



Atmosphere Monitoring

Forecasting atmospheric composition: a brief update on CAMS

Laurence ROUIL





COPERNICUS ATMOSPHERE MONITORING SERVICE (CAMS)

Within the 6 Copernicus Services, CAMS mandate is to deliver consistent and quality-controlled information related to atmospheric composition and its impact on air pollution and health, solar energy, climate forcing, everywhere in the world with a focus over Europe.



Air quality



Policy tools



Solar energy



Ozone layer and UV radiation



Emissions and surface Fluxes

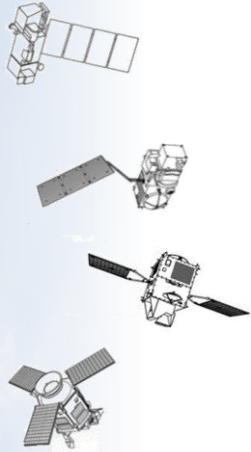


Climate forcing

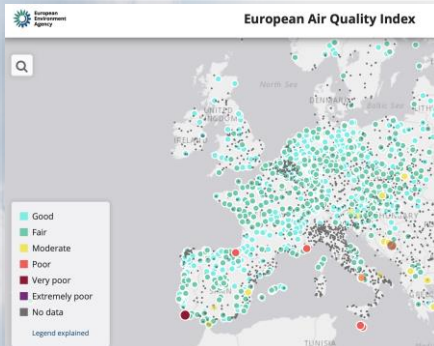


Atmosphere
Monitoring

CAMS: A UNIQUE INTEGRATED SYSTEM...



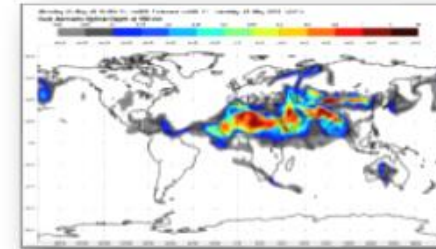
Earth Observation
from satellite (>90
instruments) and in-
situ (regulatory and
research)



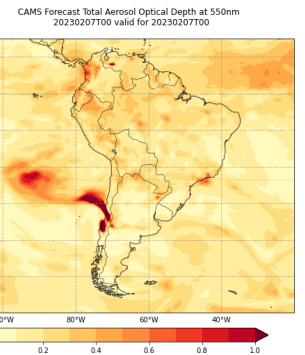
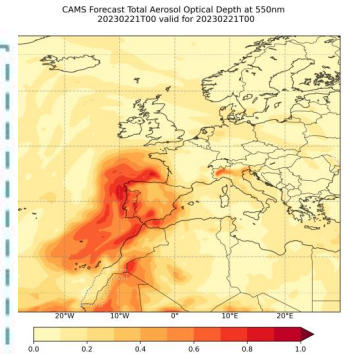
Instrument	Satellite	Space Agency	Provider	Species	Status
AATSR	ENVISAT	ESA	ESA	AOD	REA(A)
AHI	Himawari-8	JMA	JMA	FRP	GFAS(P)
GOME-2	METOP-B, -C/ METOP-B, -C/ METOP-A/ METOP- A, -B	EUMETSAT-ESA	AC-SAF	O ₃ , NO ₂ , SO ₂ / HCHO/ O ₃ , NO ₂ , SO ₂ , HCHO/ O ₃ , NO ₂	GRTF(A)/ GRTF(M)/ GRTF(M)/ REA(A)
IASI	METOP-B, -C/ METOP-A/ METOP- A, -B, -C/ METOP-A, -B/ METOP-A, -B/ METOP-A, -B	EUMETSAT-CNES/ -/-/-/EUMETSAT	AC- SAF/AC- SAF/ULB- LATMOS/L MD/LMD/ EUMETSAT	CO/CO/O ₃ , SO ₂ / CH ₄ /CO ₂ /CH ₄ , CO ₂	GRTF(A)/ GRTF(M)/ GRTF(P)/ GDM(A)/ GDM(P) / REA(A)
Imager	GOES-E, -W	NOAA	NOAA	FRP	GFAS(P)
MIPAS	ENVISAT	ESA	ESA	O ₃ profile	REA(A)
MLS	EOS-Aura	NASA	NASA	O ₃ profile	GRTF(A)/REA(A)
MODIS	EOS-Aqua, -Terra	NASA	NASA	AOD/AOD/FRP	GRTF(A)/ REA(A)/ GFAS(A)
MOPITT	EOS-Terra	NASA	NCAR	CO	GRTF(A)/ REA(A)
OCO-2	OCO-2	NASA	NASA	CO ₂	GDM(P)/ GHGI(A)
OMI	EOS-Aura	NASA	KNMI	O ₃ , NO ₂ , SO ₂ / O ₃ , NO ₂	GRTF(A)/ REA(A)
OMPS	S-NPP, NOAA-20	NOAA	EUMETSAT	O ₃	GRTF(A)
PMAp	METOP-A, -B/ METOP-C	EUMETSAT	EUMETSAT	AOD	GRTF(A)/ GRTF(M)
SBUV-2	NOAA-19/ NOAA- 14, -16, -17, -18 and -19	NOAA	NOAA	O ₃ profile	GRTF(M)/ REA(A)
SCIAMACHY	ENVISAT	ESA	KNMI	O ₃ , NO ₂ , CH ₄ , CO ₂	REA(A)
SEVIRI	MSG	EUMETSAT	ICARE/ EUMETSAT	AOD/FRP	GRTF(P)/ GFAS(P)
SLSTR	Sentinel-3	ESA-EUMETSAT	EUMETSAT	AOD/FRP	GRTF(P)/ GFAS(P)
TANSO	GOSAT	JAXA	SRON/ Uni. Bremen/ SRON-Uni. Bremen/S RON	CH ₄ / CO ₂ / CH ₄ , CO ₂ /CH ₄	GDM(A)/ GDM(A)/ REA(A) GHGI(A)
TROPOMI	Sentinel-5p	ESA-NSO	ESA-KNMI- DLR-/ ESA- KNMI- SRON-DLR	O ₃ , SO ₂ /NO ₂ , CO, HCHO/ CH ₄	GRTF(A)/ GRTF(M)/ GDM(P)
VIIRS	S-NPP, NOAA-20	NASA-NOAA	EUMETSAT	AOD	GRTF(P)

