

climate change initiative

LONG-LIVED GREENHOUSE GAS PRODUCTS PERFORMANCES

Operational monitoring of atmospheric composition: current status

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Operational monitoring



Operational monitoring in Europe

- **EUMETSAT** is the European operational satellite agency for ***monitoring weather, climate and the environment***. EUMETSAT is committed to delivering Earth observation satellite data 24/7, as well as to meeting the needs of the national weather services of its member states. We plan and develop the future satellite systems required to ensure continuity and adaptation to evolving ***forecasting and climate monitoring*** needs.
- **Copernicus** is providing accurate, timely and easily accessible information ***to improve the management of the environment, understand and mitigate the effects of climate change and ensure civil security***.
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- **ESA's Earth Watch** provides missions operated in partnership with other organizations. The missions target specific strategic applications incl. operational add-ons



Definition of user requirements in Europe



2000-2005: Themes to be supported through operational monitoring of atmospheric composition (EU/ESA/IGACO/EUMETSAT)

Themes

- (A) Stratospheric Ozone and Surface UV radiation
- (B) Air Quality
- (C) Climate

User categories

- (1) Protocol monitoring and emission verification
- (2) Near-real time data use / data assimilation
- (3) Scientific assessment / research applications

2006-2010: The EU Sentinel program was defined without the user requirements for research applications (ESA Earth Explorers)



Operational Atmospheric Chemistry

Monitoring Missions

ESA contract no. 17237/03/NL/GS

CAPACITY

**Composition of the Atmosphere: Progress
to Applications in the user Community**

October 2005





Tropomi – Sentinel 5P



Product	Application
Ozone	Ozone layer monitoring, UV-index forecast, Climate monitoring
NO ₂	Air quality forecast and monitoring
CO	Air quality forecast and monitoring
CH ₂ O	Air quality forecast and monitoring
CH ₄	Climate monitoring
SO ₂	Air quality forecast and monitoring, Climate monitoring, Volcanic plume detection
Aerosol	Air quality forecast and monitoring, Climate monitoring, Volcanic plume detection
Clouds	Climate monitoring
UV-Index	UV index forecast



Current status (excl. research missions)



Copernicus

- Sentinel 4 2025-
- Sentinel 5p 2017-
- Sentinel 5 2025-
- CO2M 2027-

Eumetsat / Meteorology

- Metop/IASI 2006-
- Metop-SG/IASI-NG 2025-
- MTG/IRS 2025-

ESA Earth Watch

- Altius 2027-





S4, IASI-NG, S5, CO2M and Tango

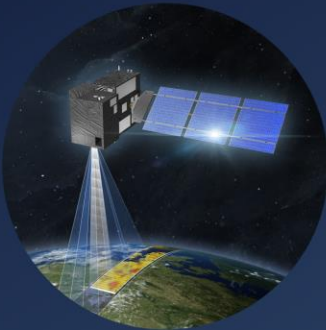


Metop SG

- S5/UVNS (Tropomi like)
- IASI-NG
- 3MI
- Metimage
- Launched August 2025
- Morning orbit

Sentinel 4

- S4/UVN
- Resolution $\sim 8 \times 8 \text{ km}^2$
- Geostationary over Europe
- Launched July 2025
- On MTG-S with IRS

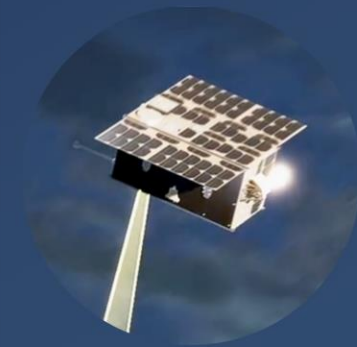


CO2M

- EU Copernicus programme
- CO_2 , CH_4 , NO_2 , Sif
- Resolution $2 \times 2 \text{ km}^2$
- Swath width $\sim 270 \text{ km}$
- No earlier than 2027
- Constellation of 3 identical satellites

TANGO

- ESA scout programme
- CO_2 , CH_4 , NO_2
- Resolution $300 \times 300 \text{ m}^2$
- Targets $30 \times 30 \text{ km}^2$
- 2 cubesats flying in formation
- No earlier than 2028

