

Copernicus Atmosphere Monitoring service: supporting BIODIVERSITY

Laurence ROUIL (ECMWF)

Director of CAMS

Biospace 2025 – ESA/ESRIN – 13th Feb 2025



Copernicus
Europe's eyes on Earth



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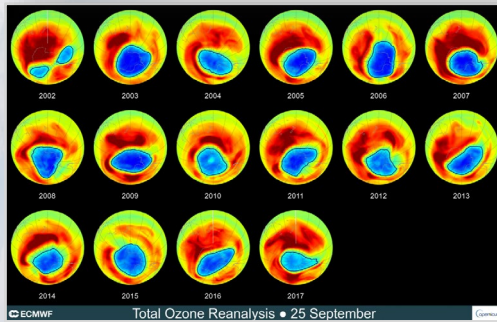
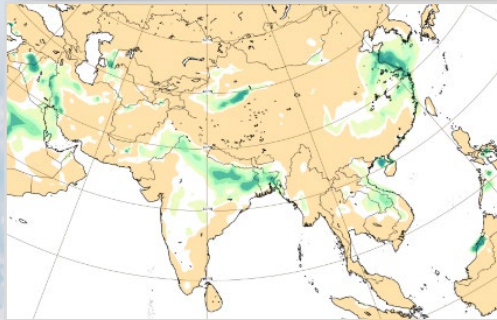
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Atmosphere
Monitoring

CAMS SCOPE – Atmospheric Composition



Implemented by ECMWF as part of The Copernicus Programme

Atmosphere Monitoring Service

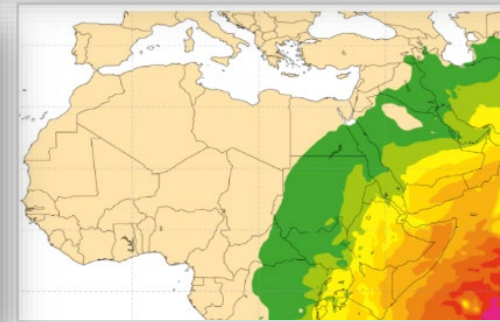
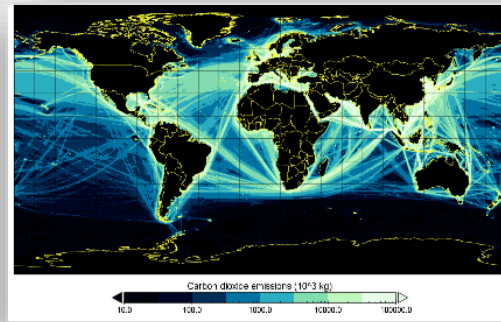
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DATA ABOUT US WHAT WE DO QSEARCH

European Commission Copernicus IMPLEMENTED BY ECMWF

We provide consistent and quality-controlled information related to air pollution and health, solar energy, greenhouse gases and climate forcing, everywhere in the world.

Today's air quality forecasts



CAMS provides open & free information products based on Earth Observation about:

- past, current and near-future (forecasts) global atmospheric composition;
- the ozone layer;
- European air quality;
- emissions and surface fluxes of key pollutants and greenhouse gases;
- solar radiation;
- climate radiative forcing.

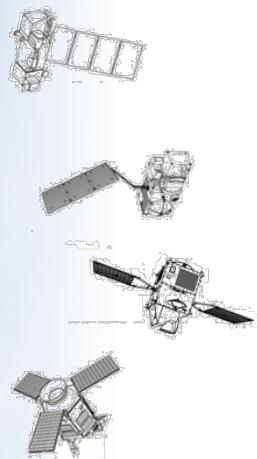
<http://atmosphere.copernicus.eu>
<http://ads.atmosphere.copernicus.eu>