**Global and European
forecasts, analyses
and reanalyses**

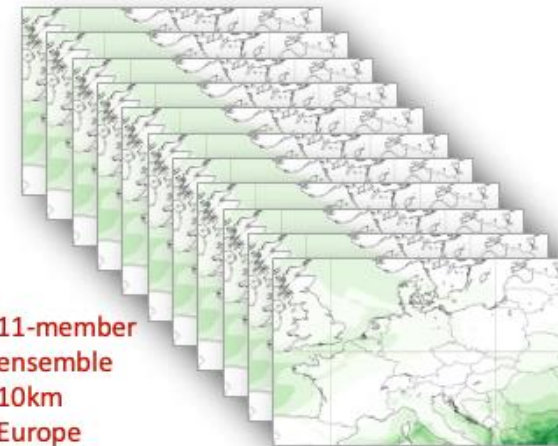
**= Europe's eyes
on Earth**



IFS 40km (oper) Globe



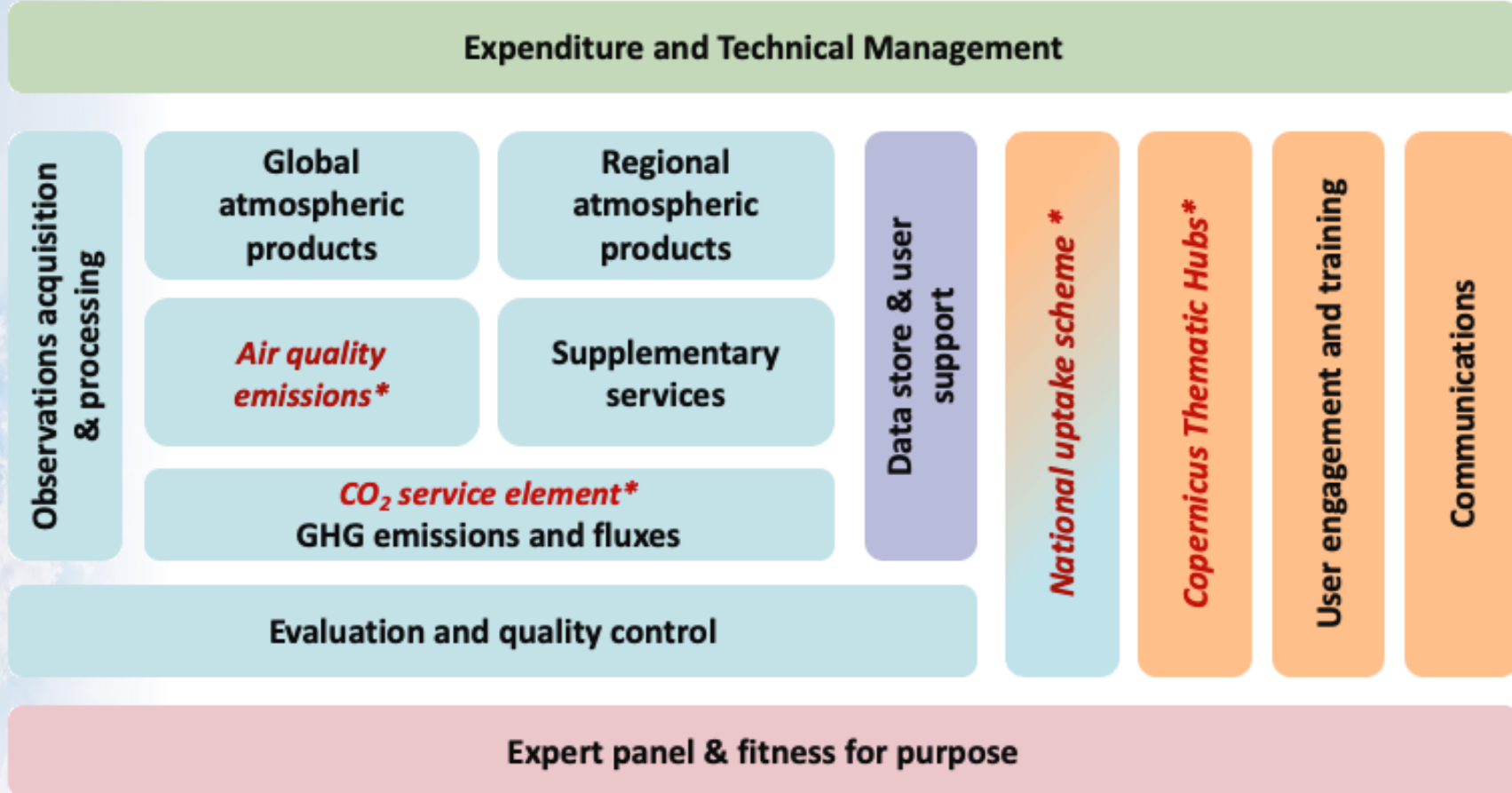
**CAMS main operational data
assimilation and modelling systems**



**11-member
ensemble
10km
Europe**



CAMS ARCHITECTURE



Management

Production

Delivery

Uptake

Advice/Evaluation

**new service components*



Atmosphere
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In-situ observation networks

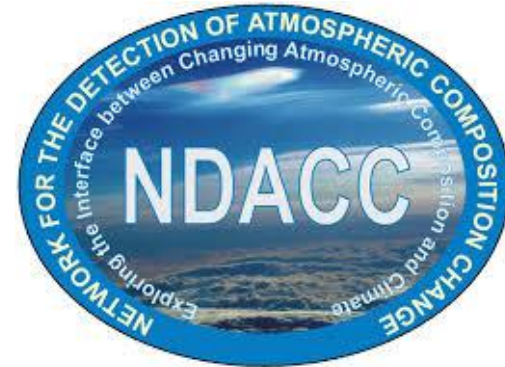
ICOS

● ● ●
**Integrated
Carbon
Observation
System**

Support acquisition, automation / faster data access, quality control. Main aim so far : underpin Evaluation and Quality Control and assimilation of regulatory observations gathered by the EEA



GAW



**European
Environment
Agency**



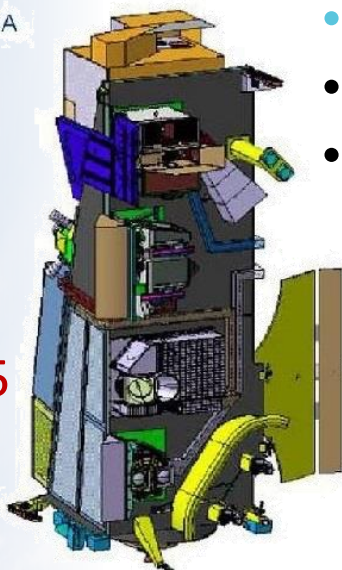


Atmosphere
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DRIVER: EVOLUTION OF THE OBSERVING SYSTEMS

