An update on the **Copernicus Atmosphere Monitoring Service**

Vincent-Henri Peuch
ECMWF, Director of CAMS

Atmosphere Monitoring

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COPERNICUS ATMOSPHERE MONITORING SERVICE

Atmosphere Monitoring

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

Air quality

Policy tools

Solar energy

Ozone layer and UV radiation

Emissions and surface Fluxes

Climate forcing

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CAMS2.0 SERVICE ARCHITECTURE

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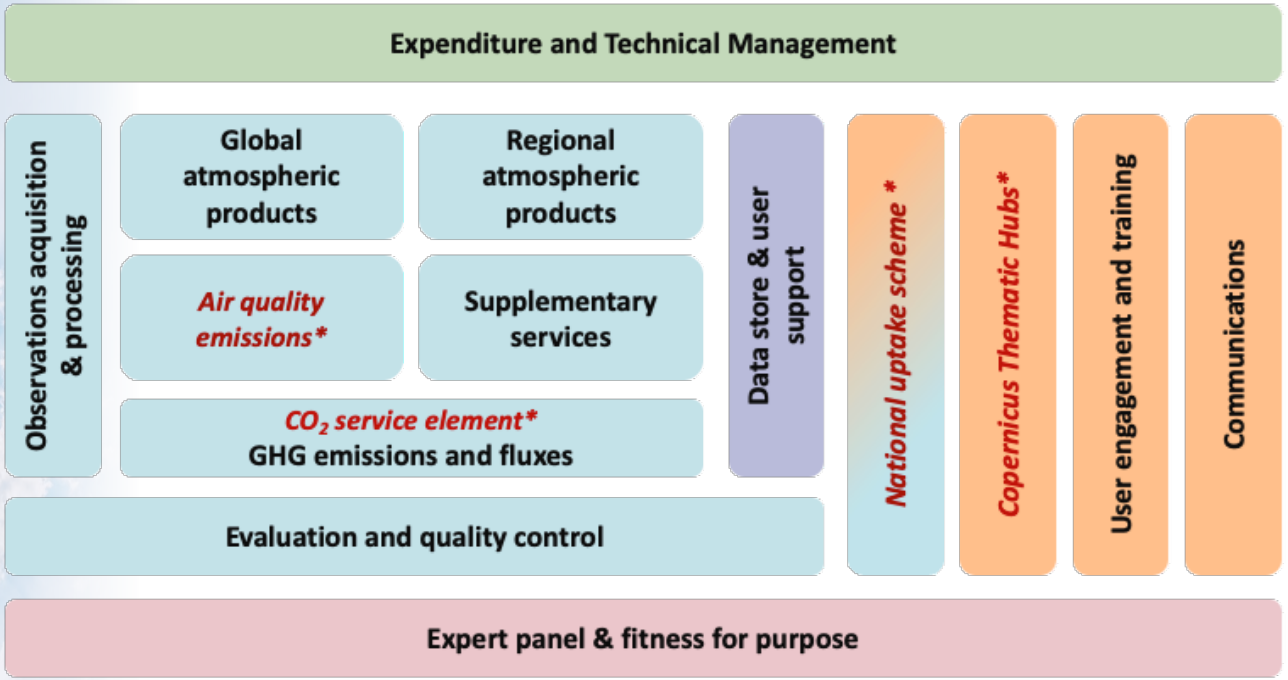

Management

Production

Delivery

Uptake

Advice/Evaluation

*new service components

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THE PEOPLE BEHIND CAMS

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The 7th CAMS General Assembly had an 'events within the event' format including the Copernicus Health Hub launch, the 1st CAMS National Collaboration Programme in-person workshop and a User Day targeting Spanish users and many side meetings on transverse aspects.

389 participants: +60% vs 2022 (180 onsite, 209 online)

Average satisfaction rating of **4.8 out of 5**.

Live streamed (and some remote participation within side sessions).

Presentations, etc… can be found here:

https://atmosphere.copernicus.eu/7th-cams-general-assembly-copernicus

STATUS OF CAMS2.0 & CAMS/C3S JOINT CONTRACTS Q3 2023

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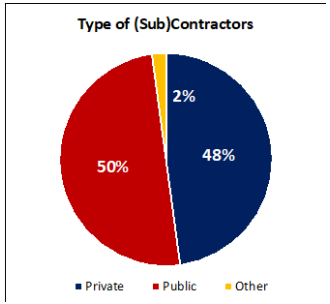
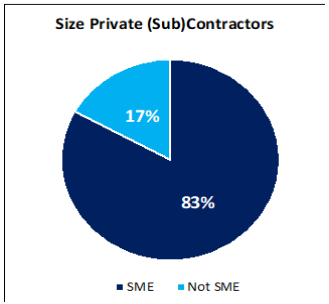
105 (+6 since Q2)
Entities involved as contractor or subcontractor

from
21 European countries
and **1** third country





37 Signed Contracts

Total value of signed Framework Agreements
~43 M €

See open ITTs here:
https://www.ecmwf.int/en/about/suppliers/copernicus-procurement/update-itts
https://atmosphere.copernicus.eu/current-tenders

DRIVER: EVOLUTION OF THE OBSERVING SYSTEMS

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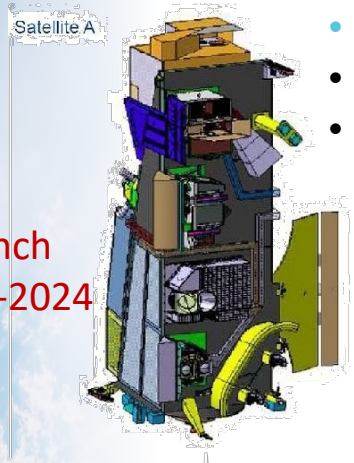
MetOp-SG-A



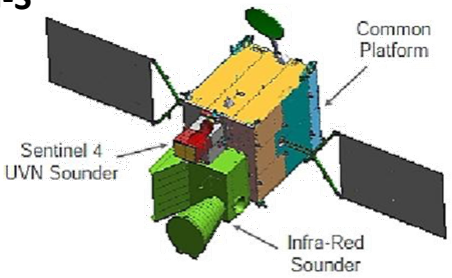
- Sentinel-5
- IASI-NG
- 3MI

Launch end-2024

EUMETSAT

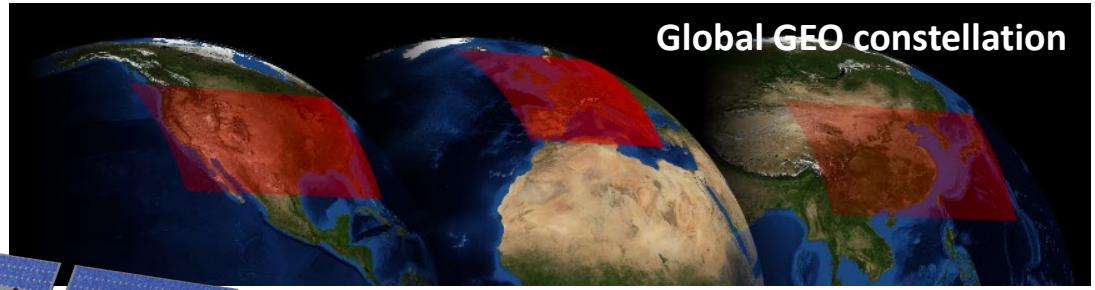
esa

MTG-S



- Sentinel-4
- IRS

Launch mid-2025



CO2M

Launch x3
Mid-2026 to mid-2027

Preparatory activities in progress
Use of GEMS (Asia) & TEMPO (North America)

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CAMS INFORMATION WORKFLOW

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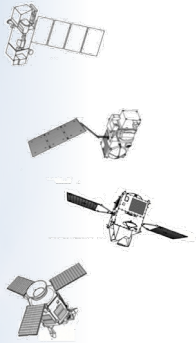
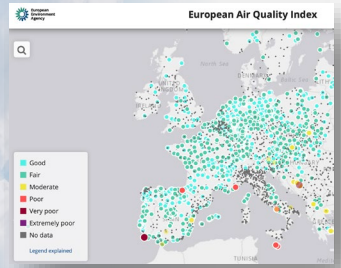


Earth Observation from satellite (>90 instruments) and in-situ (regulatory and research)



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/LMD/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/SRON	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)

- Only satellite data of atmospheric composition used for assimilation in the CAMS global system (*in situ* used for verification and assimilated in regional systems over Europe).
- All other data used for ECMWF NWP assimilated (about 70-75 streams) – not described here.

Status (A: assimilated; M: monitored; P: planned / research mode) depends on the different applications:

- Global real-time forecast (GRTF)
- Global delayed mode (GDM)
- Global reanalysis (REA)
- Global fire assimilation system (GFAS)
- Global surface net flux inversions of GHG (GHGI)

CAMS WORKFLOW

NEW / UPDATED

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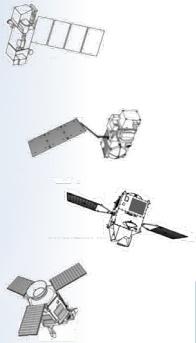
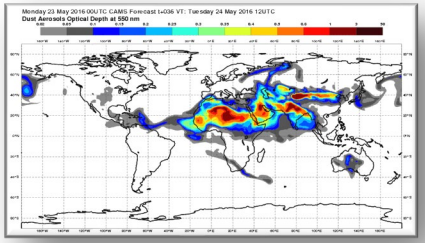
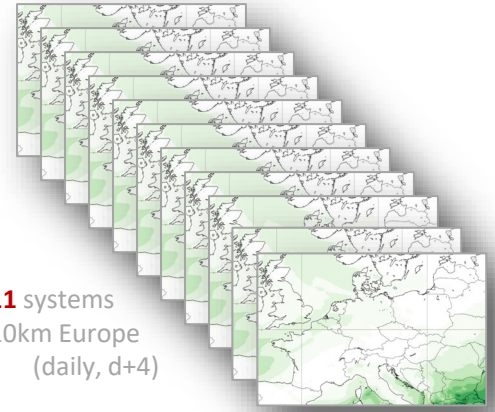


Earth Observation
See next slides

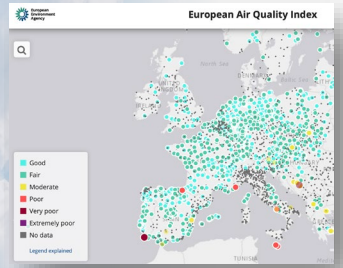


Detailed tropo. and **strato.** chemistry, 40km Globe (twice daily, d+5)

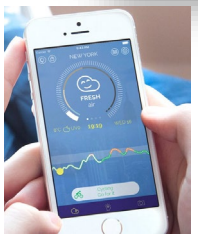
CAMS main operational **data assimilation and modelling systems**



11 systems
10km Europe
(daily, d+4)



CAMS users
>31000
(>2700 routine)



Major multiplication factor
(100Mil+)

Windy.com

The Weather Channel

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IMPACT OF NEW ASSIMILATED DATA

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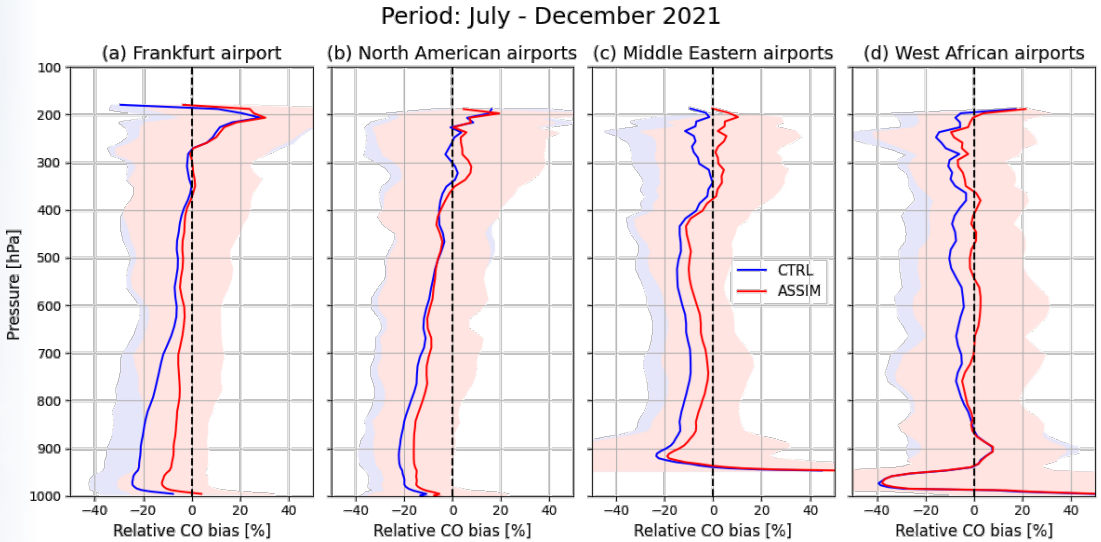

Old operations using MOPITT and IASI

New operations adding Sentinel-5p

Adding new data streams in the assimilation is a continuous effort in CAMS. Recently, S-5P CO data has been activated in the CAMS operational assimilation system. Benefits could be demonstrated using aircraft profiles (IAGOS).

