



Atmosphere Monitoring

An update on the Copernicus Atmosphere Monitoring Service

Vincent-Henri Peuch
ECMWF, Director of CAMS



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Atmosphere
Monitoring

COPERNICUS ATMOSPHERE MONITORING SERVICE

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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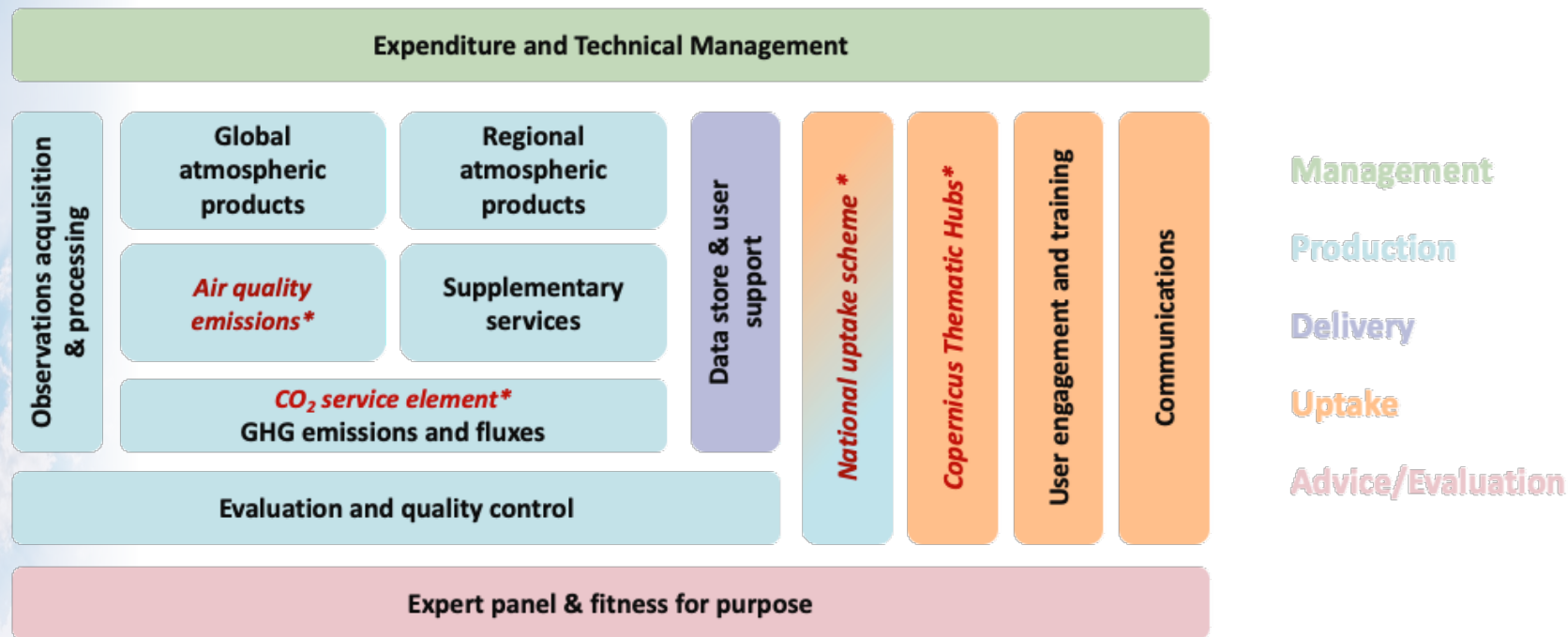
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CAMS2.0 SERVICE ARCHITECTURE



**new service components*



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THE PEOPLE BEHIND CAMS



13-15
June 2023

7th Copernicus Atmosphere Monitoring Service
(CAMS) General Assembly

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>



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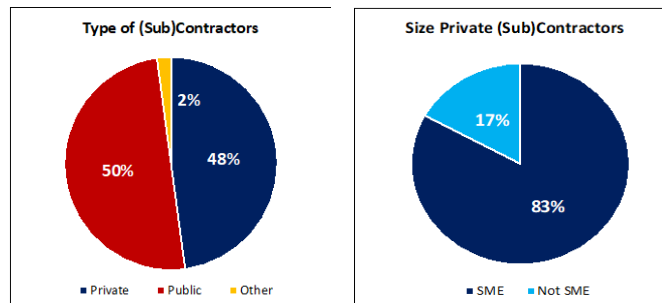


