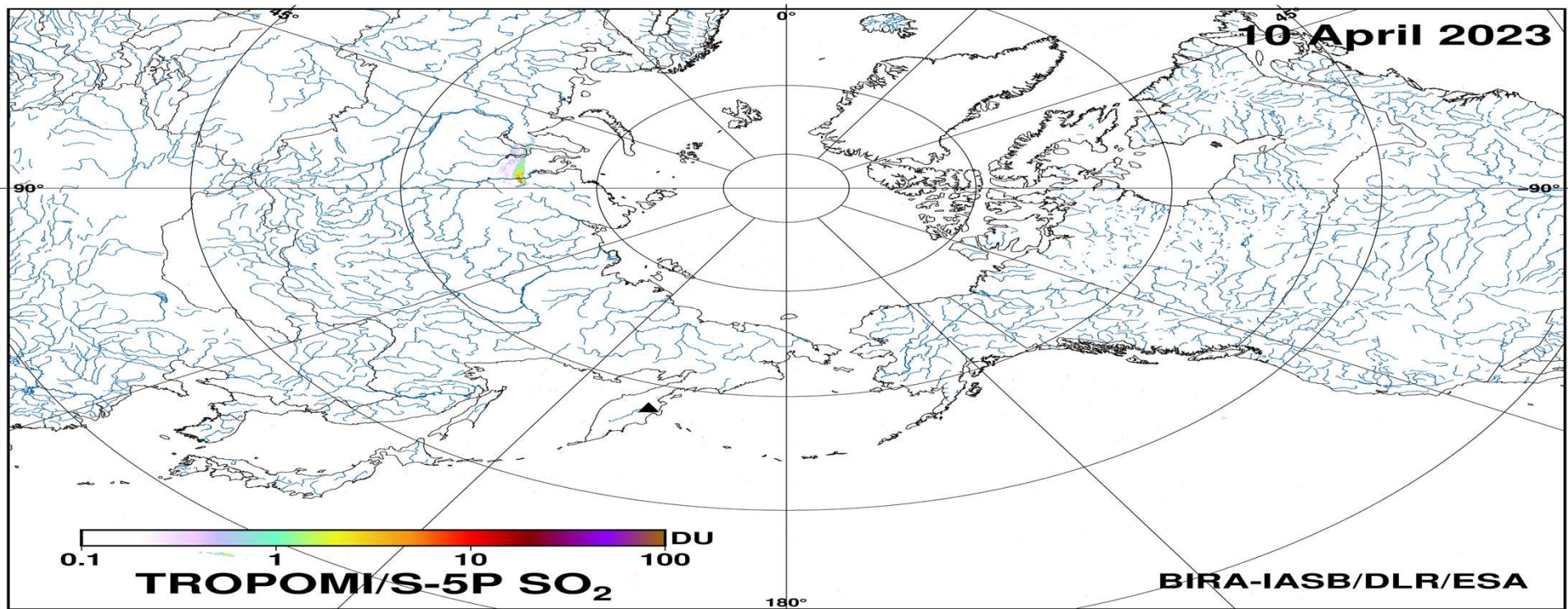


European Space Agency

Sentinel-5P Air Pollution Monitoring Volcanic Emissions



European Union

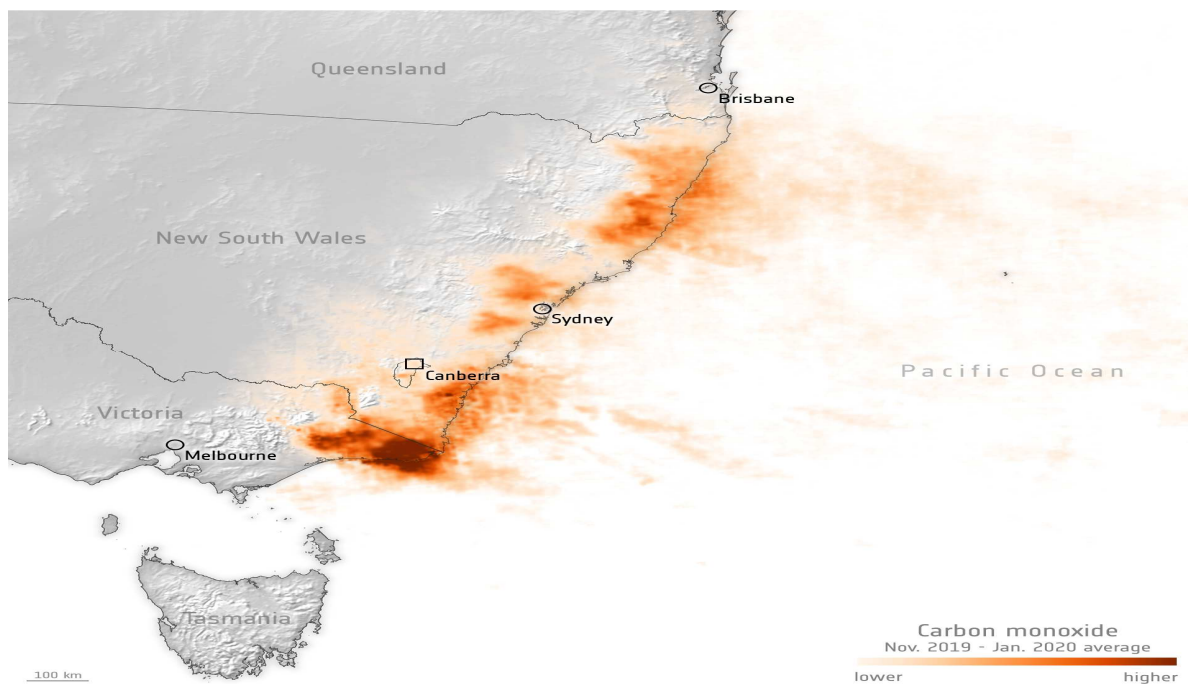


*Sentinel-5P SO₂ measurements emitted by the Russian volcano Shiveluch
Copyright: Contains modified Copernicus Sentinel data (2023), processed by BIRA/IASB*

Sentinel-5P Air Pollution Monitoring Bush-Fire Emissions in Australia



https://www.esa.int/Applications/Observing_the_Earth/Aerosols_released_from_Australian_bushfires_triggers_algal_blooms



these bushfires (Nov. 2019 – Jan. 2020) released CO equivalent to 715 million tonnes of CO₂ in just three months

van der Velde, I.R., van der Werf, G.R., Houweling, S. *et al.* Vast CO₂ release from Australian fires in 2019–2020 constrained by satellite. *Nature* **597**, 366–369 (2021). <https://doi.org/10.1038/s41586-021-03712-y>



CO measurements - Credits: contains modified Copernicus data (2019/20) processed by SRON

Trio of Sentinel satellites map methane super-emitters



European Union

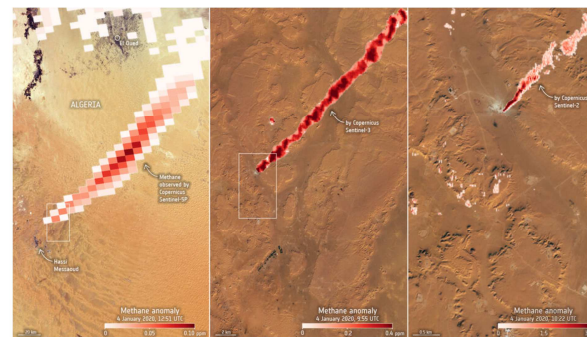


Methane – monitoring –include the emission map and S5p/GHGSat plume measurements image

- CH₄ super-emitters release a disproportionately large amount of methane compared to other emitters e.g. oil and gas operations, coal mines, or even landfills
- New algorithm that automatically discovers methane super-emitter plumes in Sentinel-5P data using machine learning.



Libya: 2021-07-26 2021-04-17



Three tiered approach
S5p, S3, S2

https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Trio_of_Sentinel_satellites_map_methane_super-emitters

Sentinel-5 Precursor – Key Milestones since last year



- **A complete mission data reprocessing** of the operational Sentinel-5P products was finalized early 2023.
- **All reprocessed - over instrument life time - data sets** (13 operational products) are now available at: <https://s5phub.copernicus.eu>
- The next PDGS update is planned during the second half of Nov. 2023 to include a Methane retrieval algorithm that is independent of SUOMI-NPP VIIRS data and an **ALH** algorithm (inclusion of albedo info) that works also over land
- **Six Sentinel-5P pre-operational products** (Aerosol Optical Thickness, Bromine Monoxide, Glyoxal, Sun-Induced Fluorescence, Water Vapour, and a Sulphur Dioxide product using the new Covariance-Based Retrieval Algorithm (COBRA)) are being provided to the public via: <https://data-portal.s5p-pal.com>