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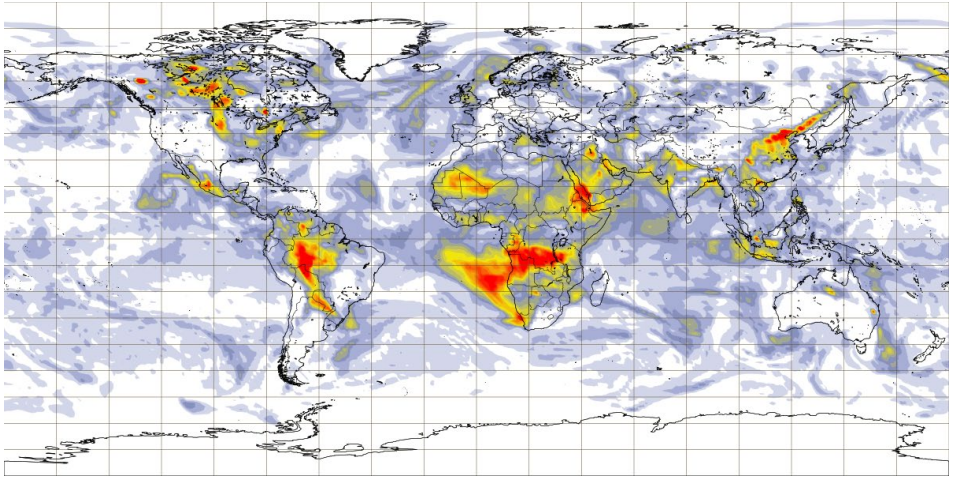
JUNE 2023: CAMS GLOBAL SYSTEM UPGRADE

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 also introduced **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.

CAMS: EUROPE's EYE ON EARTH

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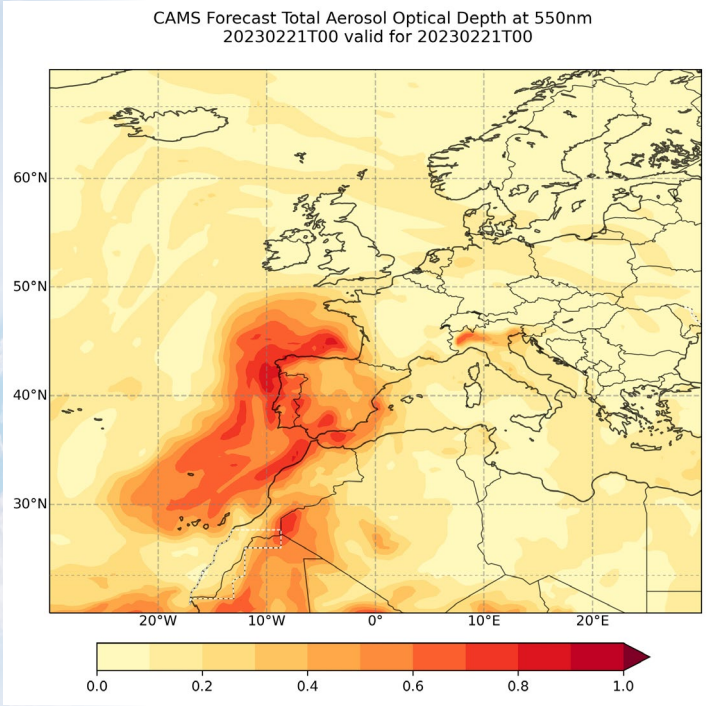
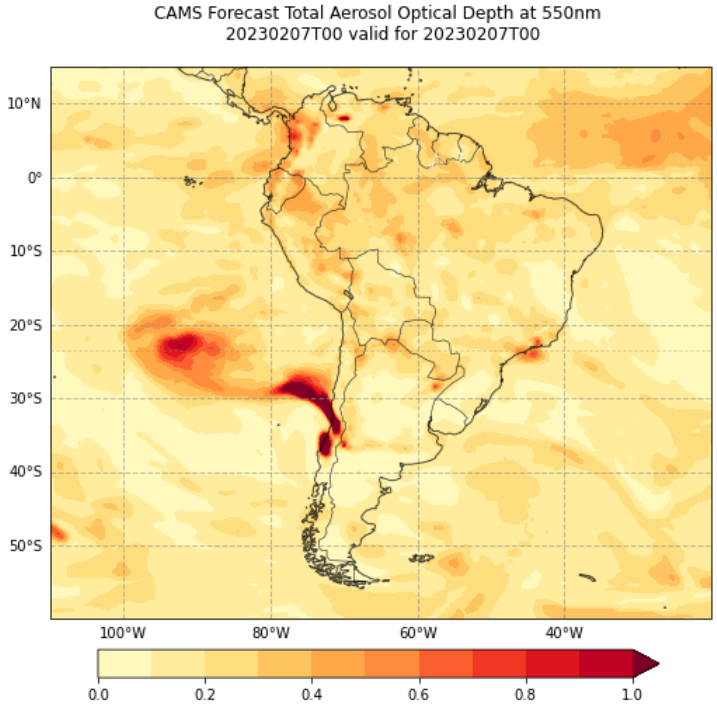


Dust aerosol



Fire aerosol

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CAMS REANALYSIS: PUTTING WHAT IS GOING ON IN CONTEXT

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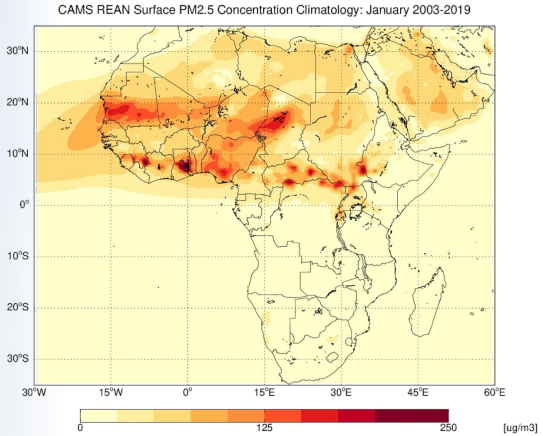

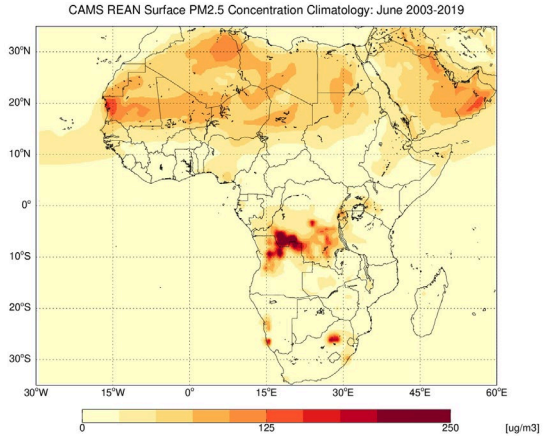

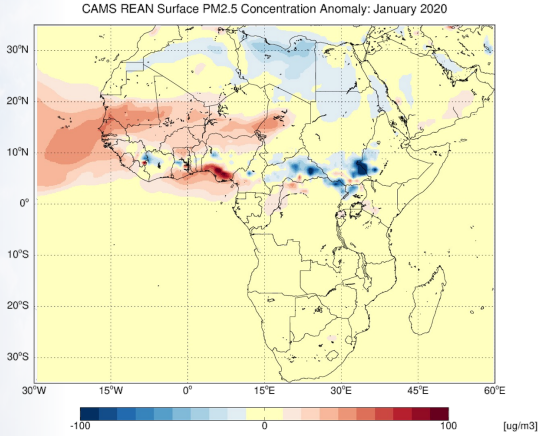

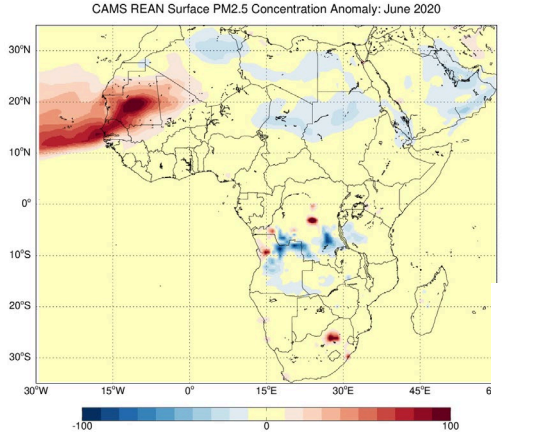

- CAMS reanalysis provides a consistent dataset for understanding long-term changes in global atmospheric composition and air quality.
- This example shows January and June monthly climatology of surface PM2.5 concentration calculated as the mean for the data from 2003-2019.
- Maps of anomalies for January and June 2020 highlight increased desert dust and decreased fire emissions.
- Support for WMO/GAW & BAMS annual bulletins.

CAMS EUROPEAN AIR QUALITY ASSESSMENT 2022

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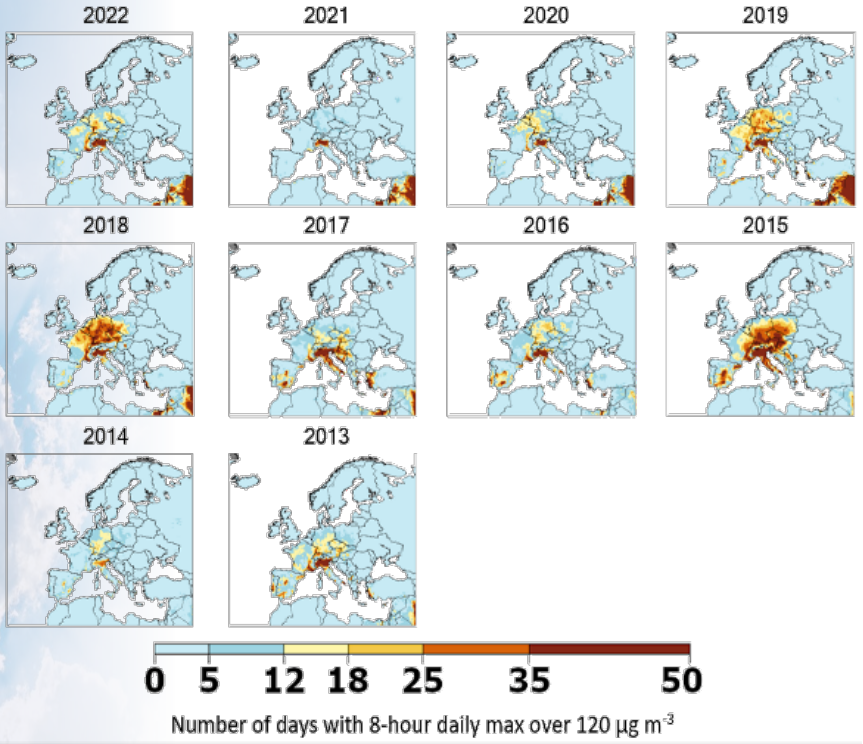

See details here: https://atmosphere.copernicus.eu/cams-releases-interim-assessment-report-air-quality-europe

CAMS has published in June the 2022 Air Quality assessment report based on “up-to-date” surface observations, offering a **first detailed insight into last year's air quality** situation.

In 2022, the **effects of the COVID-19 pandemic had subsided**, and the year was less influenced by pandemic-related anthropogenic emissions changes compared to 2020 and 2021. However, the **energy and security crises in Europe had a significant impact** on air quality, surpassing any lingering effects of COVID-19.

The data is widely used including by data journalists (ex.: Deutsche Welle…)

See: https://www.dw.com/en/air-pollution-nearly-everyone-in-europe-breathing-bad-air/a-66657048?mobileApp=true)

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CAMS DIRECT USERS (Q3 2023)

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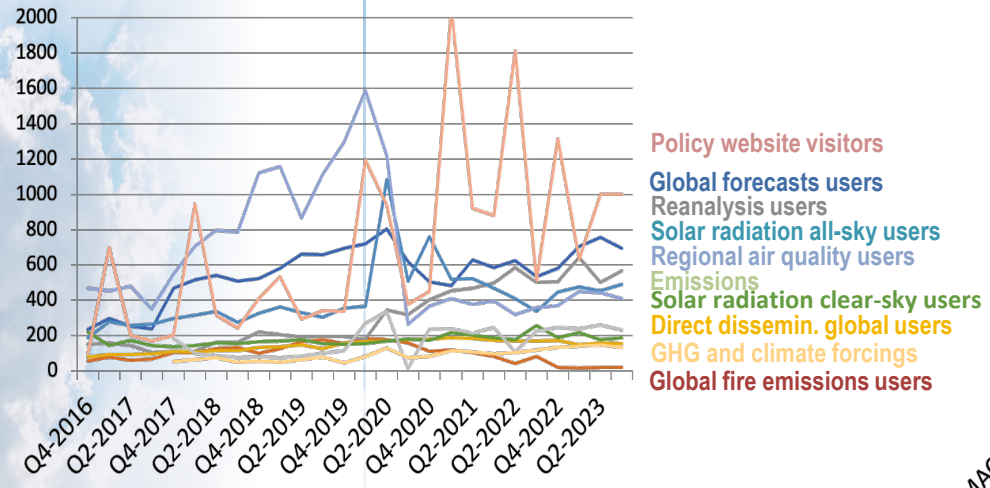
About half of CAMS products have over **400 routinely (often daily) active users**. The **ADS** has now **16925 registered users** (+8.6% vs Q2). **309 TB** of CAMS data was downloaded in Q3 (+34.9% vs Q2). Growth in registered users was **+3.8%** during Q3.