MetOp-SG-A

Satellite A

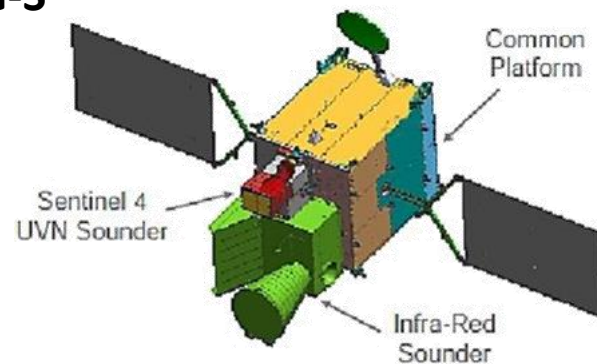


- Sentinel-5
- IASI-NG
- 3MI

Launch
end-2025

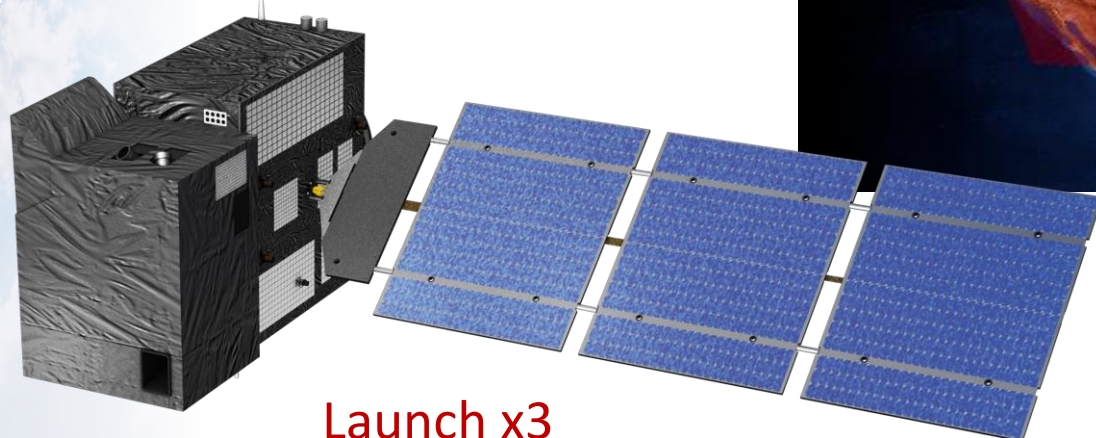


MTG-S



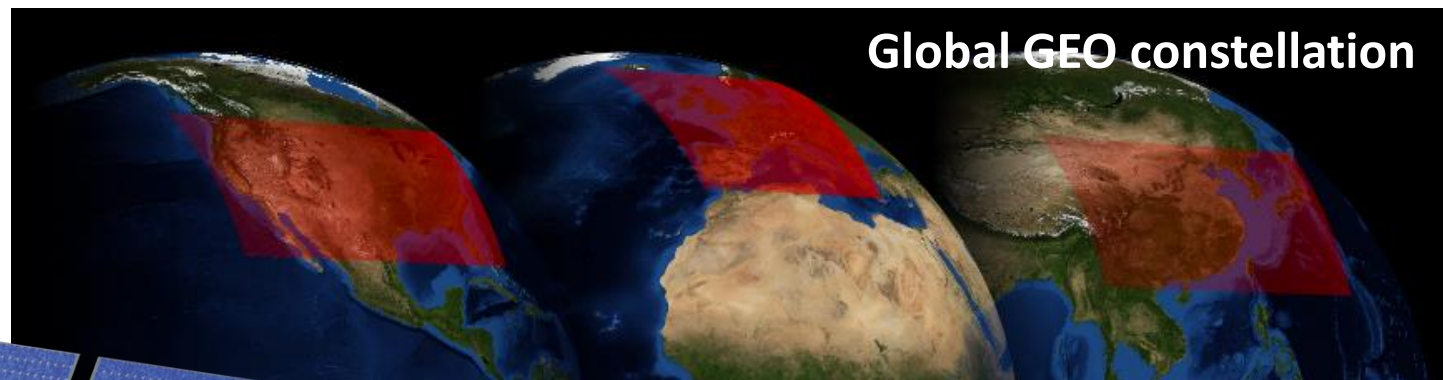
- Sentinel-4
- IRS

Launch
beginning
2025



CO2M

Launch x3
End-2026 to end-2027

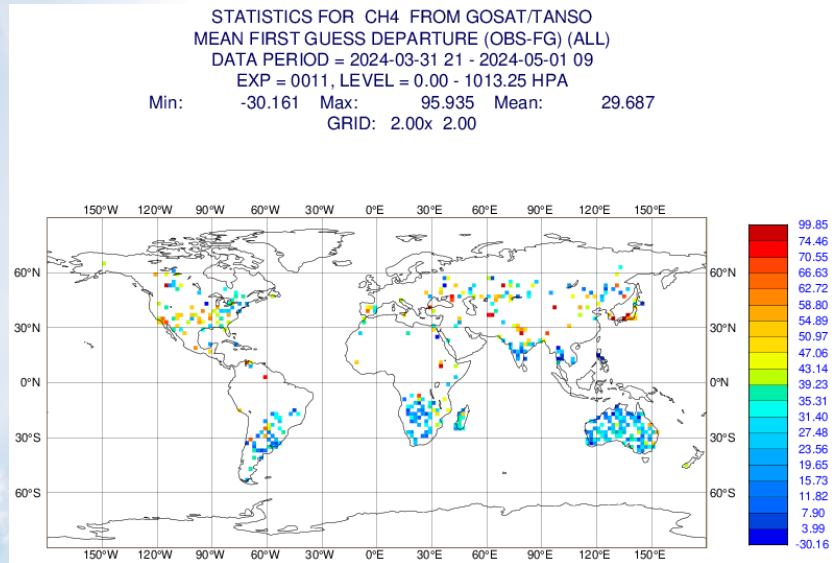


Global GEO constellation

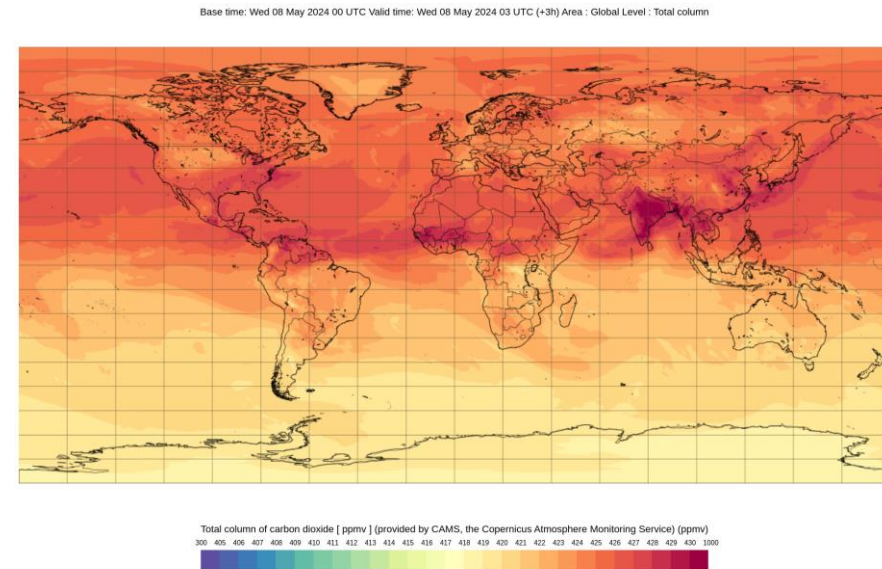
Preparatory activities in progress
Plans for use of GEMS (Asia) &
TEMPO (North America)



Global analyses and forecasts from IFS



Carbon Dioxide forecasts