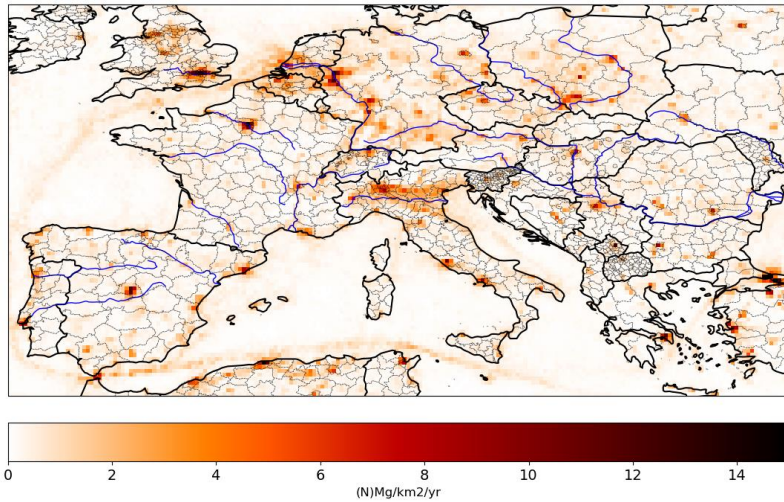




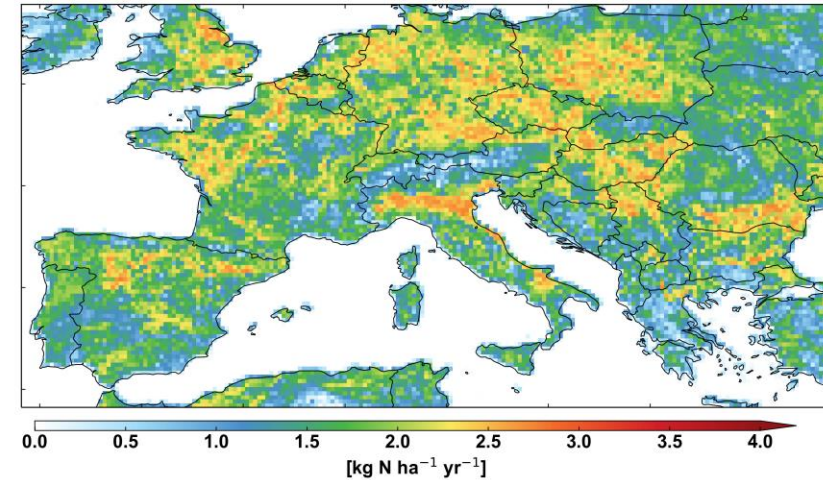
Tropomi NO₂ emissions



Anthropogenic NO_x



Soil NO_x



Lin et al., 2024

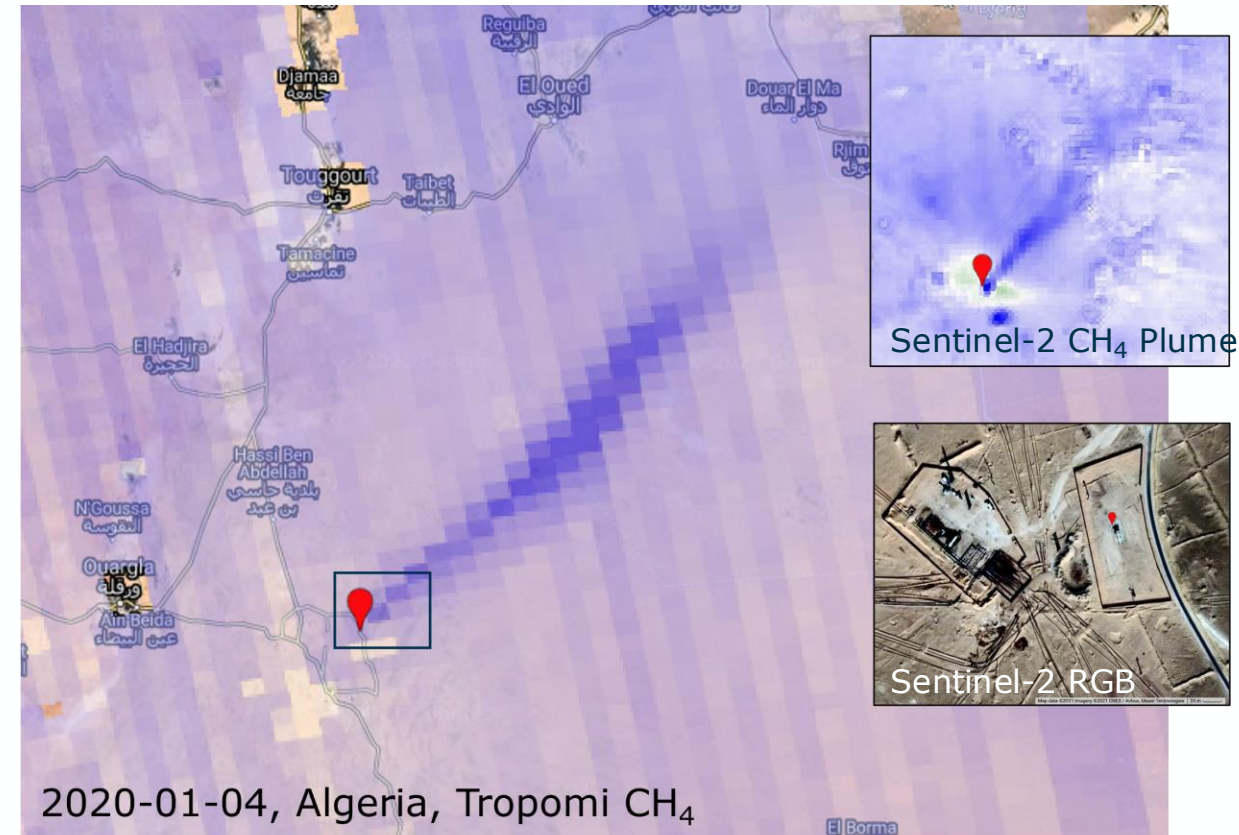
<https://doi.org/10.1029/2024JD041492>



Methane emissions using Tropomi and Sentinel-2



- Satellites allow for the global verification of the Paris Agreement and the Methane Pledge.
- Satellites can detect methane leaks and provide data in near-real-time.