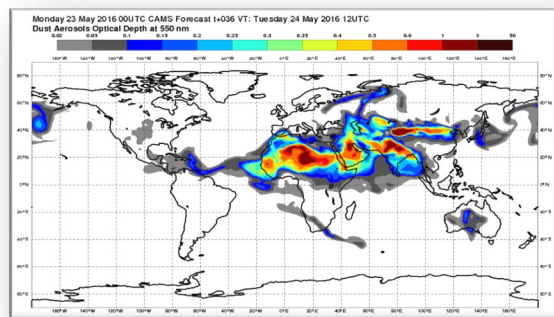
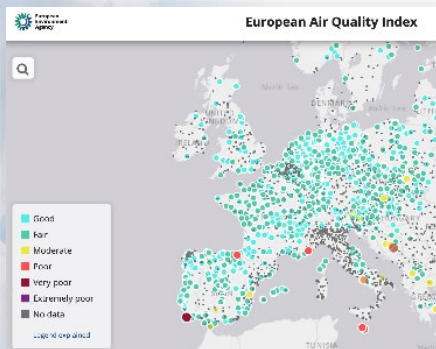


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CAMS WORKFLOW (Combining observations with models)

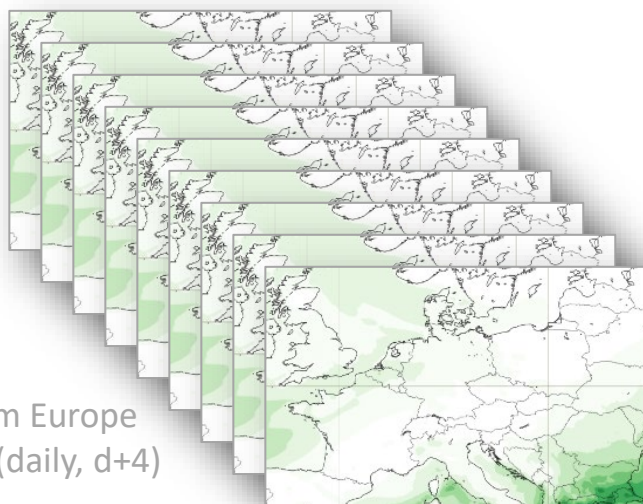


Earth Observation from satellite (>80 instruments) and in-situ (regulatory and research)

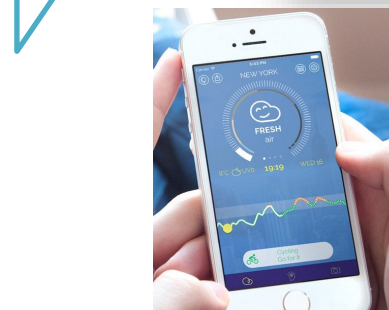
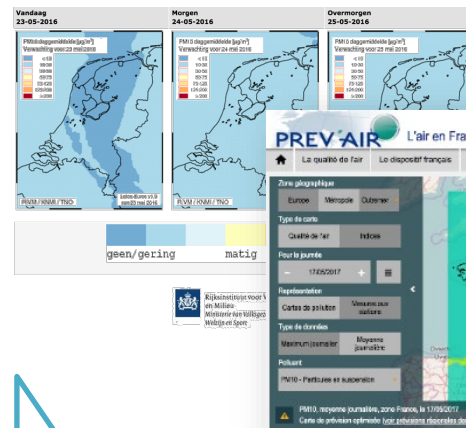


40km Globe (twice daily, d+5)

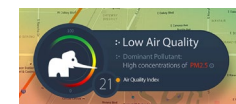
CAMS main operational data assimilation and modelling systems



10km Europe (daily, d+4)



Major multiplication factor (100Mil+)



CAMS users >23500 (>3050 routine)