Daily analyses (Tco399, \approx 25 km) and forecasts (Tco1279, \approx 9 km) based on CY48r1, of atmospheric concentrations of NO₂, O₃, NMVOCs, PM₁, PM_{2.5}, PM₁₀, organic and inorganic aerosol compounds, CO₂ and CH₄ and carbon cycle variables are now routinely produced.

Dissemination via ADS is being implemented (<http://ads.atmosphere.copernicus.eu>).

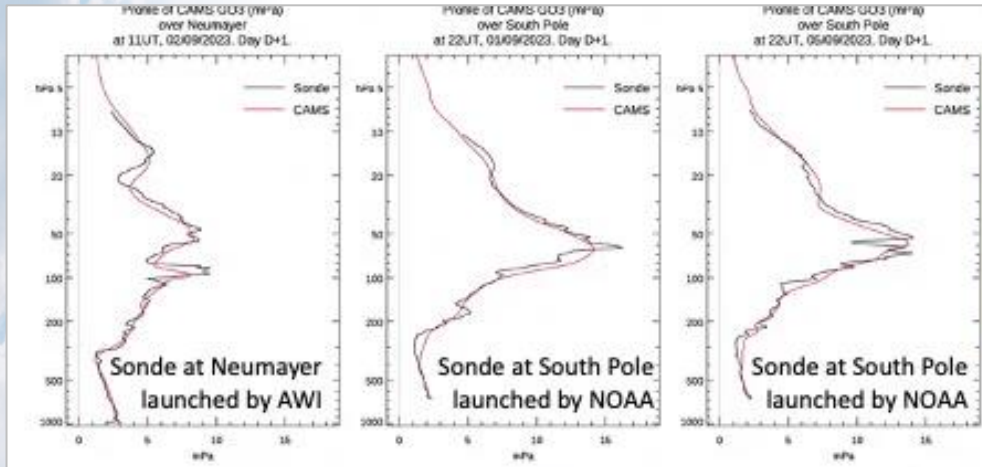
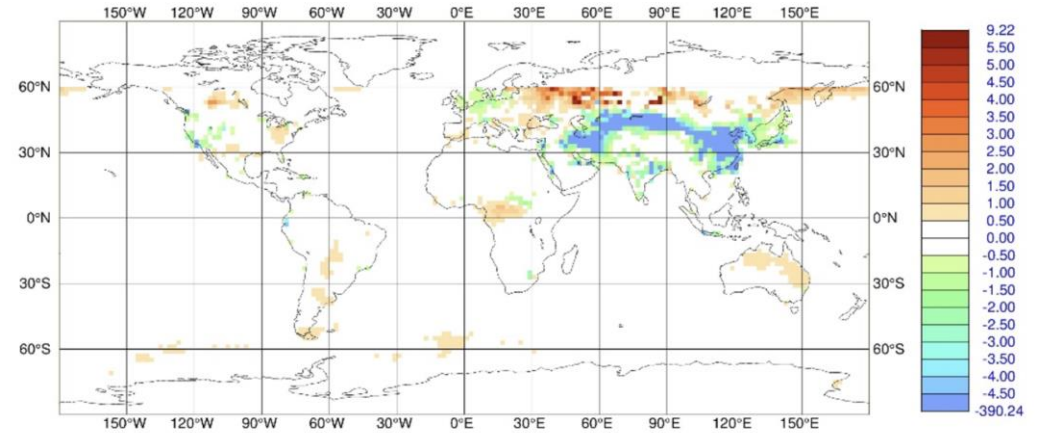
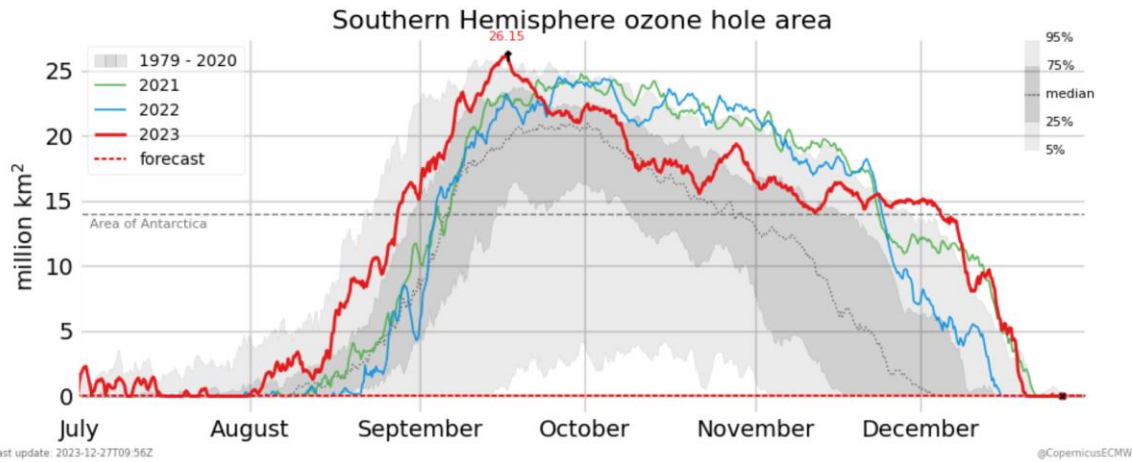
These use prescribed emissions from CAMS emission inventories and modelled biogenic fluxes from ECLand. Improvement of some model parametrizations via CAMS contracts (aerosols, wetlands, photosynthesis)