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STATUS OF CAMS2.0 & CAMS/C3S JOINT CONTRACTS Q3 2023

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>



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ECMWF
CAMS and joint services

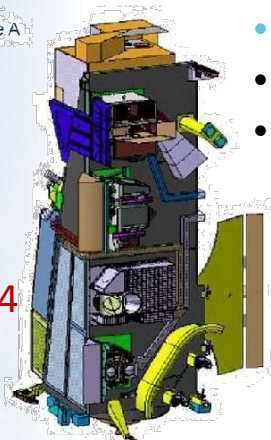


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DRIVER: EVOLUTION OF THE OBSERVING SYSTEMS

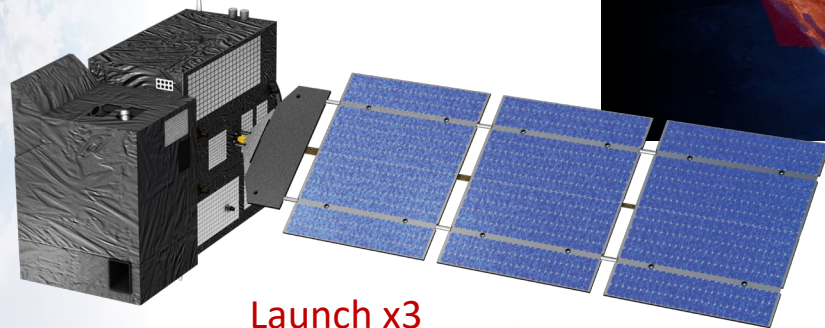
MetOp-SG-A

Satellite A



- Sentinel-5
- IASI-NG
- 3MI

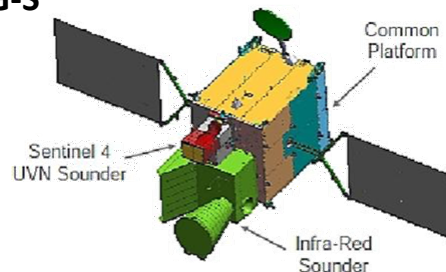
Launch
end-2024



CO2M

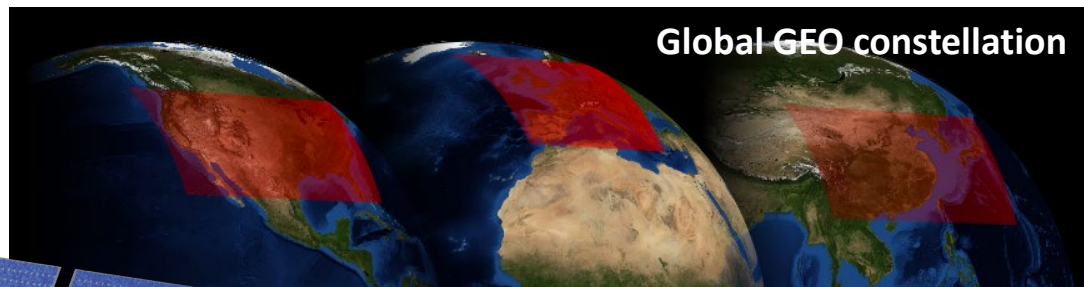
Launch x3
Mid-2026 to mid-2027

MTG-S



- Sentinel-4
- IRS

Launch
mid-2025



Global GEO constellation

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



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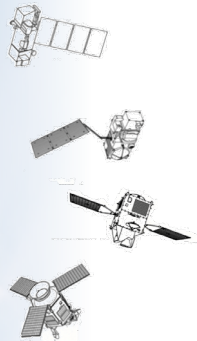
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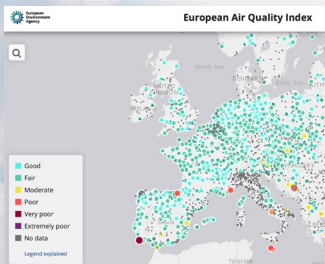


CAMS INFORMATION WORKFLOW

Atmosphere Monitoring



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)/ GHG(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) GHG(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:

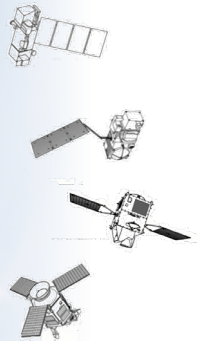
- Global real-time forecast (GRTF)
- Global delayed mode (GDM)
- Global reanalysis (REA)
- Global fire assimilation system (GFAS)
- Global surface net flux inversions of GHG (GHG)