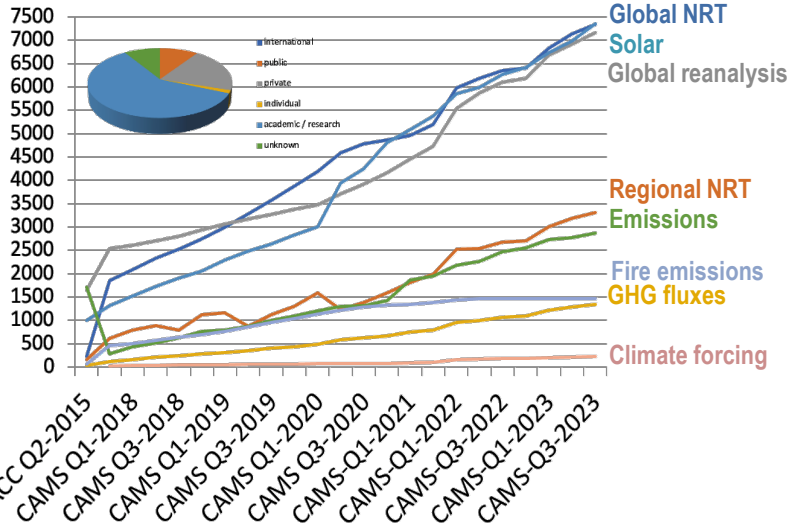
ACTIVE USERS DURING Q3 2023

Total: 2732 (-31 compared to Q2 2023; only "data" users counted, policy tool/website users not counted)



CAMS REGISTERED USERS END Q3 2023

Total: 31074 (+1125 compared to Q2 2023)



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COMMUNICATION HIGHLIGHTS (Q3 2023)

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Media

In Q3, CAMS experienced a record of **5083 mentions**, the Canadian wildfires release was by the largest share of the mentions for CAMS in the Quarter with 2,317, followed by wildfires in Greece with 1,956 mentions. All in all, the wildfires topic received the biggest share of mentions with a total of 4,273.

Partnership

Detailed performances of **CAMS Air Quality Index bulletin** broadcast on **CNN**

July-Sept. 2023	Estimated reach	Frequency	Number of impacts
Grand total	**259,153,842**	**8,7**	**2,266,027,715**
Total EMEA	38,587,923	7,6	294,395,232
Total Asia	174,914,103	8,6	1,502,541,536
Total LATAM	45,651,816	10,3	469,090,948

Digital

atmosphere.copernicus.eu

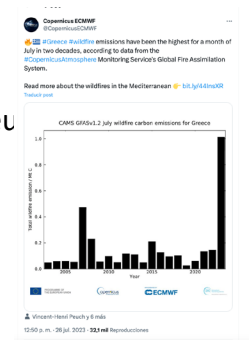
- **128k** page views
- **68.7k** users

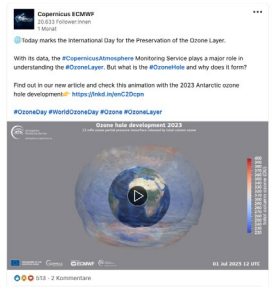
X/Twitter

- **59.2k** followers

LinkedIn

- **21.2k** followers





Top social media posts

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READY TO USE CAMS DATA?

- Just having a look
- (can also have a look at some of the CAMS data with some of our users)
- Training and experimenting with CAMS data using Jupyter Notebooks
- Downloading data and using it locally on your own machines (ADS)
- Using WEkEO

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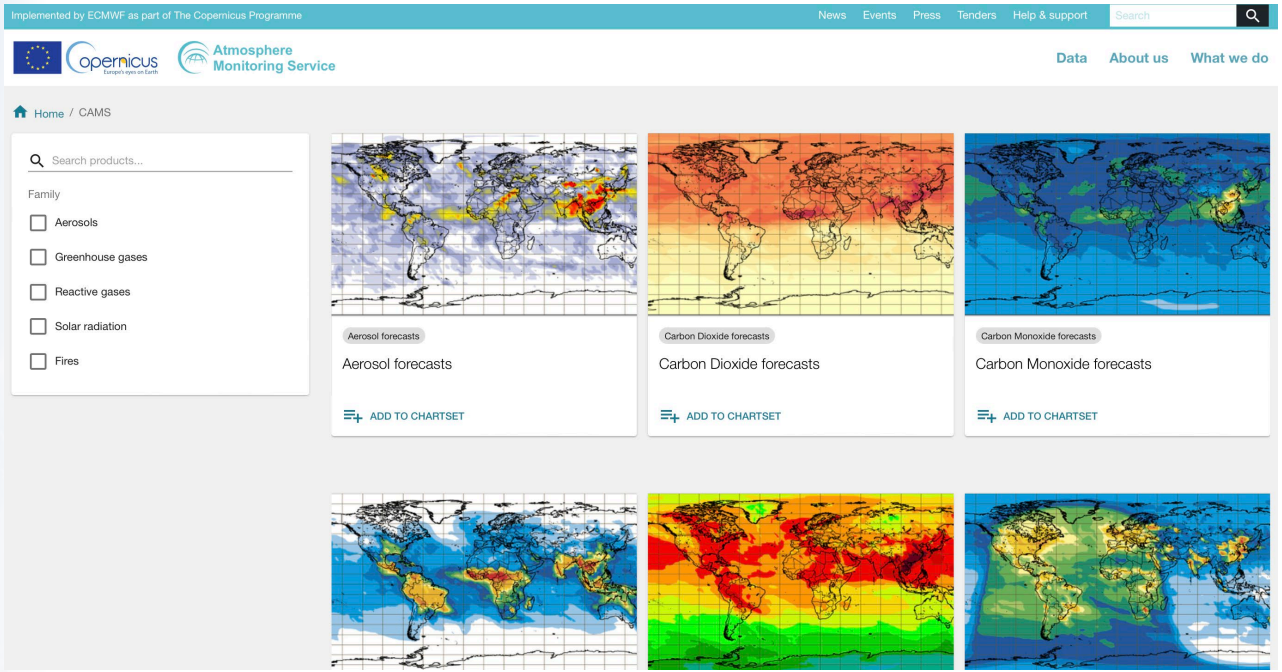
JUST HAVING A LOOK

https://atmosphere.copernicus.eu/charts/packages/cams/



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WHAT'S THE SITUATION TODAY?

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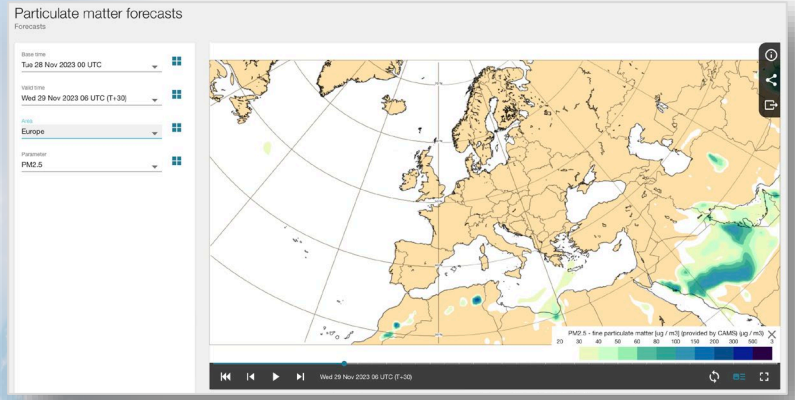

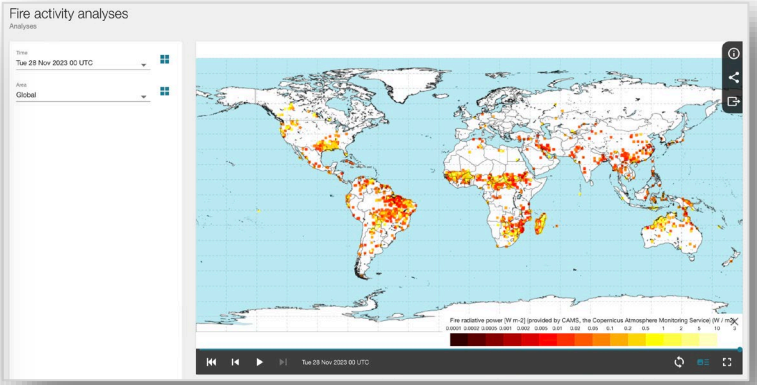

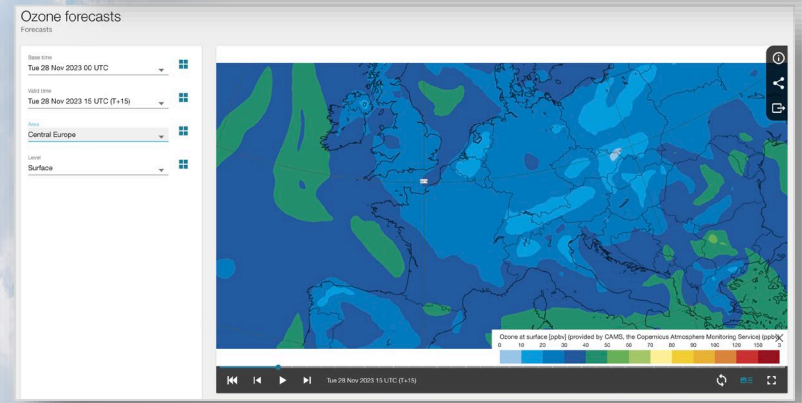

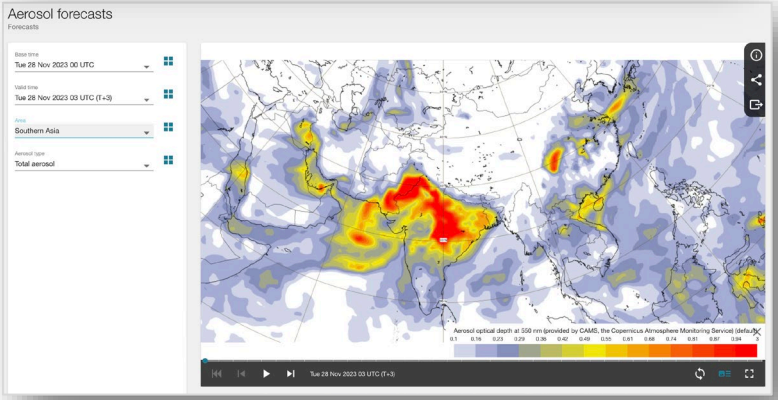

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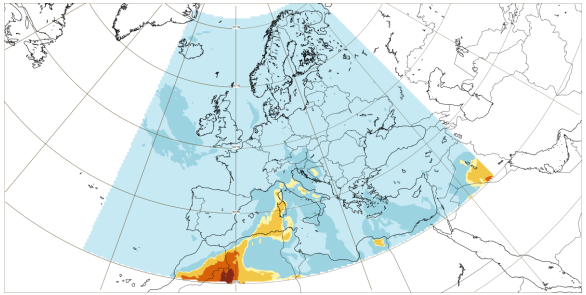
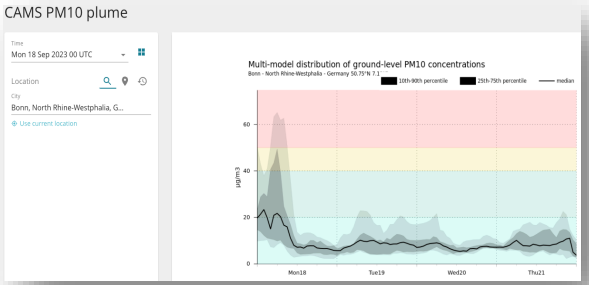
A NEW INTERFACE UNVEILED FOR EUROPEAN AIR QUALITY

CAMS has introduced **a revamped interface for the European air quality forecasts**. The look and feel of the charts changes, with new intuitive navigation features in line with the global forecasts interface.



A new feature is that **by clicking anywhere in the observed area of the map you can obtain a timeseries** of the requested forecast for the selected location. These provide a visualisation of the spread between the forecasts of the 11 models in the ensemble, giving an indication of the uncertainty of the forecast for the selected location. Until now this feature was only available for selected cities.



This is available here: https://atmosphere.copernicus.eu/european-air-quality-forecast-plots.