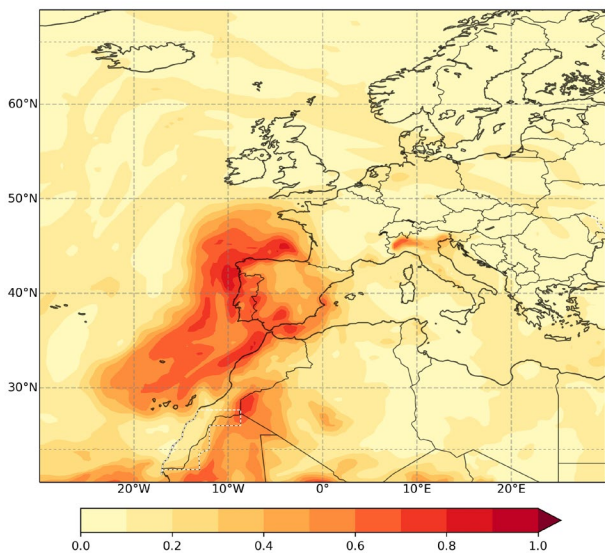


Example of services related to air pollution

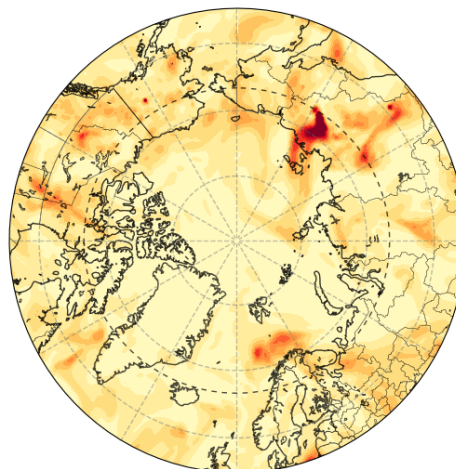
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Dust plumes

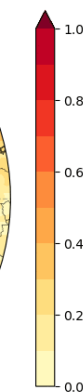
CAMS Forecast Total Aerosol Optical Depth at 550nm
20230221T00 valid for 20230221T00



CAMS Forecast Total Aerosol Optical Depth at 550nm
20240619T00 valid for 20240619T00



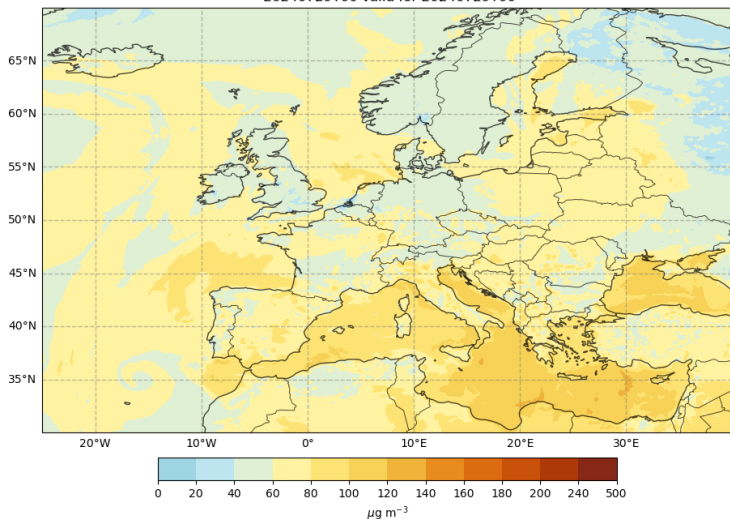
Wildfires



- <https://atmosphere.copernicus.eu>
- <https://policy.atmosphere.Copernicus.eu>
- <https://ads.atmosphere.copernicus.eu/cdsapp#!/search?type=dataset>

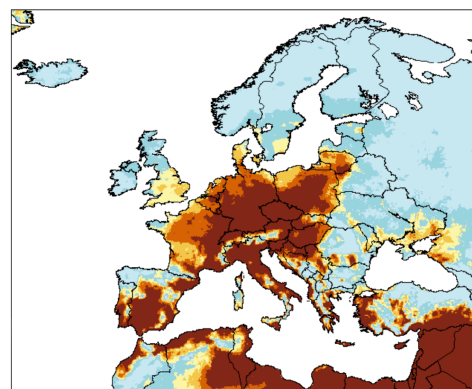
Reanalyses of air quality metrics (since 2013)