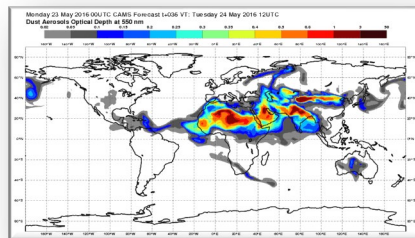
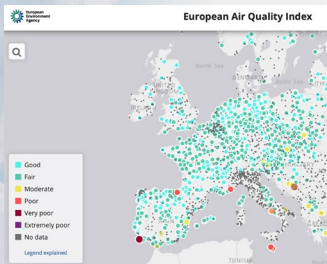
CAMS WORKFLOW

NEW / UPDATED

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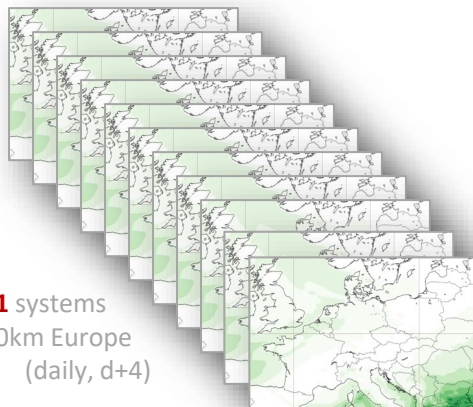


Earth Observation
See next slides

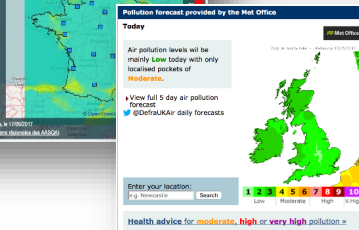
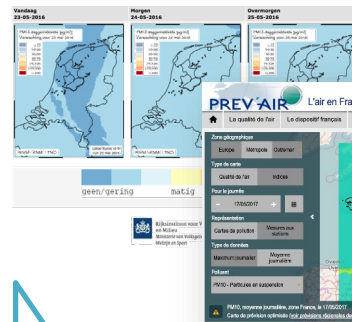


Detailed tropo. and **strato.** chemistry,
40km Globe (twice daily, d+5)

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



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



Major multiplication factor
(100Mil+)



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CAMS users
>31000
(>2700 routine)

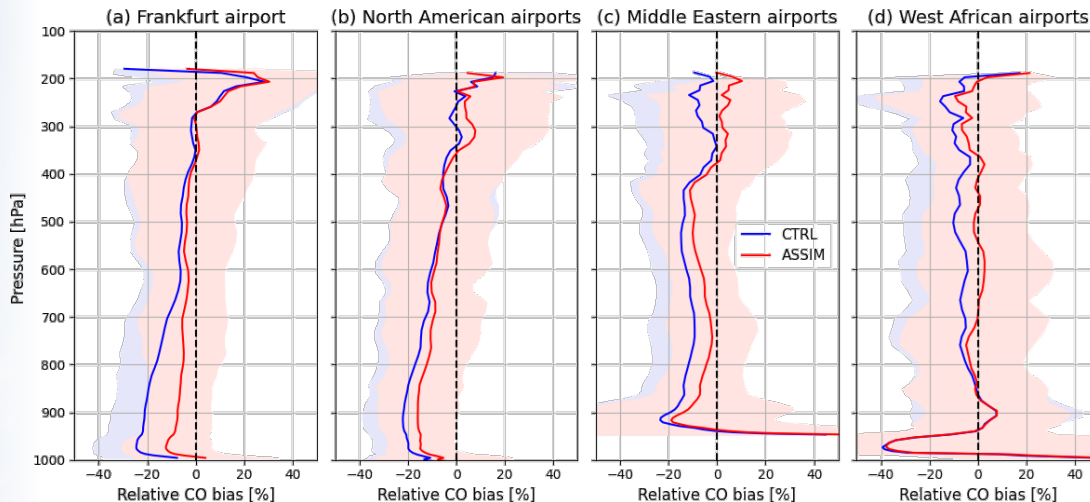


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IMPACT OF NEW ASSIMILATED DATA