See details here: https://atmosphere.copernicus.eu/new-interface-our-european-air-quality-forecasts

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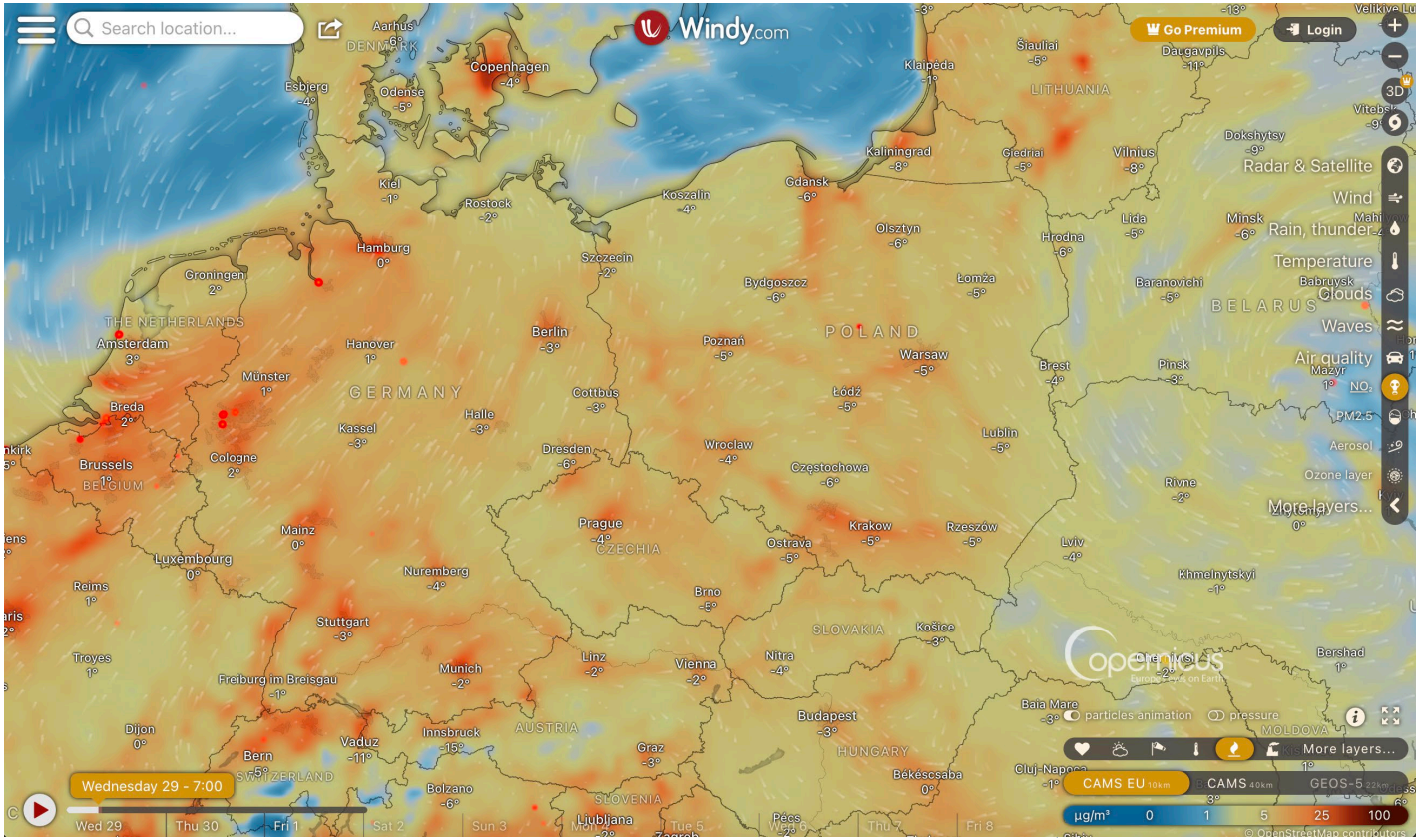
CAMS INFORMATION IS AVAILABLE ON MANY PLATFORMS

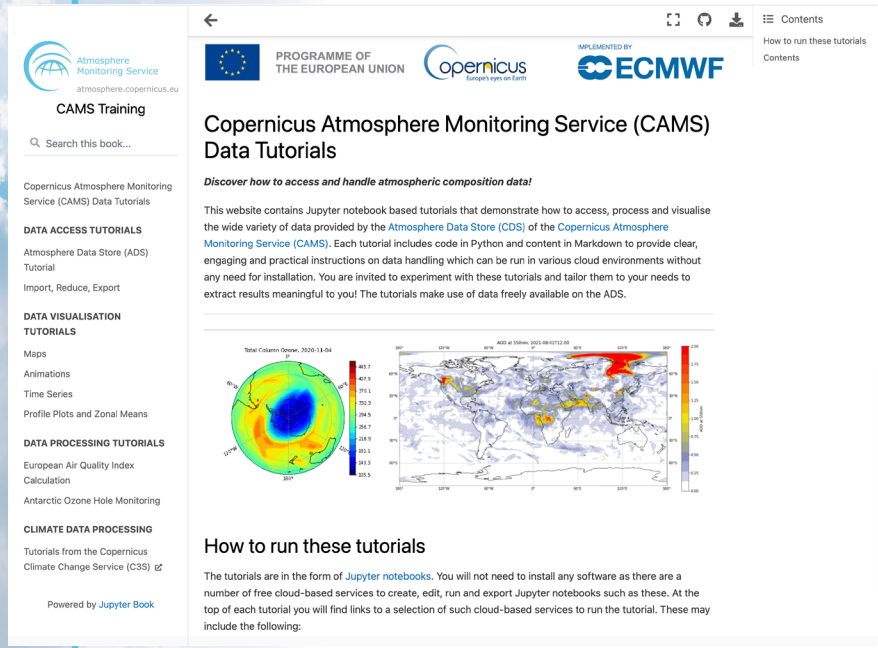
https://www.windy.com

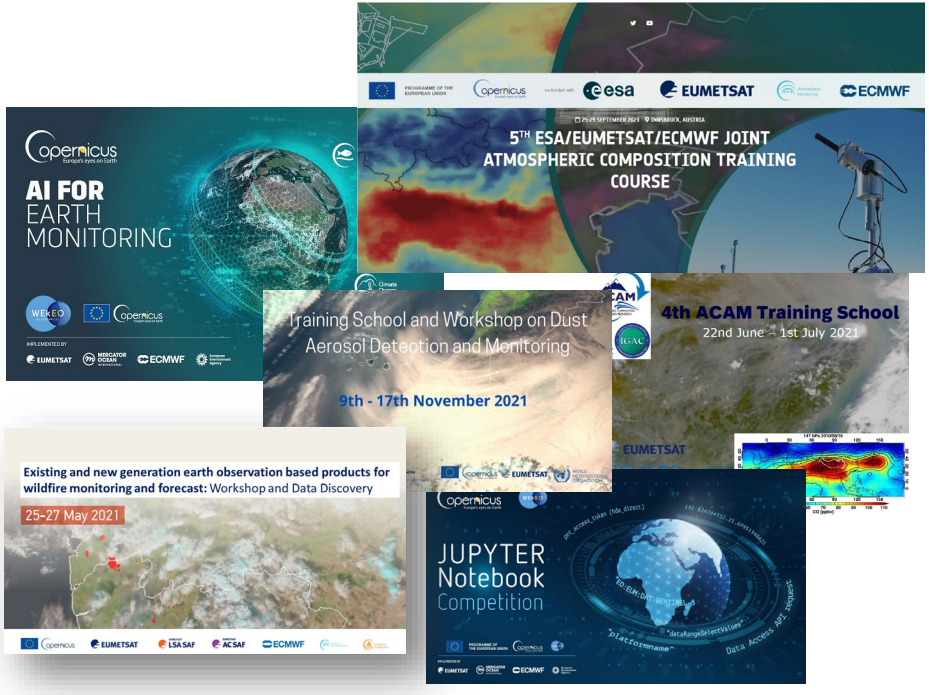


TRAINING ACTIVITIES

Atmosphere Monitoring

CAMS works very closely with its partners on training about atmospheric composition (science, data, model, use of tools…).





CAMS also provides its own training resources (e.g., via Jupyter notebooks).

https://atmosphere.copernicus.eu/training

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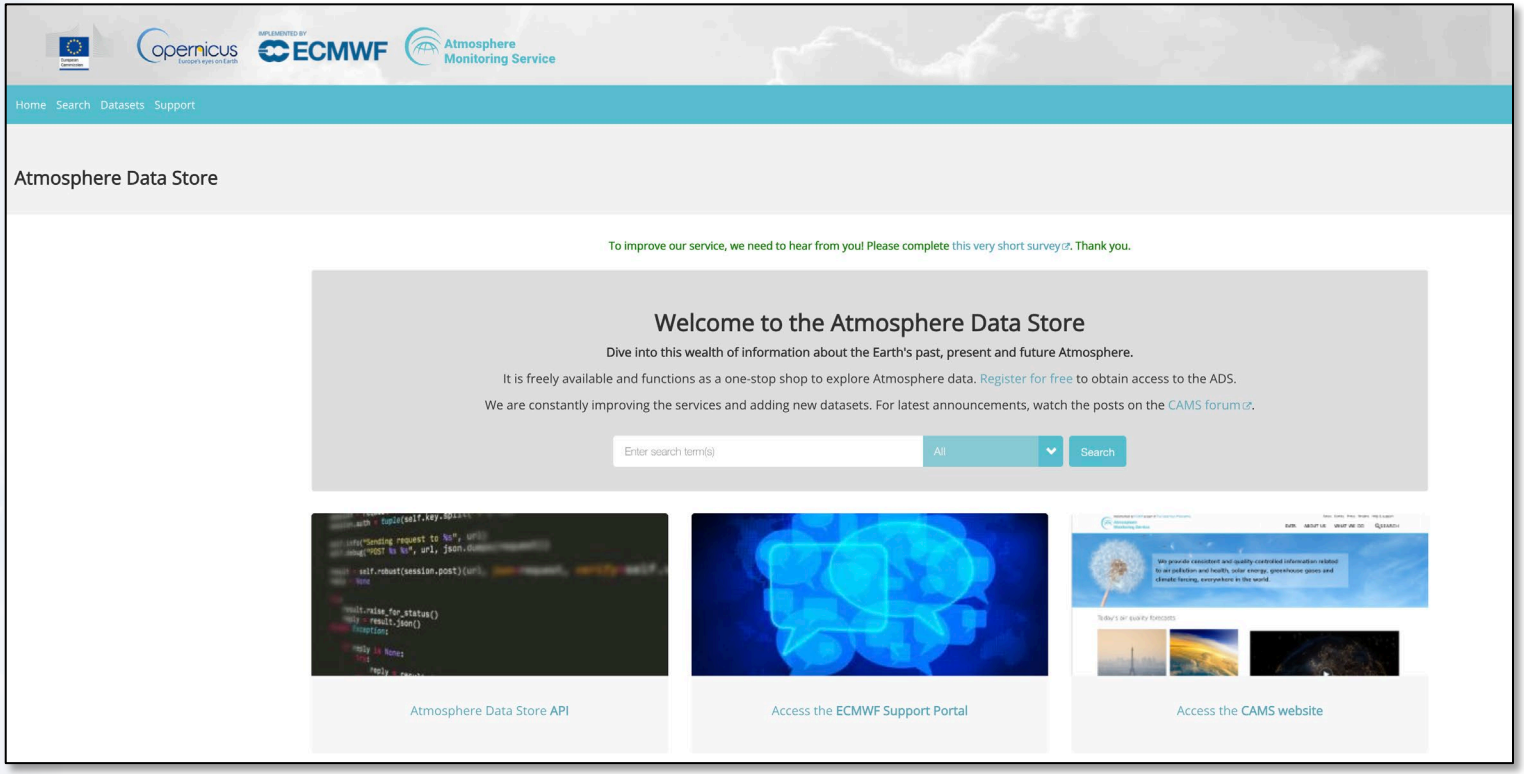
ACCESS TO DATA: THE ATMOSPHERE DATA STORE (ADS)

Atmosphere Monitoring

http://ads.atmosphere.copernicus.eu



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IMPLEMENTED BY ECMWF

ADS: AVAILABLE DATA SETS

Atmosphere Monitoring

PROGRAMME OF THE EUROPEAN UNION

IMPLEMENTED BY ECMWF

ADS: DATASET DESCRIPTION

Atmosphere Monitoring

Copernicus | ECMWF | Atmosphere Monitoring Service

Login/register

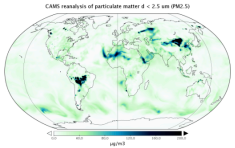
Home Search Datasets Support

CAMS global reanalysis (EAC4)

To improve our service, we need to hear from you! Please complete this very short survey. Thank you.

Overview | Download data | Documentation

EAC4 (ECMWF Atmospheric Composition Reanalysis 4) is the fourth generation ECMWF global reanalysis of atmospheric composition. Reanalysis combines model data with observations from across the world into a globally complete and consistent dataset using a model of the atmosphere based on the laws of physics and chemistry. This principle, called data assimilation, is based on the method used by numerical weather prediction centres and air quality forecasting centres, where every so many hours (12 hours at ECMWF) a previous forecast is combined with newly available observations in an optimal way to produce a new best estimate of the state of the atmosphere, called analysis, from which an updated, improved forecast is issued. Reanalysis works in the same way to allow for the provision of a dataset spanning back more than a decade. Reanalysis does not have the constraint of issuing timely forecasts, so there is more time to collect observations, and when going further back in time, to allow for the ingestion of improved versions of the original observations, which all benefit the quality of the reanalysis product.