CAMS Regional Ensemble Forecast o3 conc at 0m:
20240729T00 valid for 20240729T00

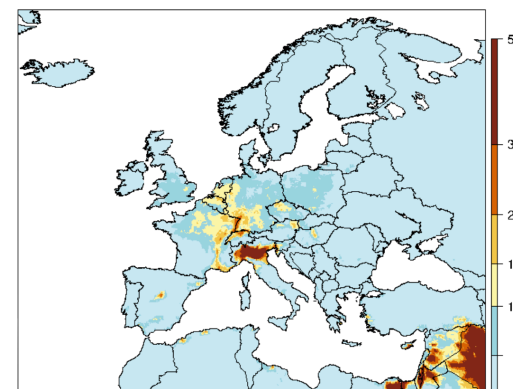


PM ₁₀	PM _{10, exc}	PM _{2.5}	O ₃	O_{3, exc}	SOMO35 (O ₃)	AOT40 (O ₃)	NO ₂	SO ₂	CO _{max}
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Ozone 2023 analysis
T100 Nb of days with exceedance of daily highest 8-hour mean of 100 µg/m³



Ozone 2023 analysis
T120 Nb of days with exceedance of daily highest 8-hour mean of 120 µg/m³



Air pollution episodes



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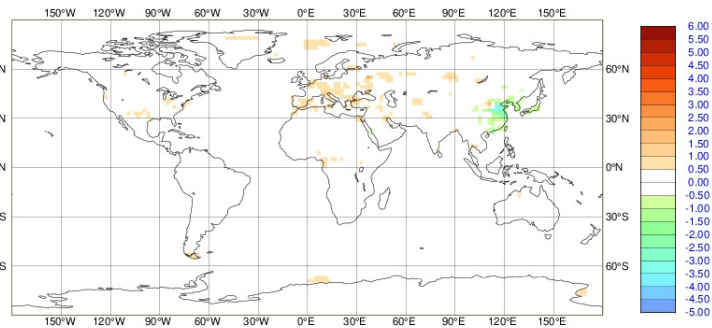
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Re-analyses: the best estimate