Period: July - December 2021



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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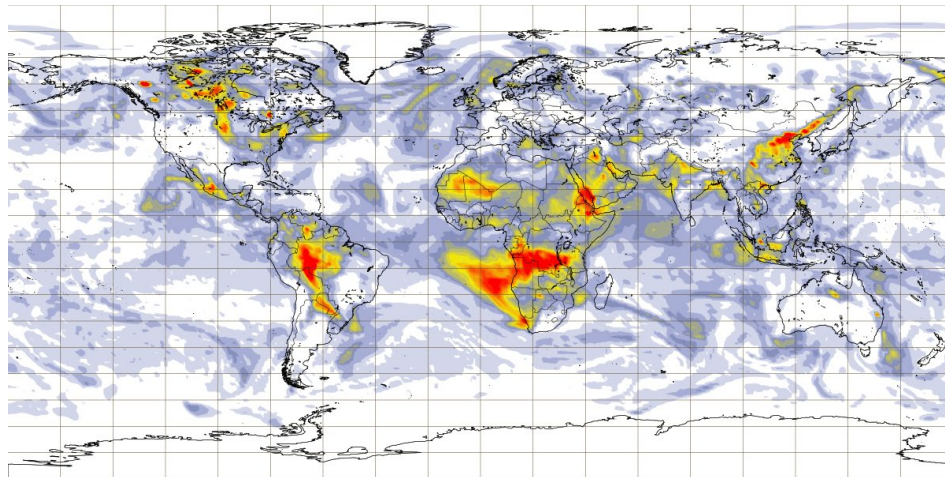
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JUNE 2023: CAMS GLOBAL SYSTEM UPGRADE

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.



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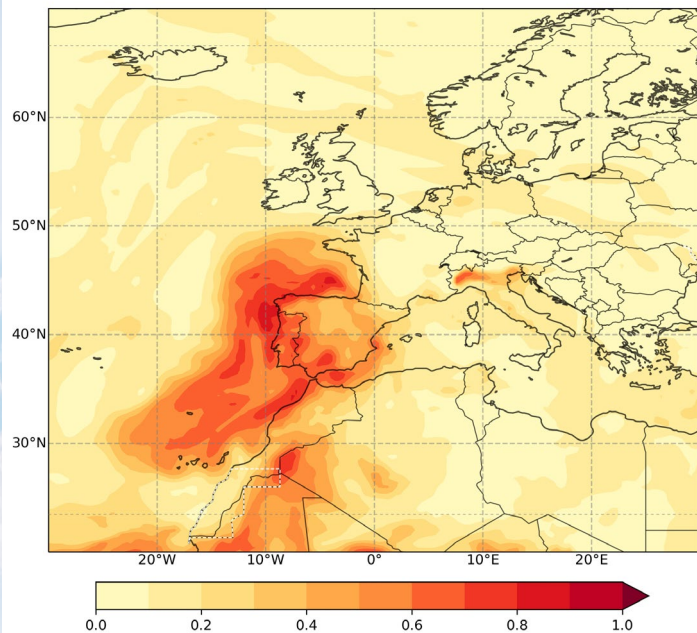




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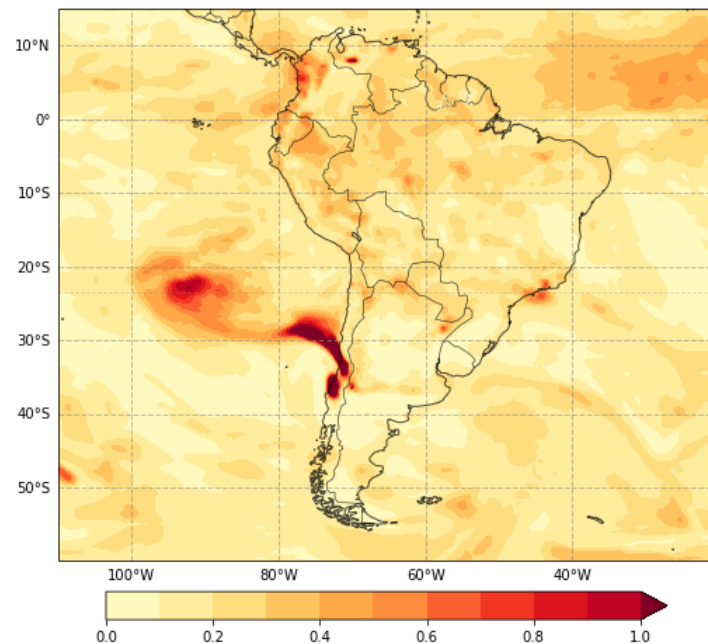
CAMS: EUROPE'S EYE ON EARTH

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



Dust aerosol

CAMS Forecast Total Aerosol Optical Depth at 550nm
20230207T00 valid for 20230207T00