Last developments on the global system

Atmosphere Monitoring

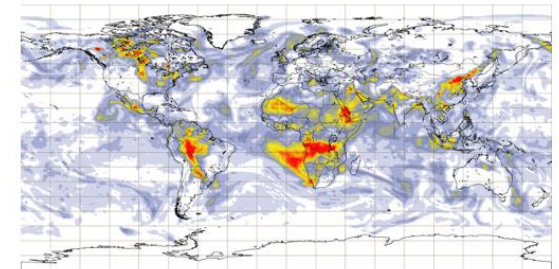
October 2023: operational use of Sentinel 5p NO2 observations in the global forecasting system



Atmosphere Monitoring

28 JUNE: CAMS GLOBAL SYSTEM UPGRADE

Some of the key elements of the latest CAMS system upgrade include the addition of **detailed stratospheric chemistry** using the Belgian Assimilation System for Chemical Observations (BASCOE) scheme, involving the **addition of 57 chemical species** including bromine monoxide (BrO) and monochlorine monoxide (ClO).



See details here:

<https://atmosphere.copernicus.eu/cams-operational-forecasting-and-data-assimilation-system-upgraded>

The upgrade will also introduce **changes to the modelling of dust aerosol**, which will result in a redistribution of aerosol particles towards larger sizes. Finally, two secondary organic aerosols (**anthropogenic and biogenic secondary organic aerosol**) have been added. The upgrade has also **updated prescribed emissions** to more recent versions.

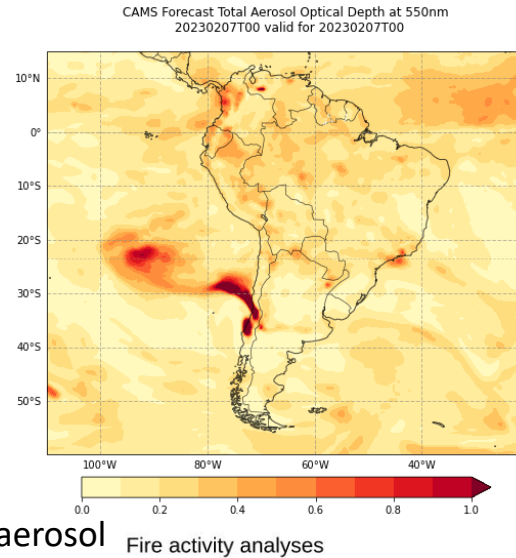
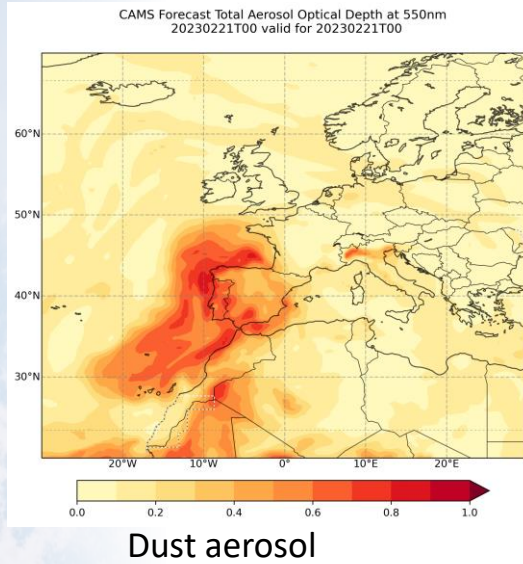




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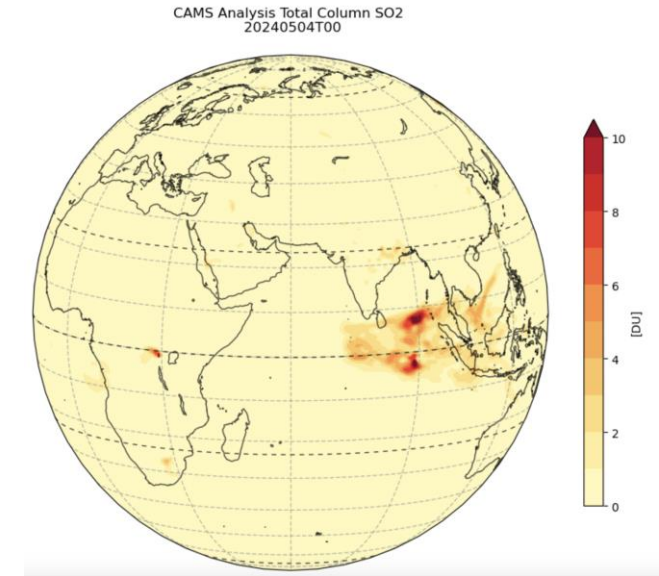
Monitoring large scale natural air pollution events

CAMS has capacity to characterise emission events that are not in inventories and provide information on their long-range transport (NRT and reanalyses).



Fire activity analyses

Base time: Mon 26 Feb 2024 00 UTC Valid time: Tue 27 Feb 2024 00 UTC (+24h) Area: Global



Implemented by ECMWF as part of the Copernicus Programme

News Events Press Tenders Help & Support

copernicus Atmosphere Monitoring Service

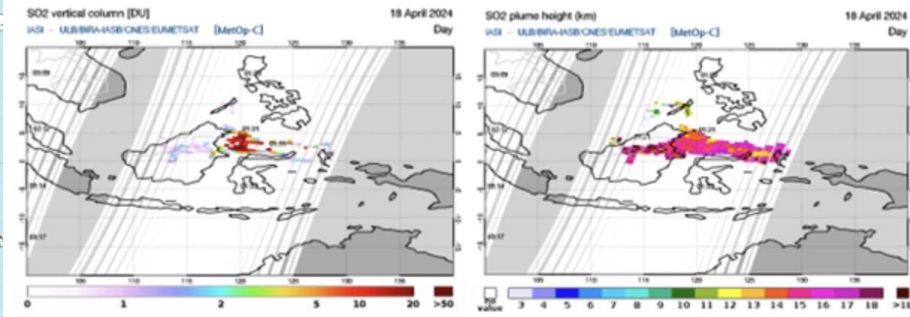
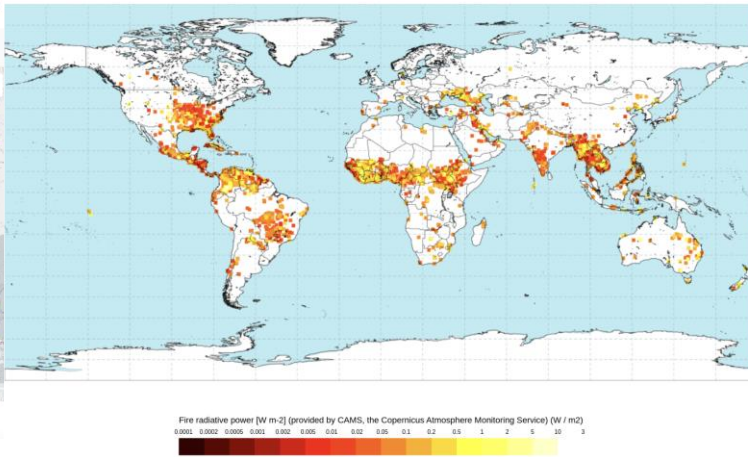
Aerosol Alerts My alerts Gallery Evaluation About