- Combined use of Sentinel 5P and (here) Sentinel 2 is crucial for **attribution** and **emission verification**
- Combination of ground-based and satellite observations in inverse models will contribute to the national reporting.
- Transparency through open data and open algorithms are essential for credibility.

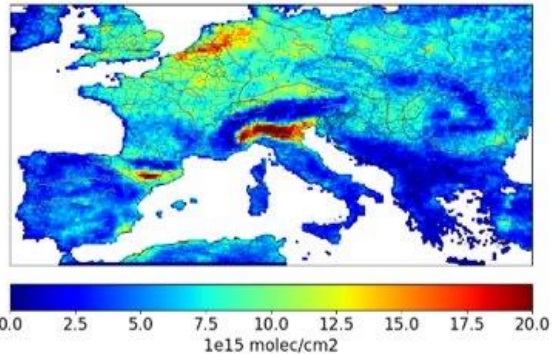
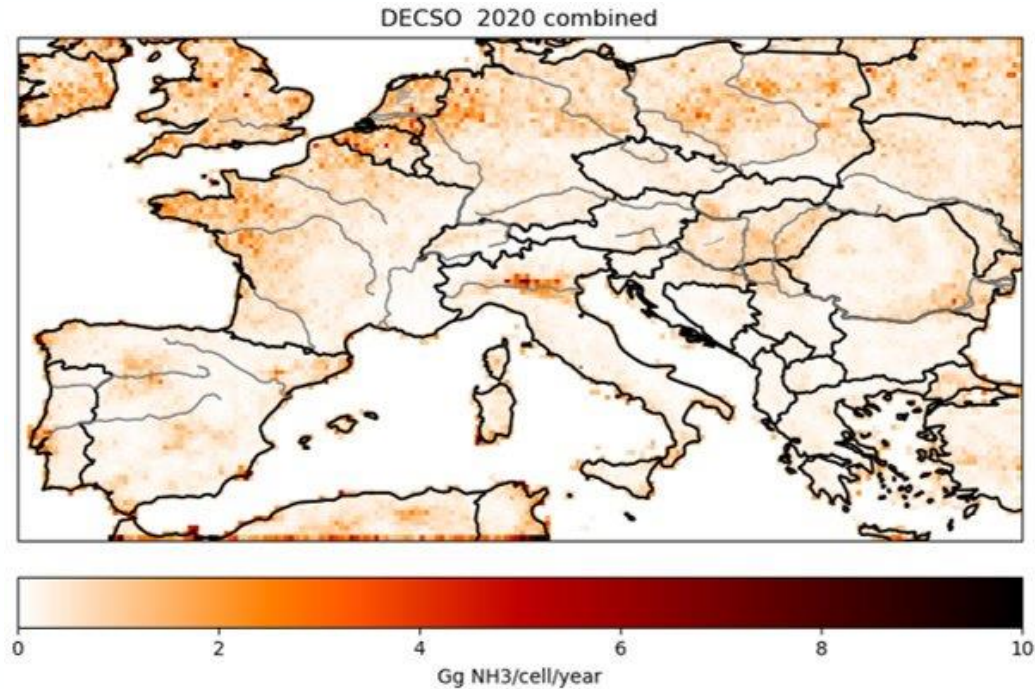