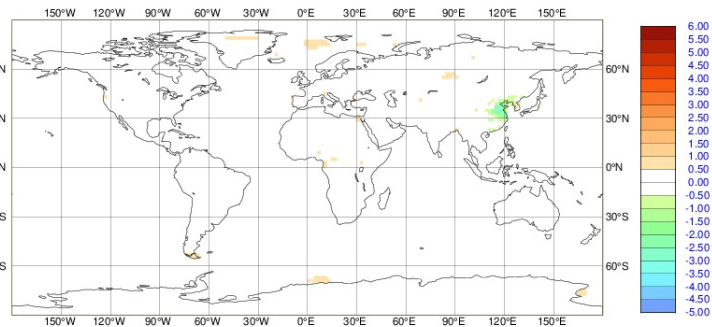
Example : Tropomi tropospheric NO2

Using CAMS re-analysis (2003-NRT) of atmospheric composition

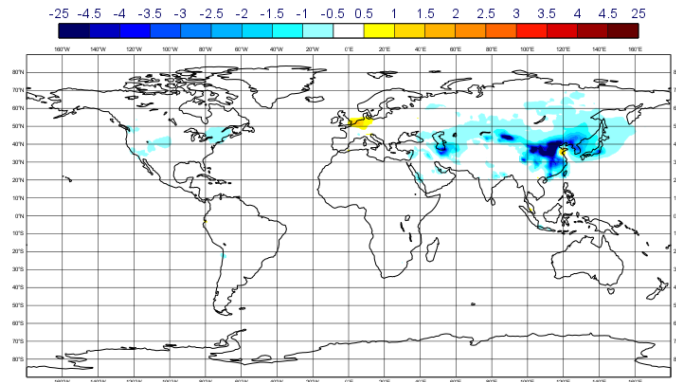
S5P NO2 first-guess departures



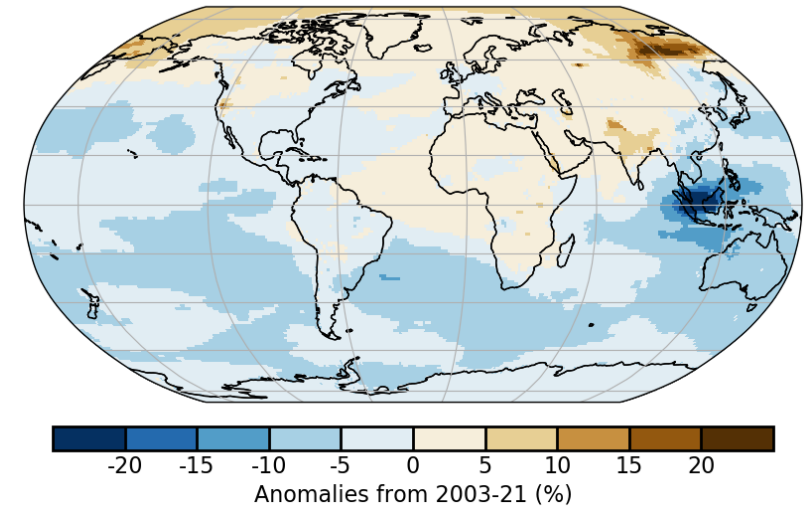
S5P NO2 analysis departures



ASSIM minus CONTROL



Ex: 2021 CO anomaly



Assimilation of TROPOMI NO2 data reduces the CAMS NO2 analysis over Asia and improve the quality of the assessment

Active since 12 Oct 2021



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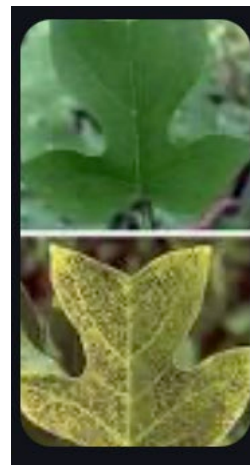
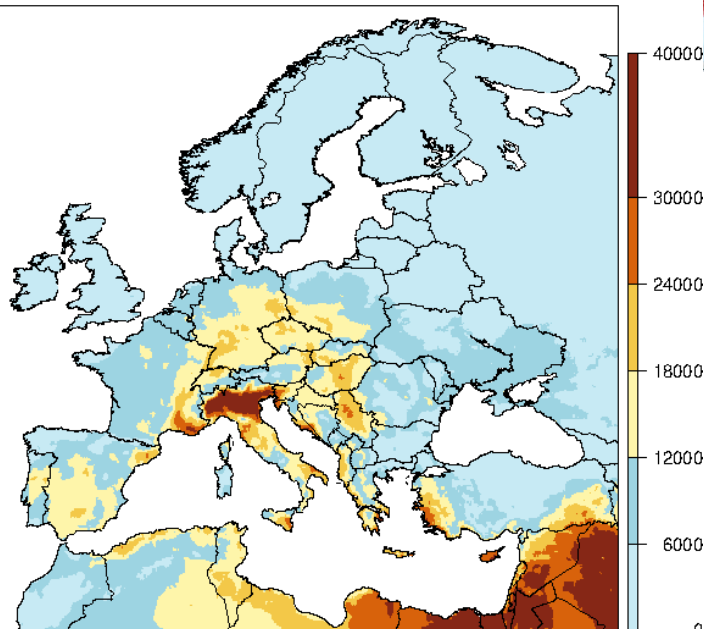
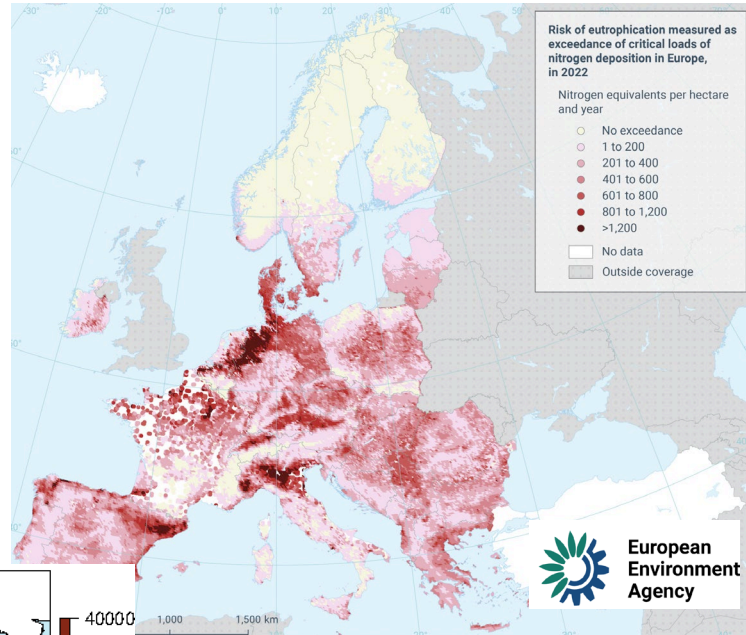