Fire aerosol



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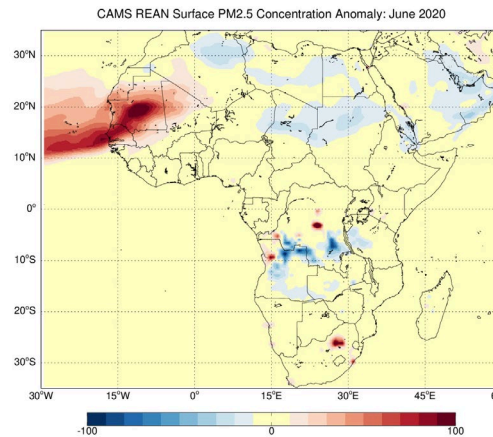
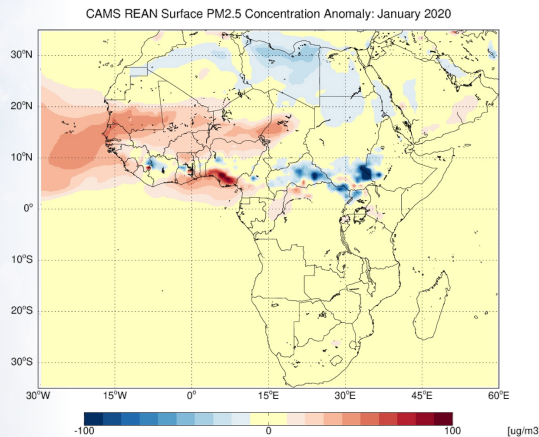
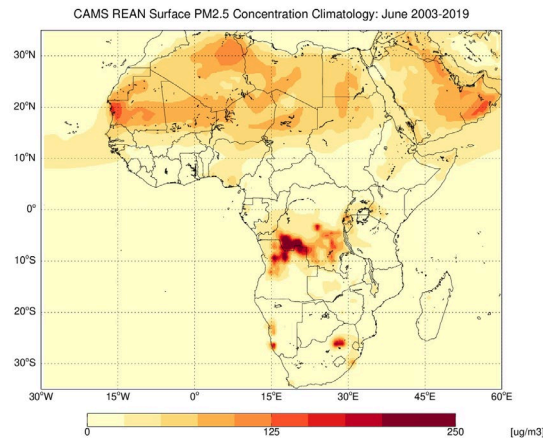
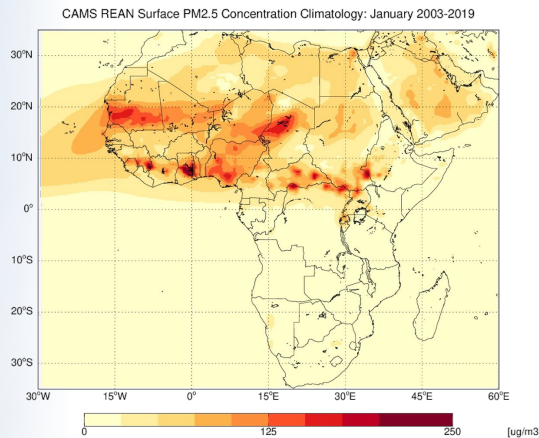
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CAMS REANALYSIS: PUTTING WHAT IS GOING ON IN CONTEXT

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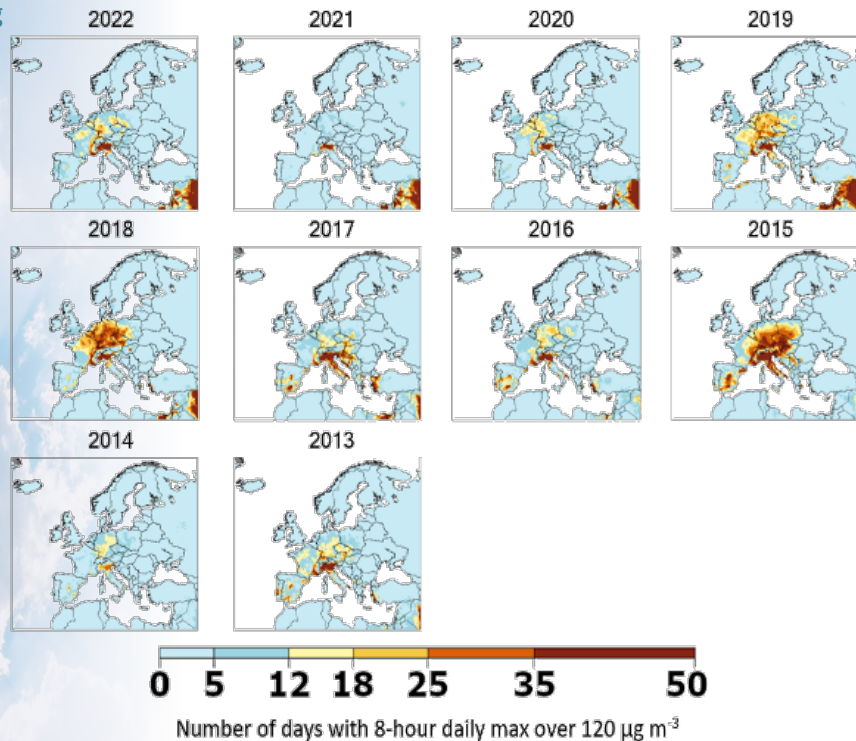