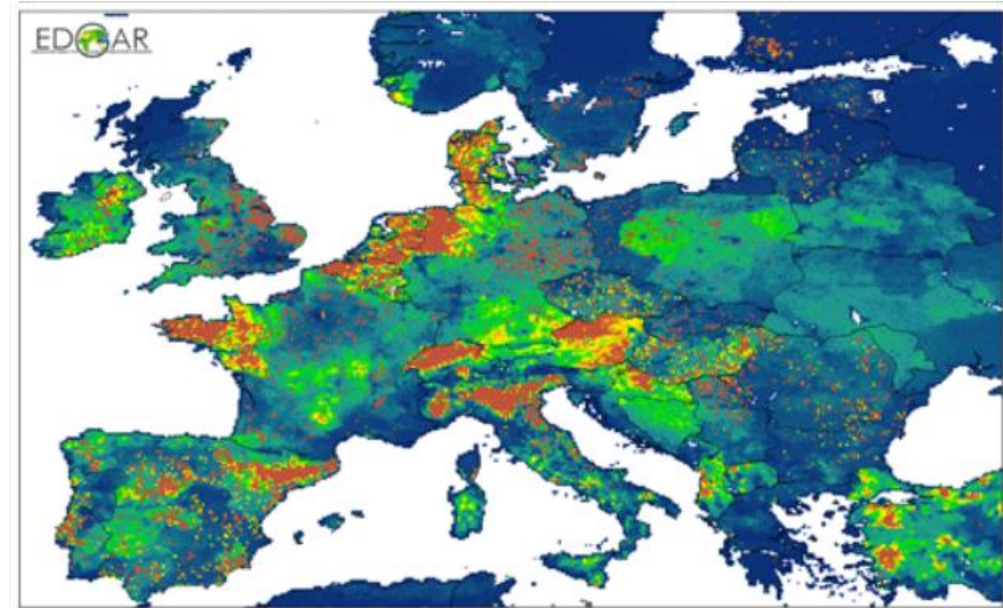
Agriculture



Derived NH_3 Emissions



Bottom-up N_2O Emissions*



* intensive animal farming and manure management practices using NH_3 hot spot observations

Crippa et al., 2024; <https://doi.org/10.5194/essd-16-2811-2024>



Summary



- The operational space monitoring system created by Europe encompasses multiple components including atmospheric composition
- Greenhouse gas monitoring is integral part of this system, with a focus on CO_2 and CH_4
- The operational space system however provides important constraints on unobserved components
- Short-lived precursor gases provide important fingerprinting for specific GHG emission monitoring
- Methods are developed to use NH_3 and soil NO_x products in constraining N_2O (and CH_4) surface fluxes
- Land use satellite data provide additional constraints for the N_2O and CH_4 budgets

=> Combination of multi-disciplinary operational satellite data and ancillary information is key for the operational attribution and verification of CO_2 and non- CO_2 GHG emission inventories.



NCGG-10 in Utrecht, 15-17 June 2026





NCGG

10th International Symposium on
Non-CO₂ Greenhouse Gases (NCGG10)
June 15-17, 2026, Utrecht, The Netherlands

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NCGG10

10th International Symposium on Non-CO₂ Greenhouse Gases

June 15-17, 2026, Utrecht, The Netherlands

NCGG: the other half of the problem

The 2026 NCGG-10 Symposium on non-CO₂ greenhouse gases targets the greenhouse gases methane (CH₄), nitrous oxide (N₂O), fluorocarbons, and halogenated species (HFC/CFC/HCFC/SF₆, etc.). Since the combined contribution of these gases to climate warming since the pre-industrial period is comparable to the warming caused by CO₂ alone (46% by non-CO₂; 54% by CO₂; ref. IPCC AR6), we refer to them collectively as "the other half of the problem." Especially CH₄ is becoming increasingly important. Attention should also be given to the impact of hydrogen (H₂) and aerosols as short-lived climate forcers agents.

Why to attend

- Gain cutting-edge insights into the latest research on non-CO₂ greenhouse gases
- Network with global experts and industry leaders
- Explore innovative technologies and strategies for reducing emissions
- Contribute to shaping future policies and regulations
- Discover new business opportunities in the growing field of climate change mitigation



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