City

https://aerosol-alerts.atmosphere.copernicus.eu

Mon Jun 03 2024

D-3 D-2 D-1 Today D+1 D+2 D+3



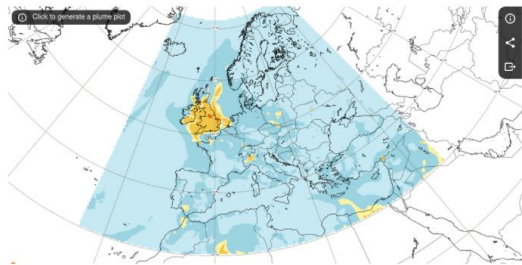


New interface for regional AQ using ec-charts

<https://atmosphere.copernicus.eu/european-air-quality-forecast-plots>

European air quality forecast plots

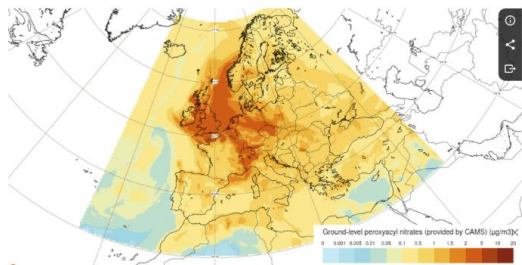
Every day CAMS provides four-day forecasts of the EU-WHO regulated pollutants, other air quality pollutants, pollens and aerosol tracers for Europe based on CAMS' regional ensemble model. The maps are accessible below, and the full range of European forecast charts and maps is available [here](#).



Regulated pollutants

Forecasts of the five main air pollutants regulated by the European Union and the World Health Organization air quality standards: nitrogen dioxide (NO₂), ozone (O₃), coarse particulate matter (PM₁₀), fine particulate matter (PM_{2.5}) and sulphur dioxide (SO₂).

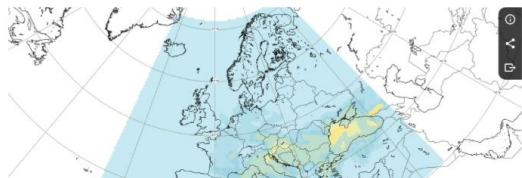
[Access the charts >](#)



Other air quality pollutants

European forecasts for other air quality pollutants: ammonia, carbon monoxide, formaldehyde, glyoxal, nitrogen monoxide, non-methane VOCs, peroxyacetyl nitrates.

[Access the charts >](#)



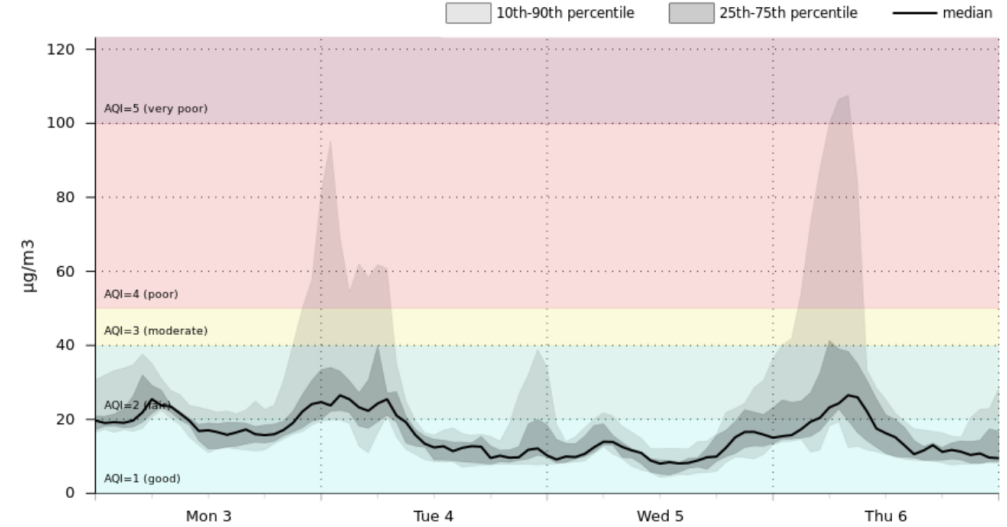
Pollens

CAMS regional ensemble produces forecasts for the main allergen pollen species: alder, birch, grass, mugwort, olive, ragweed.

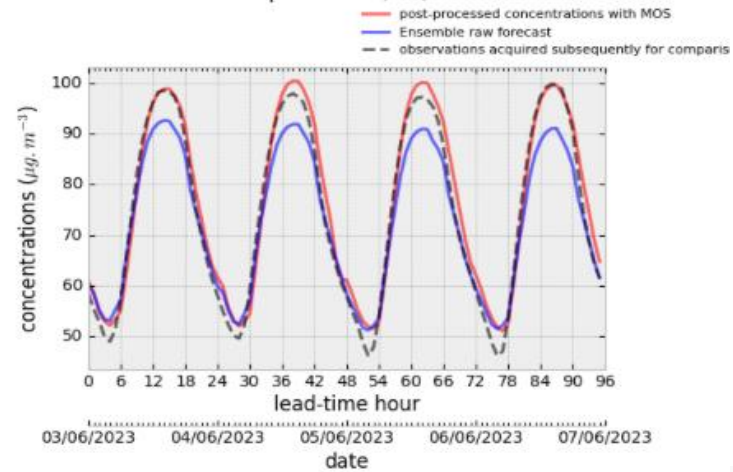
[Access the charts >](#)

Multi-model distribution of ground-level PM₁₀ concentrations

Paris - Ile-de-France - France 48.85°N 2.35°E



Average concentrations of European stations for O₃ Example for 03/06/2023



New product on the ADS since January 2024: MOS-optimised forecasts at EU monitoring stations



Atmosphere Monitoring

Policy services

More interactive policy tools

<https://policy.atmosphere.copernicus.eu>

Shipping now included in the online Air Control Toolbox

CAMS ACT: Air Control Toolbox

Read More

Air pollution scenarios [Forecasts at target cities](#)

Pollutant: PM10 (daily mean) | Forecast Base Time: 2023-10-24 | Valid Time: 2023-10-24

Total concentration
 Anthropogenic fraction

Concentration
 Absolute difference
 Relative difference

Design your emission scenario (uniform reduction)

- Traffic: reduction 100%
- Industry: reduction 100%
- Residential: reduction 100%
- Agriculture: reduction 100%
- Shipping: reduction 100%
- Other sectors: reduction 100%

PM10 daily mean (µg/m³), 2023-10-24 D+0

PM10 (daily mean) concentration map, including all European and hemispheric anthropogenic sources as well as natural emissions with an Europe-wide uniform emission reduction of: agriculture: 100 %; traffic: 100 %; residential: 0 %; industry: 0 %; shipping: 100 %; other: 0 %.