The assimilation system is able to estimate biases between observations and to sift good-quality data from poor data. The atmosphere model allows for estimates at locations where data coverage is low or for atmospheric pollutants for which no direct observations are available. The provision of estimates at each grid point around the globe for each regular output time, over a long period, always using the same format, makes reanalysis a very convenient and popular dataset to work with.

The observing system has changed drastically over time, and although the assimilation system can resolve data holes, the initially much sparser networks will lead to less accurate estimates. For this reason, EAC4 is only available from 2003 onwards.

Although the analysis procedure considers chunks of data in a window of 12 hours in one go, EAC4 provides estimates every 3 hours, worldwide. This is made possible by the 4D-Var assimilation method, which takes account of the exact timing of the observations and model evolution within the assimilation window.

More details about the products are given in the Documentation section.

DATA DESCRIPTION	
Data type	Gridded
Horizontal coverage	Global
Horizontal resolution	0.75°x0.75°
Vertical coverage	Surface, total column, model levels and pressure levels.
Vertical resolution	60 model levels. Pressure levels: 1000, 950, 925, 900, 850, 800, 700, 600, 500, 400, 300, 250, 200, 150, 100, 70, 50, 30, 20, 10, 7, 5, 3, 2, 1 hPa
Temporal coverage	2003 to 2022
Temporal resolution	3-hourly
File format	GRIB (optional conversion to netCDF)
Versions	Only one version
Update frequency	Twice a year with 4-6 month delay

MAIN VARIABLES	
Name	Units
10m u-component of wind	$m\ s^{-1}$
10m v-component of wind	$m\ s^{-1}$
2m dewpoint temperature	K

Contact

ECMWF Support Portal

Licence

Licence to use Copernicus Products

Publication date

2020-02-06

Related data

CAMS global atmospheric composition forecasts

CAMS global greenhouse gas reanalysis (EGG4)

CAMS global greenhouse gas reanalysis (EGG4) monthly averaged fields

CAMS global reanalysis (EAC4) monthly averaged fields

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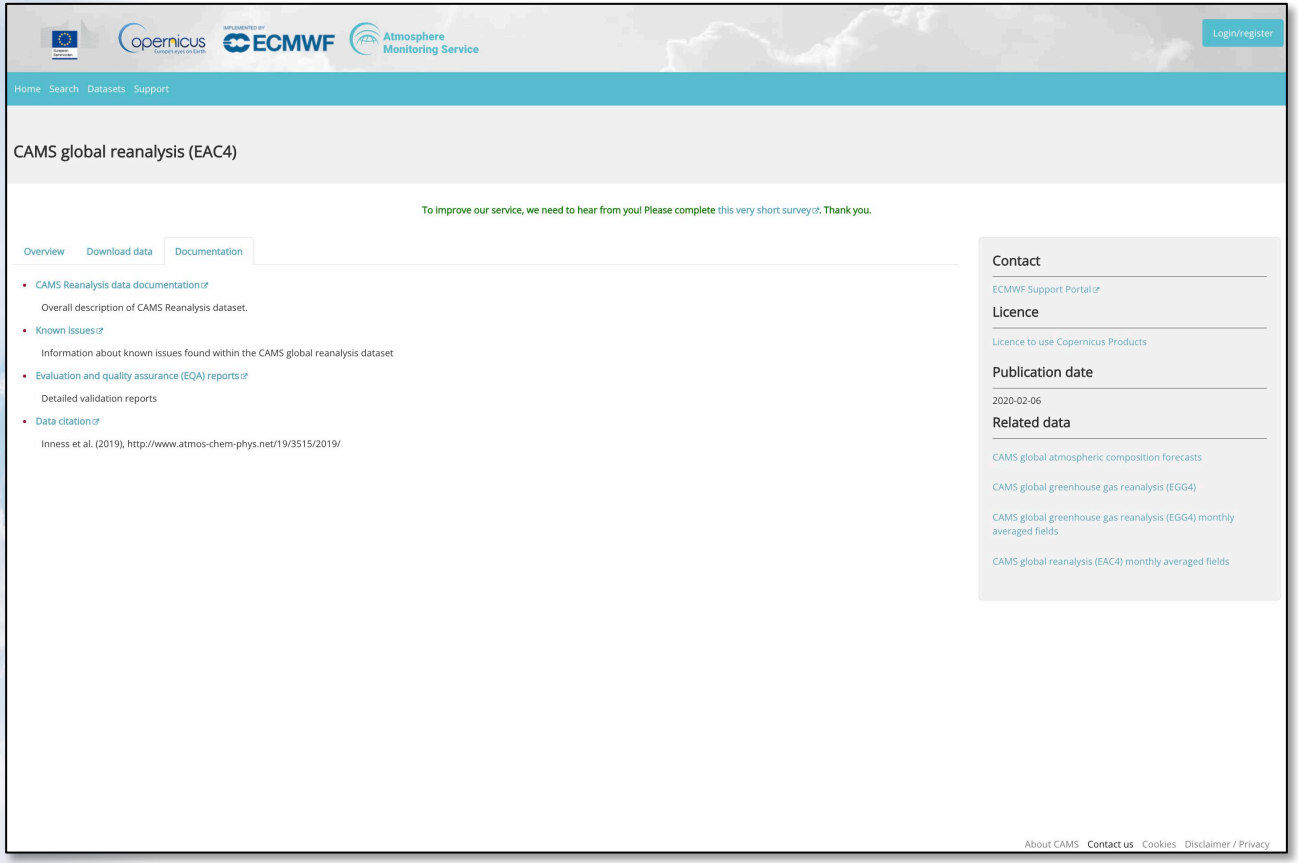
ADS: DOCUMENTATION

Atmosphere Monitoring



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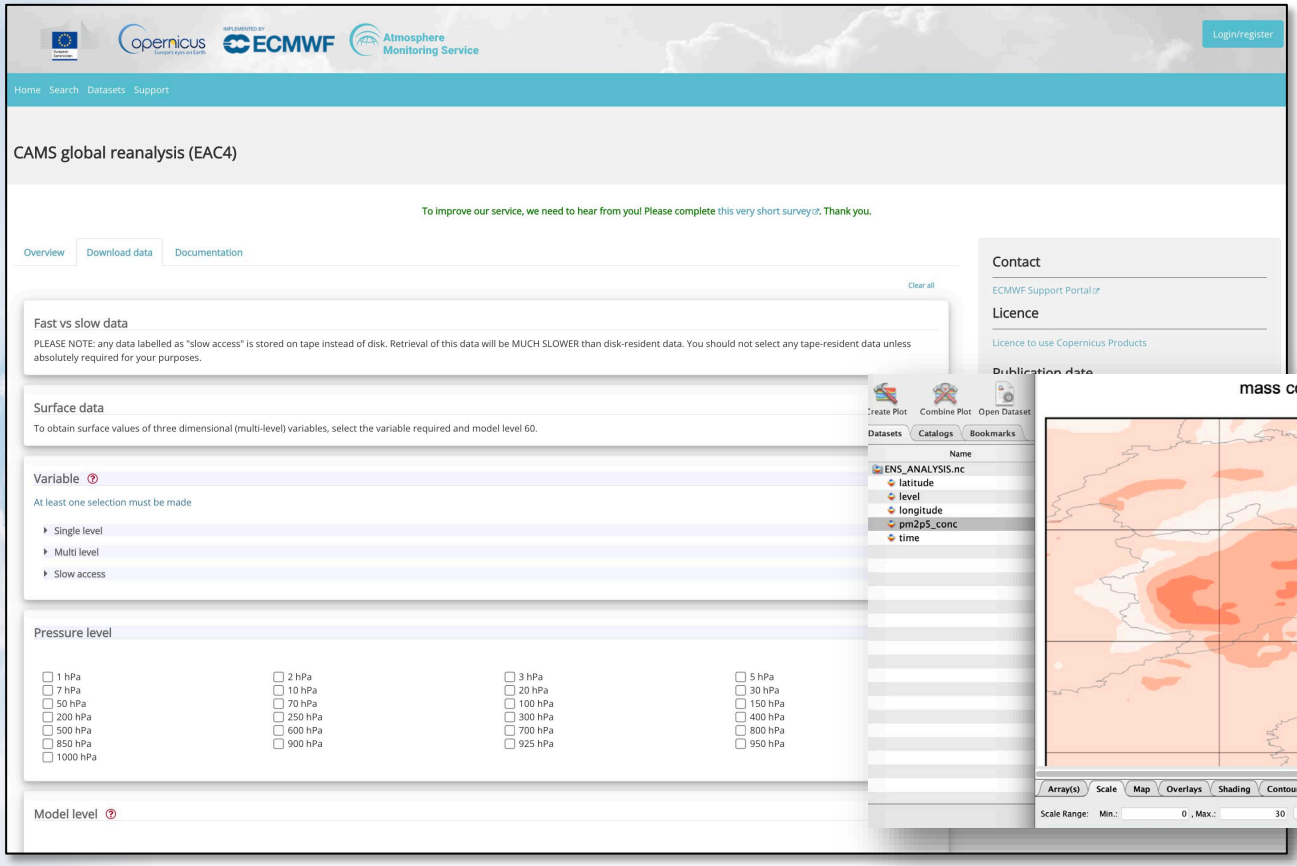
ADS:DATA DOWNLOAD

Atmosphere Monitoring



Within a few minutes (or faster), analysis ready datasets can be downloaded

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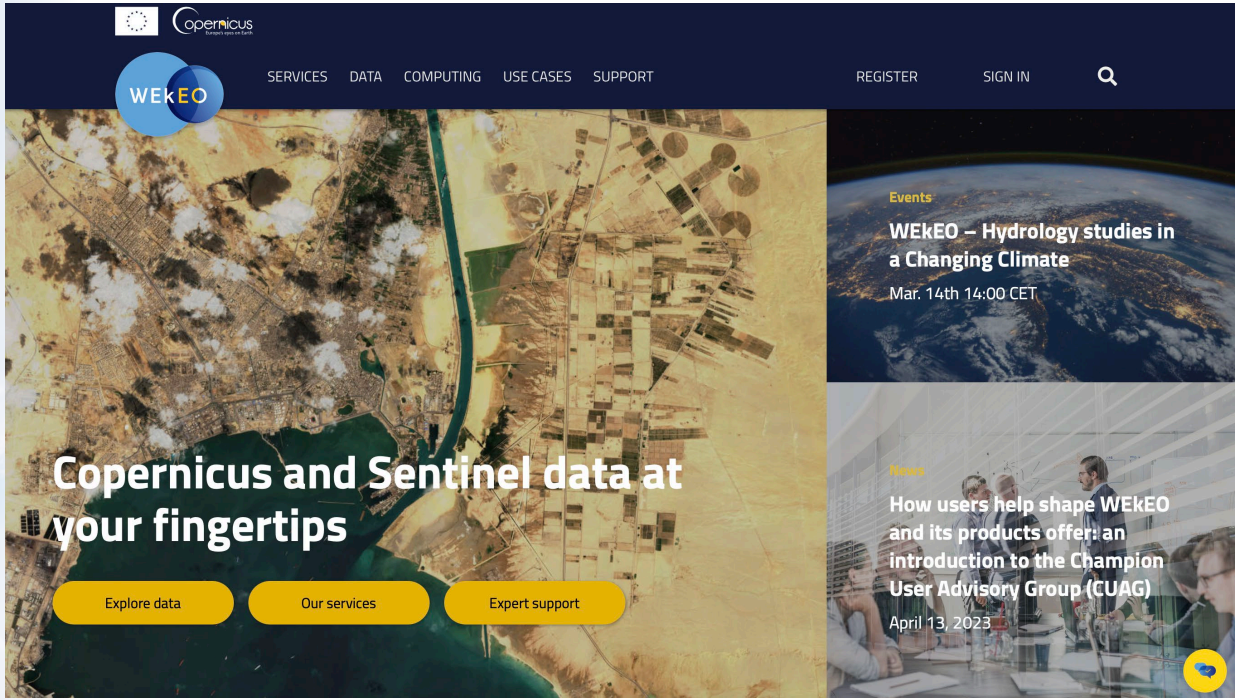
Atmosphere Monitoring

AND IF YOU NEED VIRTUAL MACHINES… THERE IS WEkEO

https://www.wekeo.eu



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Help and support

We are committed to helping users make the most of our open data. As part of our service, we provide a range of channels for getting the necessary help and support.

24/7 Knowledge Base

The Knowledge Base provides documentation and answers to frequently asked questions.

Forum

Become part of the community, work together and support each other.

Contact us

Can't find the answer you're looking for? Get in touch!

Login to the ECMWF Support Portal

Mailing lists

CAMS uses email mailing lists to inform users about changes to its forecast services, such as system upgrades and potential changes to the timing of the product availability.

DOCUMENT REPOSITORY >

ECMWF SUPPORT GUIDELINES >

Quality Assurance

We continually check the accuracy of our products against independent observations in quarterly reports.

Documentation

We provide documentation on our data products describing the underlying production systems.

Training

CAMS provides training to its users through workshops and on-line resources.

User Satisfaction Surveys

We run user satisfaction surveys every year.