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Air pollution and biodiversity

AOT40 : to measure impact
of O3 on ecosystems
CAM5 reanalysis for 2022



Science of The Total Environment

Volume 753, 20 January 2021, 141791



Assessing critical load exceedances and ecosystem impacts of anthropogenic nitrogen and sulphur deposition at unmanaged forested catchments in Europe

Martin Forsius ^a, Maximilian Posch ^b, Maria Holmberg ^a, Jussi Vuorenmaa ^a, Sirpa Kleemola ^a, Algirdas Augustaitis ^c, Burkhard Beudert ^d, Witold Bochenek ^e, Nicholas Clarke ^f, Heleen A. de Wit ^g, Thomas Dirnböck ^h, Jane Frey ⁱ, Ulf Grandin ^j, Hannele Hakola ^k, Johannes Kobler ^h, Pavel Krám ^l, Antti-Jussi Lindroos ^m, Stefan Löfgren ^j, Tomasz Pecka ⁿ, Pernilla Rönnback ^j, Milan Váňa ^a

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<https://doi.org/10.1016/j.scitotenv.2020.141791>

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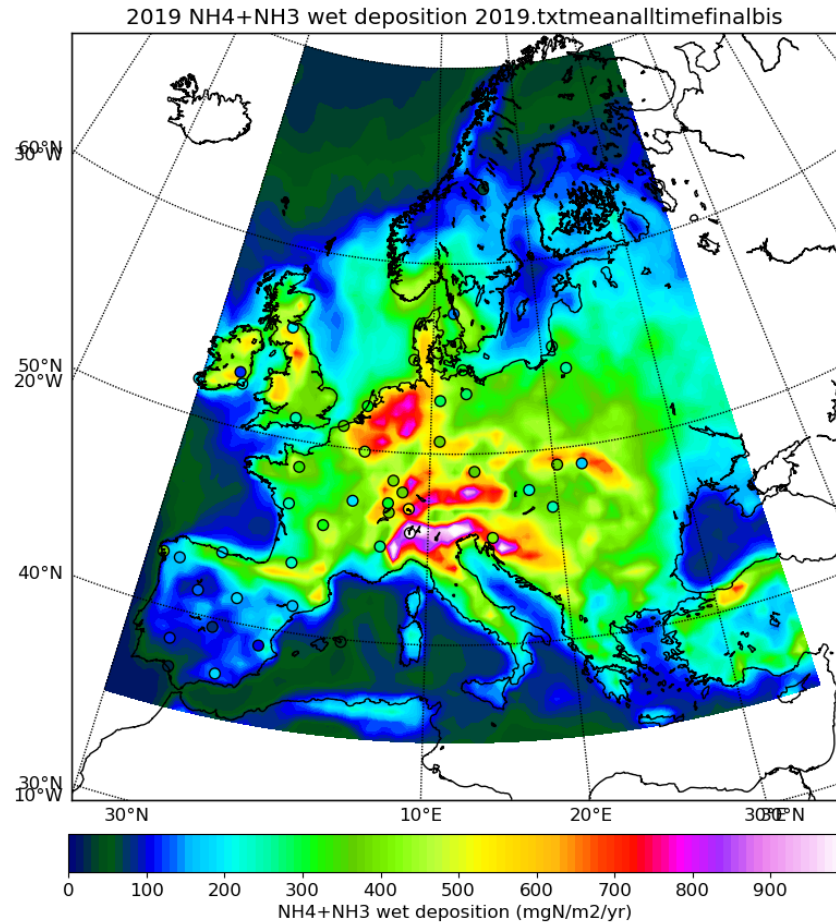