Get map

Target city: Valencia

Emission sector for x-axis

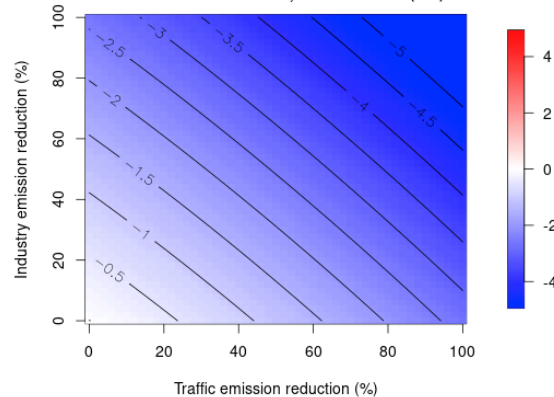
- Traffic
- Industry
- Residential
- Agriculture
- Shipping
- Other sectors*

Emission sector for y-axis

- Industry
- Residential
- Agriculture
- Shipping
- Other sectors*

* Other sectors* includes Solvents, Aviation, Offroad, Waste and GNFR 'Other' sector

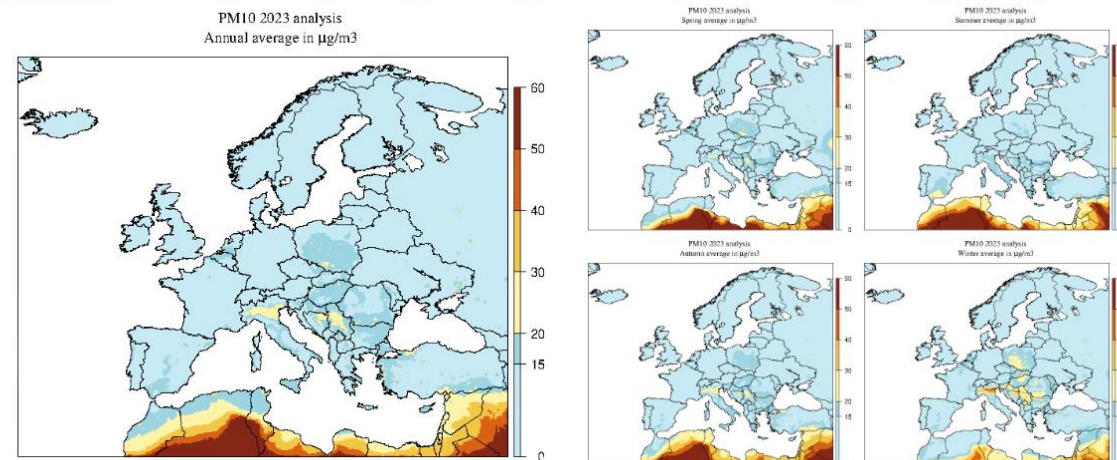
Chemical regime for daily max O3 concentrations in Valencia (µg/m3)
Forecast issued 2024-06-03, valid 2024-06-03 (D+0)



Understanding chemical regimes

Yearly synthesis of air quality indicators (since 2013)

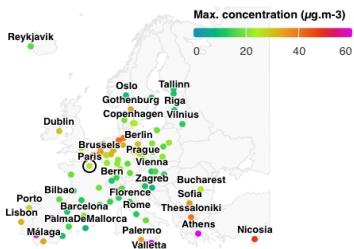
PM10	PM10_exc	PM2.5	O3	O3_exc	SOMO35 (O3)	AOT40 (O3)	NO2	SO2	CO_max
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Date: 2024/06/03 | City: Paris | Pollutant: PM10 | Model: EMEP

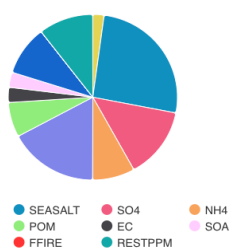
PM10 Max. (hourly)

2024-06-03:2024-06-06 (EMEP)