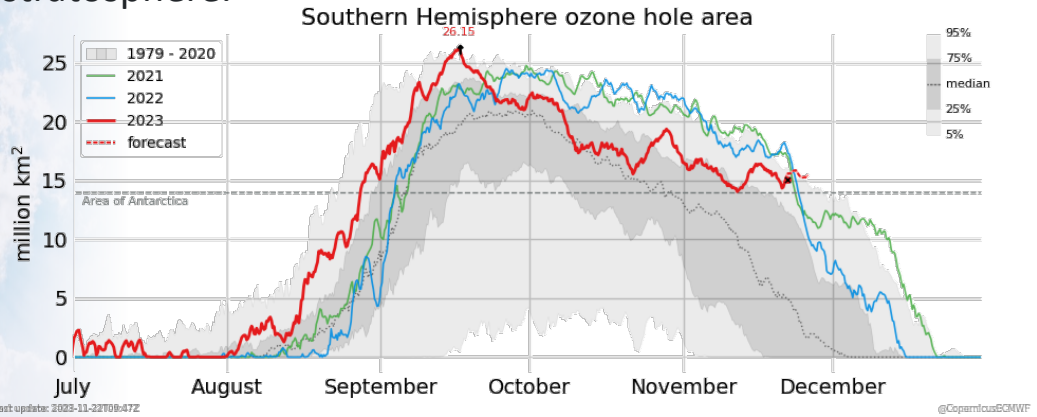
- 2020 report
- 2019 report
- 2018 Report
- 2017 Report

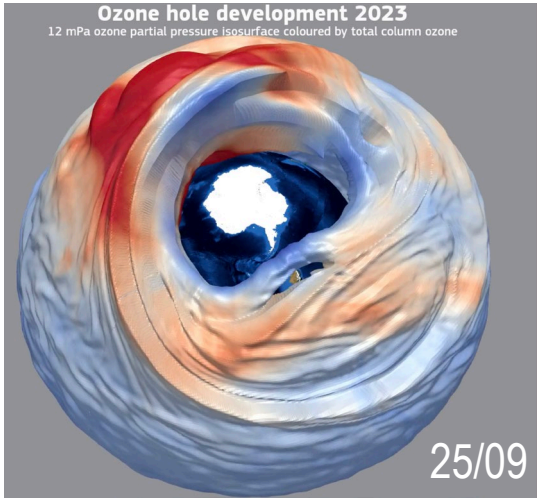
Your feedback is key to us >

Atmosphere Monitoring

TWISTS AND TURNS OF THE 2023 OZONE HOLE

The 2023 Antarctic ozone hole has had a somewhat erratic behaviour since its unusually early start beginning of August. In September it became the **sixth largest ozone hole ever observed**, before returning to average ozone hole values in October, to then spike again at the end of the month. This highly variable pattern can be related to different factors, including the **temperatures and wind patterns in the stratosphere, global warming and the eruption of the Hunga Tonga volcano in January 2022**, that injected large amounts of water vapor in the stratosphere.





See details here:
https://atmosphere.copernicus.eu/twists-and-turns-2023-southern-hemisphere-ozone-hole

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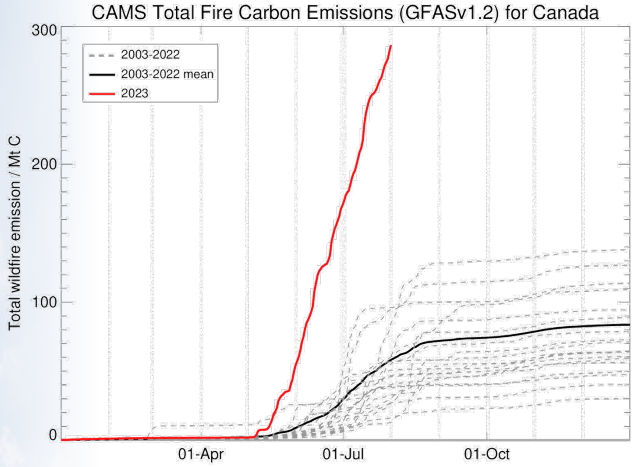
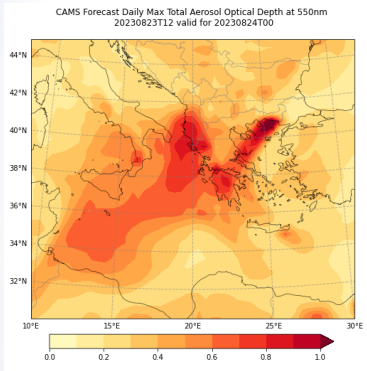
RECORD-BREAKING BOREAL WILDFIRE SEASON 2023

Atmosphere Monitoring



PROGRAMME OF THE EUROPEAN UNION



CAMS has monitored **record-breaking wildfires throughout the summer** providing near-real-time information on active fires, their impact on air quality (including long-range transport) and the resulting CO_2 emissions.

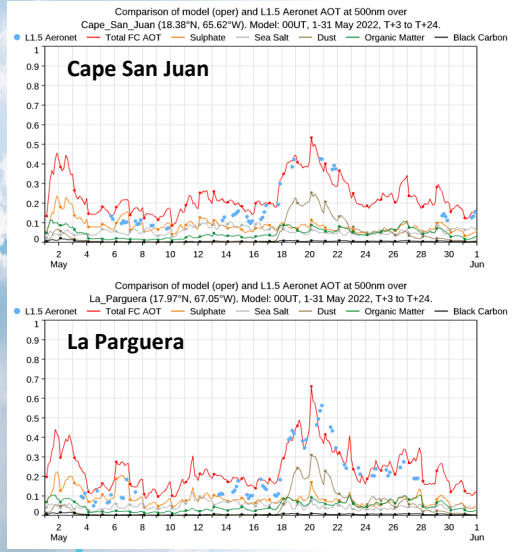
CAMS particularly covered unprecedented fires in **most Canadian states and territories** and parts of **Greece** (Rhodos…).

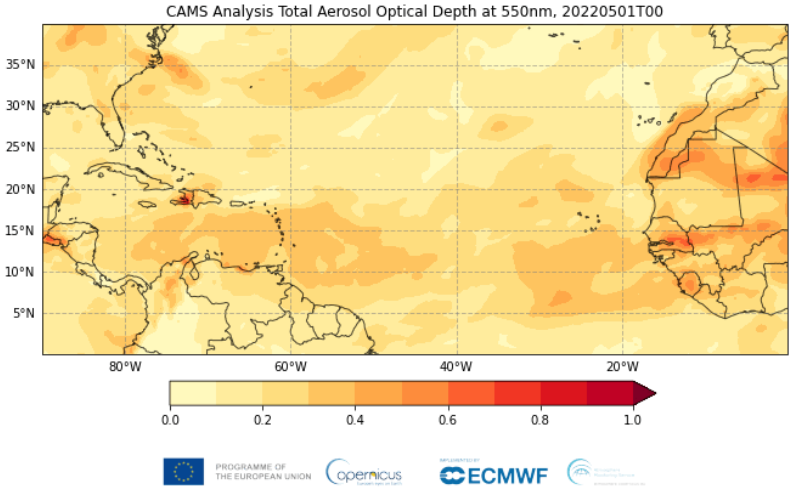
The complementarity between the information provided by CAMS and C3S made Copernicus a **go-to resource**. CAMS information was taken up in many **top tier media** and let to a number of interviews (including live ones).

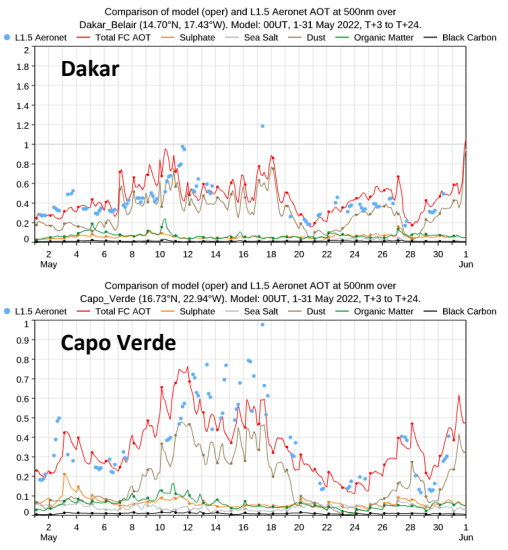
See details here:
https://atmosphere.copernicus.eu/record-breaking-boreal-wildfire-season
and: https://atmosphere.copernicus.eu/august-wildfires-ravage-northern-central-greece

EX. SAHARAN DUST EVENTS (MAY 2022)

Atmosphere Monitoring







CAMS operational forecasts and air pollution cases monitored by NRT in CAMS ‘Weather Room’. Information shared with users via CAMS website, social media and press.

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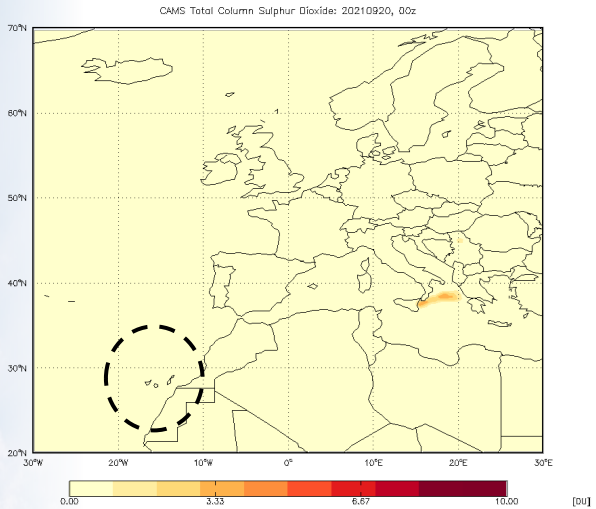
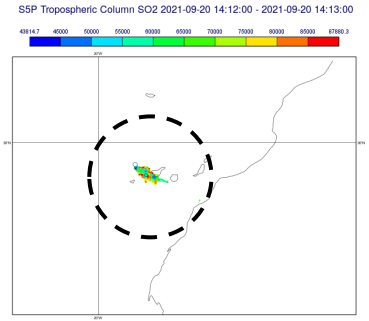
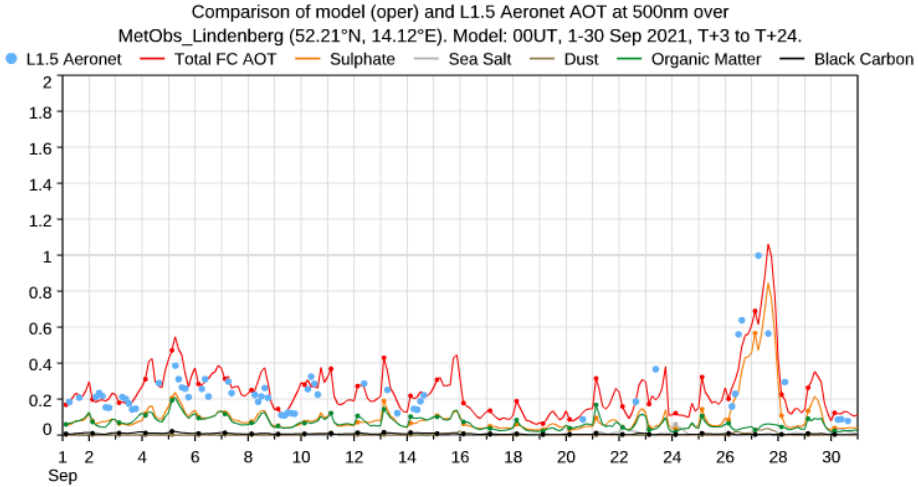
EX. VOLCANIC ERUPTIONS (SEPTEMBER 2021)

Atmosphere Monitoring







- Cumbre Vieja volcano on La Palma erupted on 19 September 2021 for first time since 1971
- First SO_2 detections from **GOME-2** & **S-5P** assimilated in IFS at 06z on 20 September (layer height ~550 hPa)
- Initial transport to the NW across N Africa, Europe and Mediterranean