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In preparation within CAMS : deposition products



CAMEO H2020 project : <https://www.cameo-project.eu/>

– Deposition flux products to be improved by:

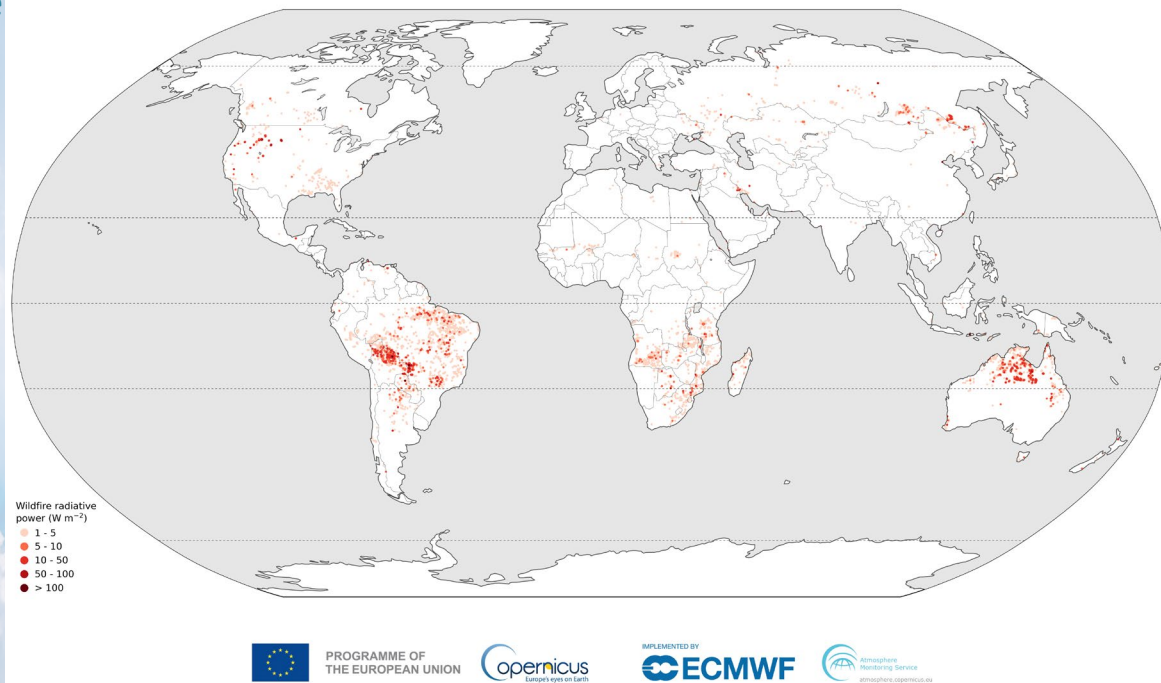
- DA of improved AQ retrievals from Geostationary GEMS, Sentinel4, TEMPO missions: high-temporal resolution over Asia, Europe and North-America
- Utilise satellite-based emissions inversion framework (CO2MVS) in global CAMS system for deposition flux correction
- Improved DA methodology
- Increased number of in-situ observations for evaluation
- Improved emission data and inventories (more timely, activity better and variability)
- Observation based correction of surface fluxes
- Provision of uncertainty information





Fire emissions monitoring in CAMS: Global Fire Assimilation System (GFAS)

GFAS Total Fire Radiative Power - October 2024



Global Fire Assimilation System (**GFAS**); see <https://ads.atmosphere.copernicus.eu/cdsapp#!/dataset/cams-global-fire-emissions-gfas?tab=overview>

Uses satellite observations of Fire Radiative Power (FRP)

- Currently Aqua and Terra MODIS FRP observations
- FRP from VIIRS, Sentinel-3, and geostationary satellites are being tested and implemented

Global Coverage at ~10km Resolution

- *Daily Output: 1-day behind NRT*
- Hourly Output (+24-h means): 7-hours behind NRT

Emissions of aerosols and gases are estimated using factors dependent on vegetation type.