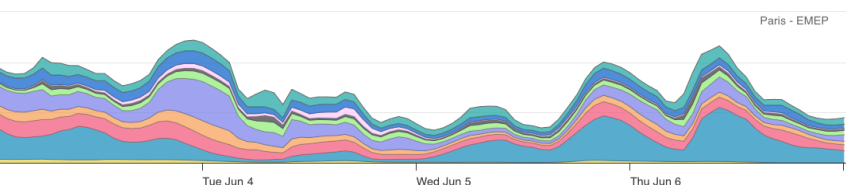


Chem. spec. of PM10 in Paris

2024-06-03T01:00:00 - 2024-06-07T00:00:00



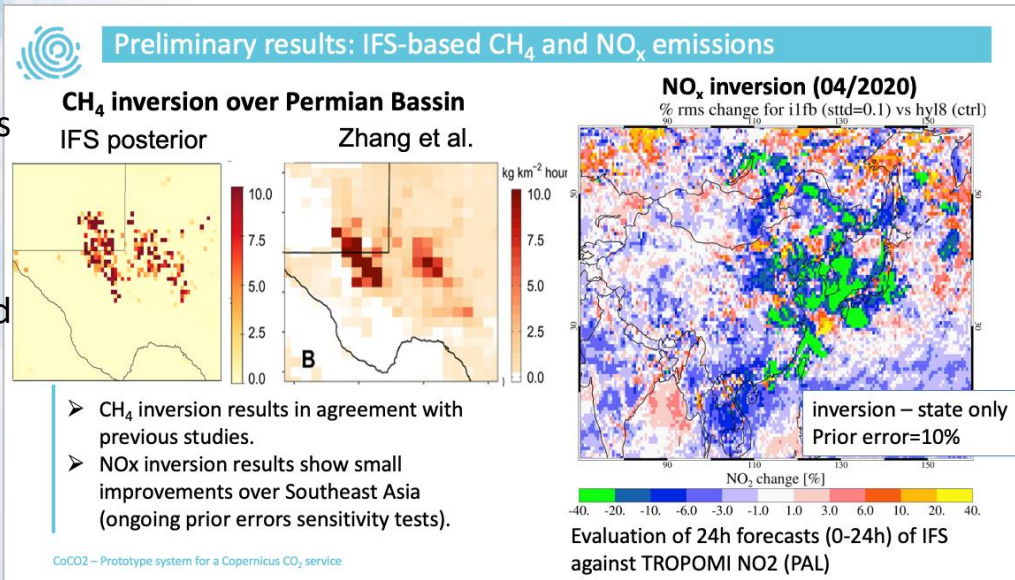
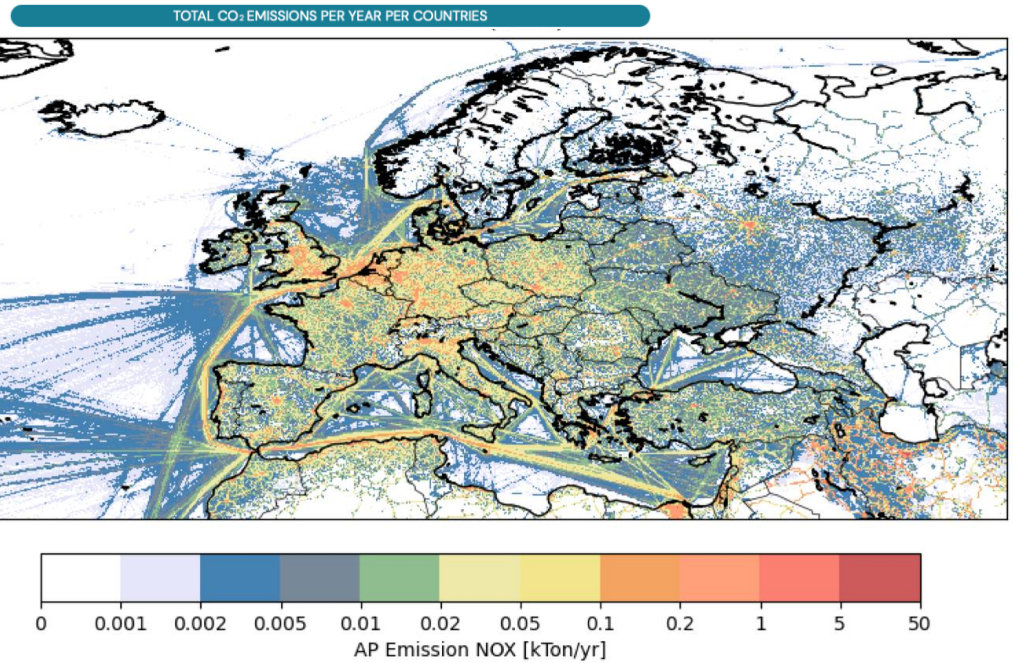
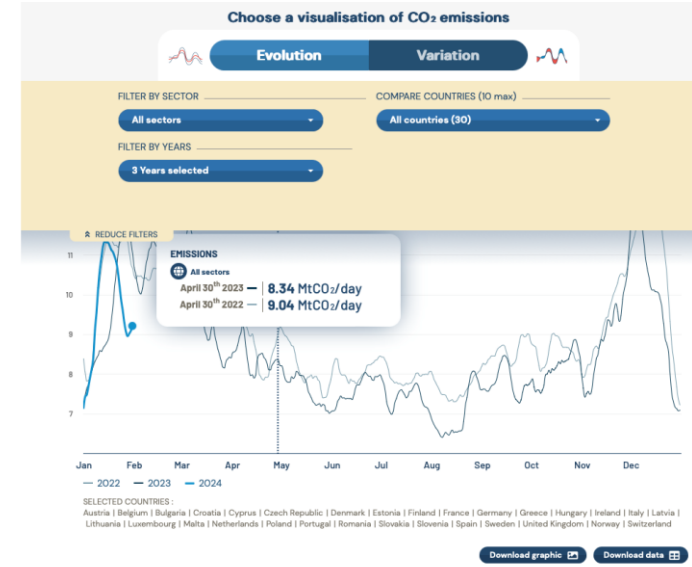
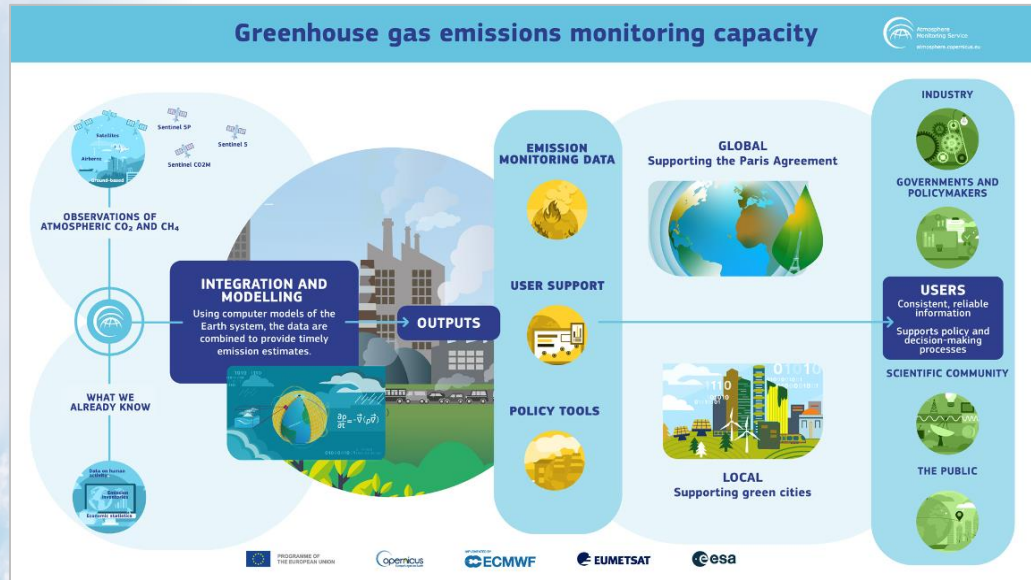
Forecasting PM chemical composition





Atmosphere Monitoring

WHAT'S NEW ON THE EMISSIONS MONITORING SIDE?



significant progress with IFS configuration for deriving observations-based emissions (CoCO2 project).



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Laurence.rouil@ecmwf.int

Thank you for your attention !