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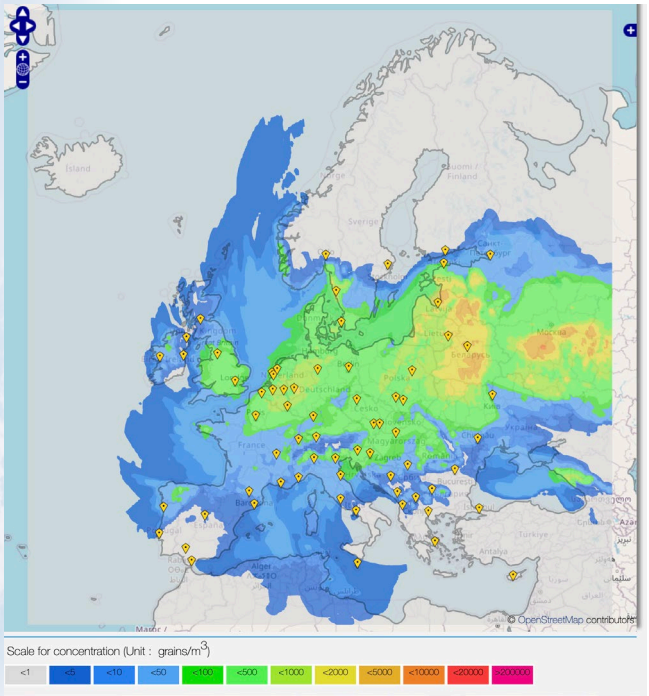
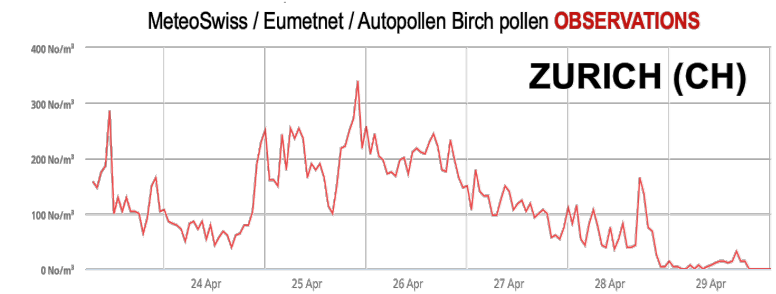
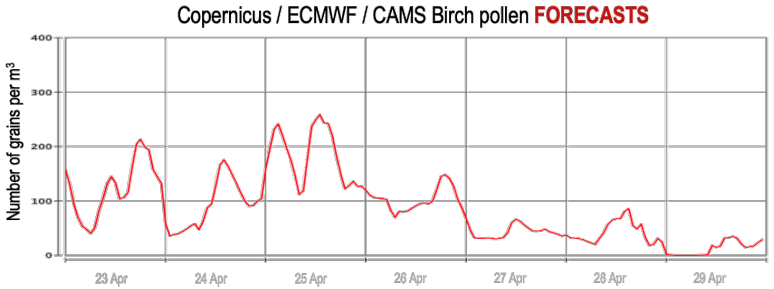
POLLEN FORECASTS & NEAR-REAL-TIME EVALUATION

Atmosphere Monitoring







CAMS provides pollen forecasts for 6 species (alder, birch, grass, mugwort, olive, ragweed) with same technology as for AQ pollutants.

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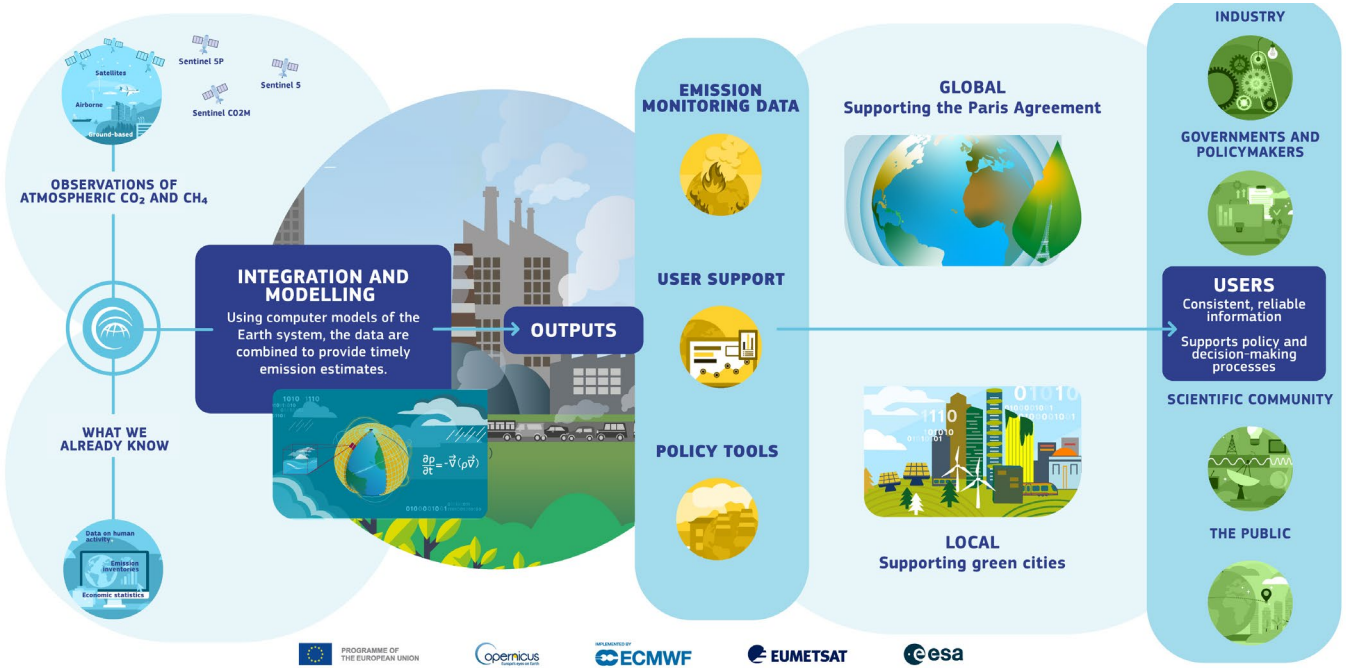
CAMS NEW FRONTIER: OBSERVATIONS BASED EMISSIONS

Atmosphere Monitoring

Main target is anthropogenic CO_2, but also CH4 and pollutants



A European contribution to CEOS, GCOS, GEO, and WMO efforts in support of the Paris Agreement.

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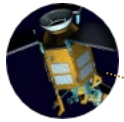
TIMELINE OF CAMS EMISSION SERVICES

Atmosphere Monitoring

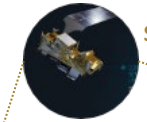
From expert groups through dedicated research funding, to operational services

ECMWF esa EUMETSAT



Sentinel 5p

Sentinel 4



Sentinel 5

CO_2 Mission

SATELLITE MISSIONS

Air Quality emissions 2025

Operational ramp-up in CAMS

SERVICE COMPONENTS

CO2 TASK FORCE GUIDANCE DOCUMENTS

2015

2017

2019

2017

CO_2 Human Emissions

2018

VERIFY

2021

CoCO2 Prototype system for a Copernicus CO_2 service

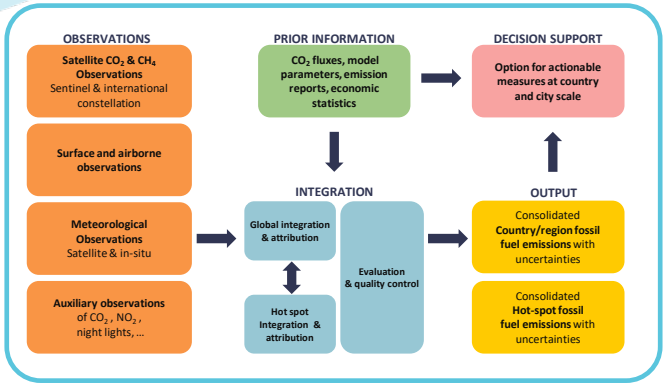
ICOS Cities

2022

horizon europe

2026

CO_2 Monitoring & Verification Support (CO_2MVS)



RESEARCH AND PREPARATORY PROJECTS

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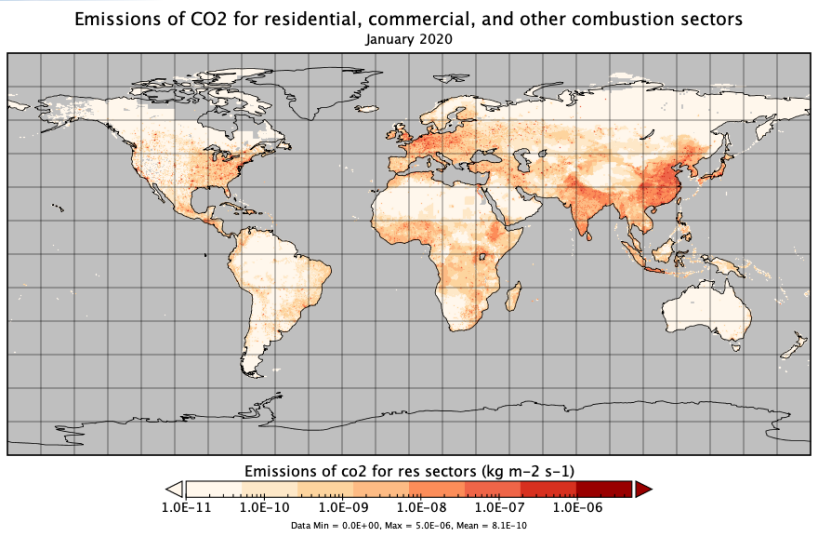
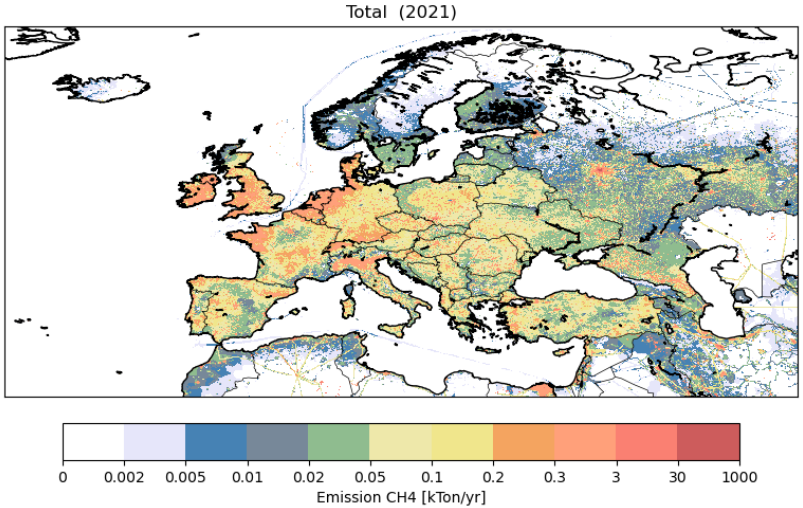
CAMS CURRENT PRODUCTS: EMISSION INVENTORIES

Atmosphere Monitoring





Global and regional emission inventories for greenhouse gases and many air pollutants based on existing global inventories using projections for latest years (global) and nationally reported emissions (regional).

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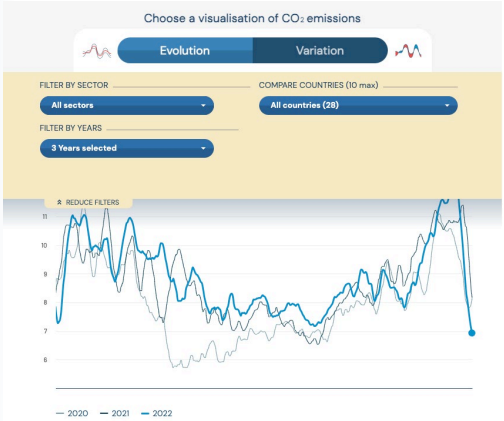
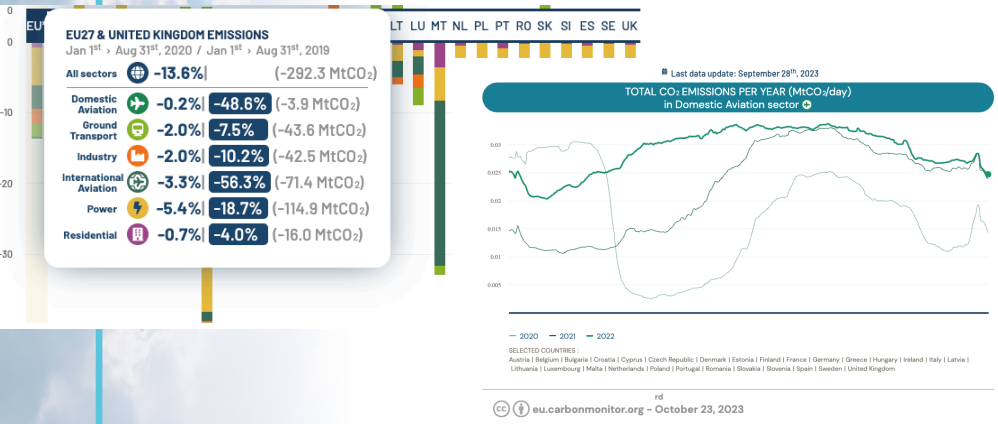
CARBON MONITOR NOW CONTRIBUTES TO CAMS

Atmosphere Monitoring





Carbon Monitor provides **one of the most advanced and CO_2 emissions datasets in the world regarding day-to-day variations**, thanks to a comprehensive inventory approach to produce daily estimates. Estimates are based on a wide range of activity data, including electrical power generation, and industrial production indices for 62 countries or regions as well as mobility data for 416 cities.