Injection heights calculated using *Plume Rise Model* and IS4FIRES schemes

- Application : Summary of forest fires in Europe, combining C3S, CAMS and EFFIS (European Forest Fire Information System) information, published for each year in the European State of the Climate report.
 - 2023 report: <https://climate.copernicus.eu/esotc/2023/wildfires>

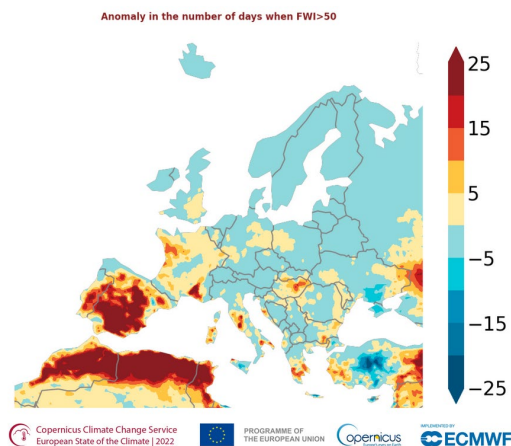


Figure 2. Anomaly in the number of days in 2022 with Fire Weather Index > 50, relative to the average for the 1991-2020 reference period. These conditions are when 'critical' fires, those above 10,000 ha, can develop. Data source: FWI based on ERA5. Credit: Copernicus EMS/ECMWF.





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R e s s o u r c e s :

- **CAMS website and news :** <https://atmosphere.Copernicus.eu>
- **Datasets provided by the CAMS services freely available on the Atmosphere datastore:** <https://ads.atmosphere.eu>
- **Policy services:** <https://policy.atmosphere.Copernicus.eu>
- **Aerosol alert service:** <https://aerosol-alerts.atmosphere.copernicus.eu>

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Data About us What we do



Atmosphere Data Store

Datasets User guide Live Background

8 Aug 2024 Check our information page to find more yourself to use ADS Beta.

Dive into this wealth of information about the Earth's past, present and future atmosphere

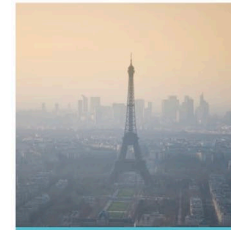
Search

API Access the full data store catalogue, with search and availability features.

Training Copernicus Atmosphere Monitoring Service (CAMS) data tutorials.

earthkit Open-source Python tools simplifying data access, processing, analysis, visualisation.

Today's air quality forecasts



Europe



Worldwide



Seasonal Atmospheric Recap

In Focus



Global carbon dioxide and methane monitoring

CAMS provides observation-based information on CO₂ and CH₄ natural fluxes and anthropogenic emissions and their trends in support of the Paris Agreement.

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City

Mon Jan 13 2025 15:00

opernicus Europe's eyes on Earth

ECMWF

Contribution to PM₁₀ in Paris (2023-03-01-07)

Potential impact on PM₁₀ in Paris (2023-03-01-07)

Country impact/contribution

Explore the potential impact of country emissions reduction on PM_{10/2.5}, ozone and NO₂ based on EMEP perturbation runs and the country contributions for PM_{10/2.5}, using LOTOS/EUROS tagging method.

daily_impact yearly_impact

daily_contrib yearly_contrib

PM10 only mean (µg/m³), 2023-03-01-07

Sector apportionment

Inspect the potential impact of different measures affecting sector emissions at targeted cities, make custom scenarios and inspect chemical regimes with the Air Control Toolbox.

daily_forecasts

Map of daily mean concentrations of PM10 for 2023-03-01-07

Policy scenarios

Investigate how the air quality will improve in 2030 through implementation of the Clean Air Programme Directive (EU) on the reduction of national emissions of certain atmospheric pollutants.

daily_forecasts





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Thank you !

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