In cooperation with CAMS, Carbon Monitor has produced Carbon Monitor Europe (CM-EU), a specific extension of the dataset for EU. **Data is presented on the CAMS website**. See details here:

https://atmosphere.copernicus.eu/carbon-monitor-and-cams-team-provide-date-co2-emissions-estimates-europe

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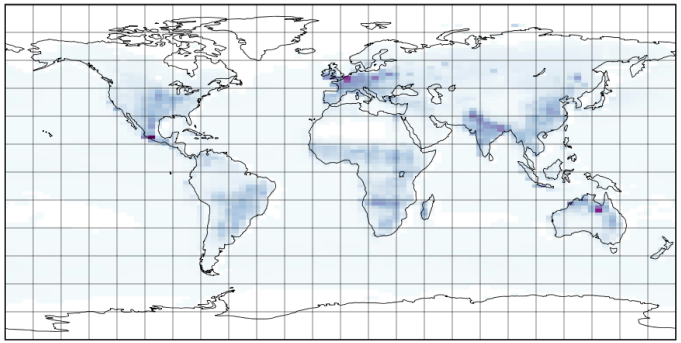
CAMS CURRENT PRODUCTS: ATMOSPHERIC INVERSION DATA

Atmosphere Monitoring

Surface upward mass flux of nitrogen

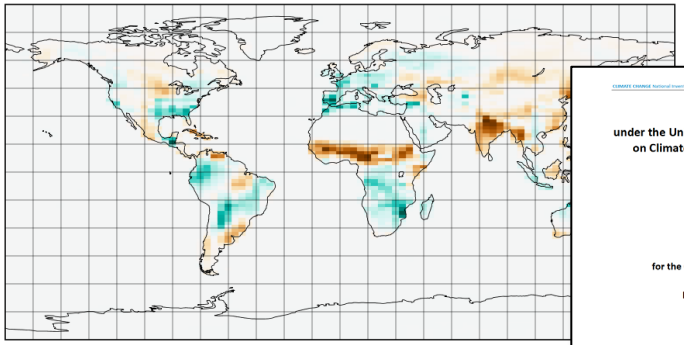


Surface upward mass flux of nitrogen for the whole grid box and the whole month (kgN m−2 month−1)

0.0E+00 1.4E−05 2.8E−05 4.2E−05 5.6E−05 7.0E−05

Data Min = −1.4E−06, Max = 6.9E−05, Mean = 3.1E−06

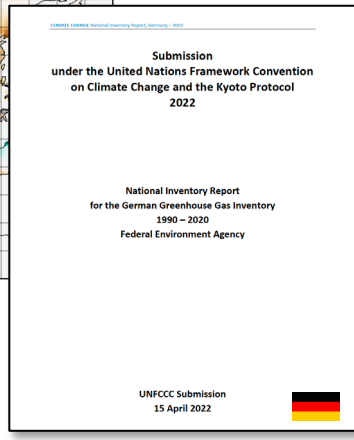
Land surface upward mass flux of carbon without fossil fuel



Land surface upward mass flux of carbon (kgC m−2 month−1)

−0.12 −0.07 −0.02 0.02 0.07 0.12

Data Min = −0.11, Max = 0.13, Mean = 0.00

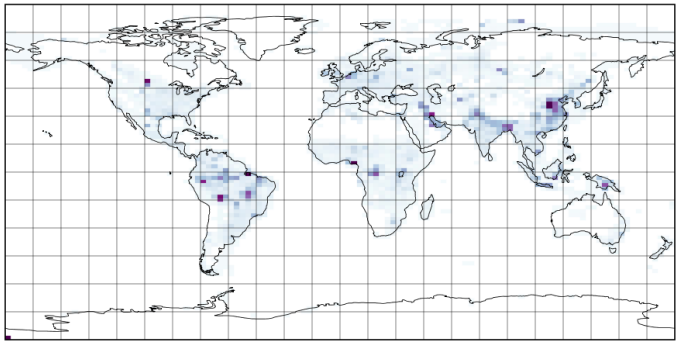


Submission
under the United Nations Framework Convention
on Climate Change and the Kyoto Protocol
2022

National Inventory Report
for the German Greenhouse Gas Inventory
1990 – 2020
Federal Environment Agency

UNFCCC Submission
15 April 2022

Surface upward mass flux of methane



surface upward mass flux of methane (kg m−2 s−1)

0.0E+00 3.0E−10 6.0E−10 9.0E−10 1.2E−09 1.5E−09

Data Min = −1.8E−11, Max = 3.9E−09, Mean = 3.3E−11

CAMS provides annually updated atmospheric inversion flux data for CO_2, CH_4, and N_2O spanning several decades, currently at relatively coarse resolution. (For latest developments, see presentation by F. Chevallier)

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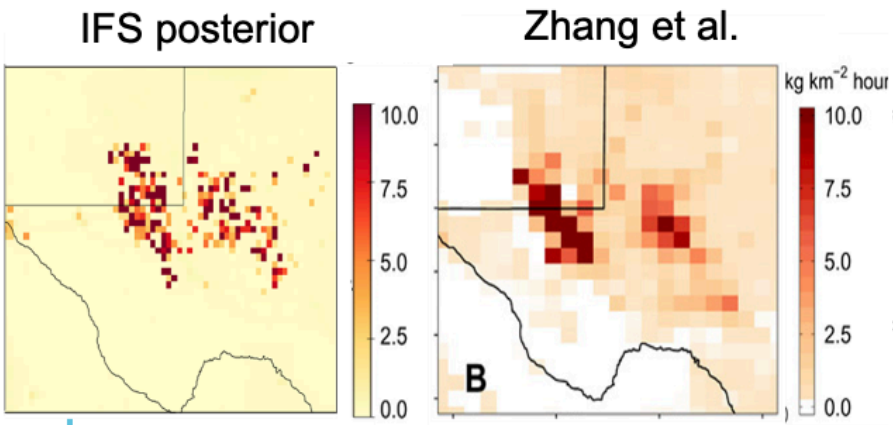
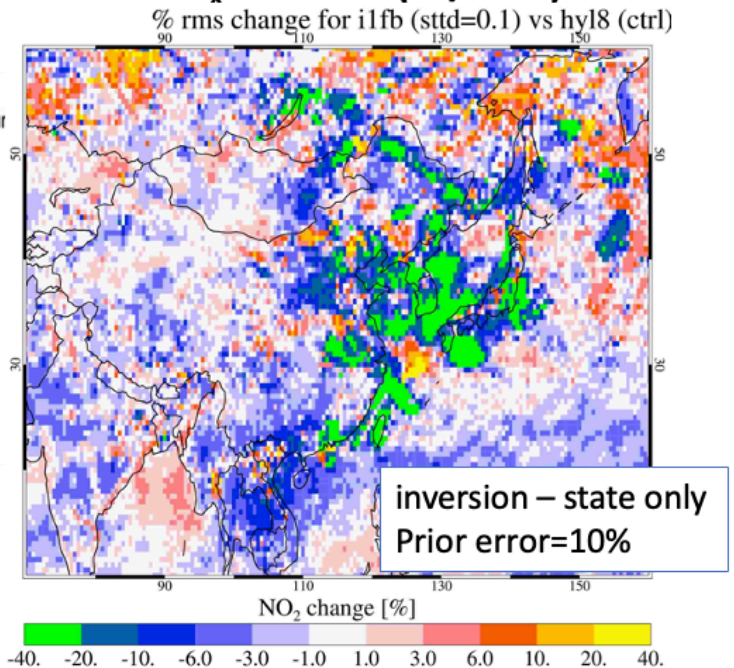
PROGRESS WITH OBSERVATIONS-BASED EMISSIONS

CH_4 inversion over Permian Bassin



- CH_4 inversion results in agreement with previous studies.
- NOx inversion results show small improvements over Southeast Asia (ongoing prior errors sensitivity tests).

NO_x inversion (04/2020)



inversion – state only
Prior error=10%

Evaluation of 24h forecasts (0-24h) of IFS against TROPOMI NO2 (PAL)

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Atmosphere Monitoring

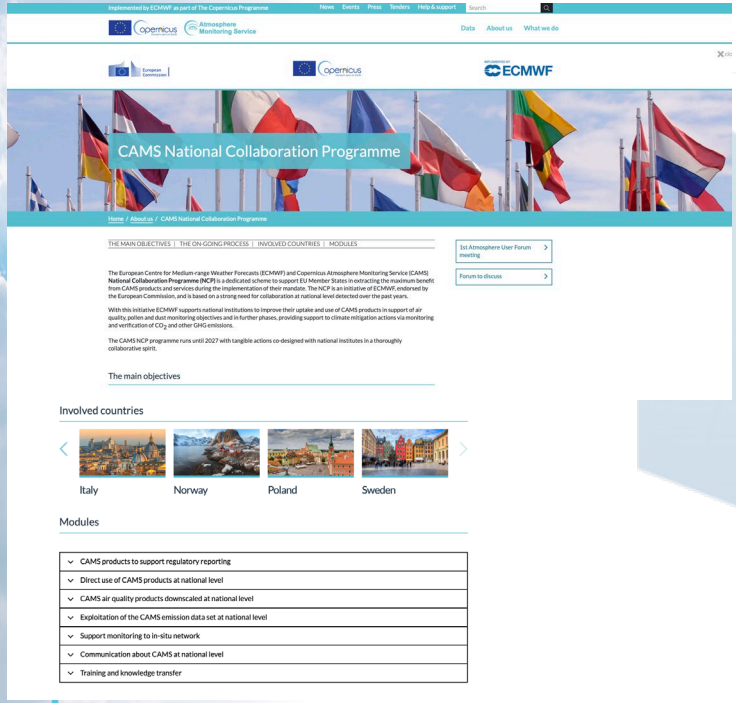
WMO's GLOBAL GREENHOUSE GAS WATCH (G3W)

Together with delegates from the European Commission DG DEFIS, ESA and EUMETSAT, CAMS was actively involved in the discussions and shared the progress towards the European Greenhouse Gas Monitoring and Verification Support Capacity. ECMWF and CAMS intend to play a key role in the **WMO-led operational Global Greenhouse Gas Watch** working with key institutions from USA, Canada, Japan, China and elsewhere.

See details here: https://atmosphere.copernicus.eu/cams-supports-global-greenhouse-gas-monitoring-initiative-led-wmo

CAMS NATIONAL COLLABORATION PROGRAMME(NCP)

Atmosphere Monitoring



New approach to the Copernicus **national institutional users**

- to enhance the uptake of CAMS products at national level by **co-designing joint activities**
- to assess the quality and fitness for purpose of CAMS products over national domain (**user feedback & user needs**)
- to provide a gateway to reach the general public at national level and in **national language (communication)**

- Budget allocated: 16M€ shared amongst all the countries
- NCP web site with countries contributions
- 2 phases covering the period 2023-2027
  - 1st phase:18 months contracts
  - 2nd phase: renewed contracts with same or differerent topics

https://atmosphere.copernicus.eu/cams-national-collaboration-programme

PROGRAMME OF THE EUROPEAN UNION

Copernicus Europe's eyes on Earth

DRIVEN BY ECMWF

LOOKING BACK AT CAMS 1.0

Atmosphere Monitoring

BAMS Article

The Copernicus Atmosphere Monitoring Service

From Research to Operations

Vincent-Henri Peuch, Richard Engelen, Michel Rixen, Dick Dee, Johannes Flemming, Martin Suttie, Melanie Ades, Anna Agustí-Panareda, Cristina Ananasso, Erik Andersson, David Armstrong, Jérôme Barré, Nicolas Bousserez, Juan Jose Dominguez, Sébastien Garrigues, Antje Inness, Luke Jones, Zak Kipling, Julie Letertre-Danczak, Mark Parrington, Miha Razinger, Roberto Ribas, Stijn Vermoote, Xiaobo Yang, Adrian Simmons, Juan Garcés de Marcilla, and Jean-Noël Thépaut

ABSTRACT: The Copernicus Atmosphere Monitoring Service (CAMS), part of the European Union's Earth observation program Copernicus, entered operations in July 2015. Implemented by the European Centre for Medium-Range Weather Forecasts (ECMWF) as a truly European effort with over 23,500 direct data users and well over 200 million end users worldwide as of March 2022, CAMS delivers numerous global and regional information products about air quality, inventory-based emissions and observation-based surface fluxes of greenhouse gases and from biomass burning, solar energy, ozone and UV radiation, and climate forcings. Access to CAMS products is open and free of charge via the Atmosphere Data Store. The CAMS global atmospheric composition analyses, forecasts, and reanalyses build on ECMWF's Integrated Forecasting System (IFS) and exploit over 90 different satellite data streams. The global products are complemented by coherent higher-resolution regional air quality products over Europe derived from multisystem analyses and forecasts. CAMS information products also include policy support such as quantitative impact assessment of short- and long-term pollutant-emission mitigation scenarios, source apportionment information, and annual European air quality assessment reports. Relevant CAMS products are cited and used for instance in IPCC Assessment Reports. Providing dedicated support for users operating smartphone applications, websites, or TV bulletins in Europe and worldwide is also integral to the service. This paper presents key achievements of the CAMS initial phase (2014–21) and outlines some of its new components for the second phase (2021–28), e.g., the new Copernicus anthropogenic CO_2 emissions Monitoring and Verification Support capacity that will monitor global anthropogenic emissions of key greenhouse gases.

KEYWORDS: Atmosphere; Numerical weather prediction/forecasting; Reanalysis data; Air quality; Societal impacts; Atmospheric composition

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An overview of CAMS 1.0 (2014-2021) was published at the end of last year. A companion paper covering C3S 1.0 is also available in the same issue.

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