- CAMS reanalysis provides a consistent dataset for understanding long-term changes in global atmospheric composition and air quality.
- This example shows January and June monthly climatology of surface PM2.5 concentration calculated as the mean for the data from 2003-2019.
- Maps of anomalies for January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



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CAMS EUROPEAN AIR QUALITY ASSESSMENT 2022



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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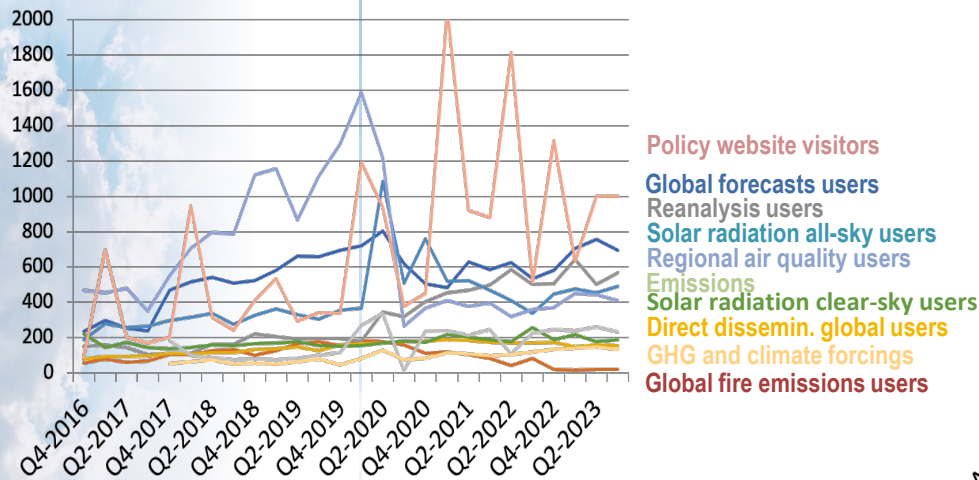


CAMS DIRECT USERS (Q3 2023)

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.

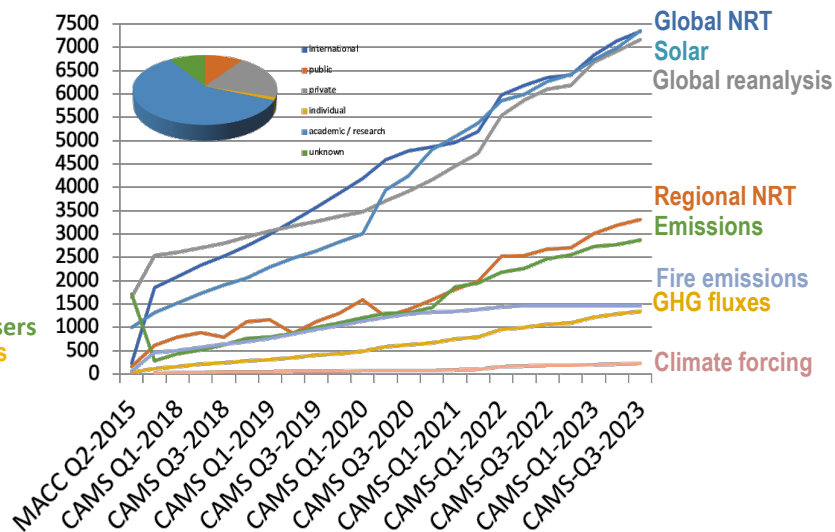
ACTIVE USERS DURING Q3 2023

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)

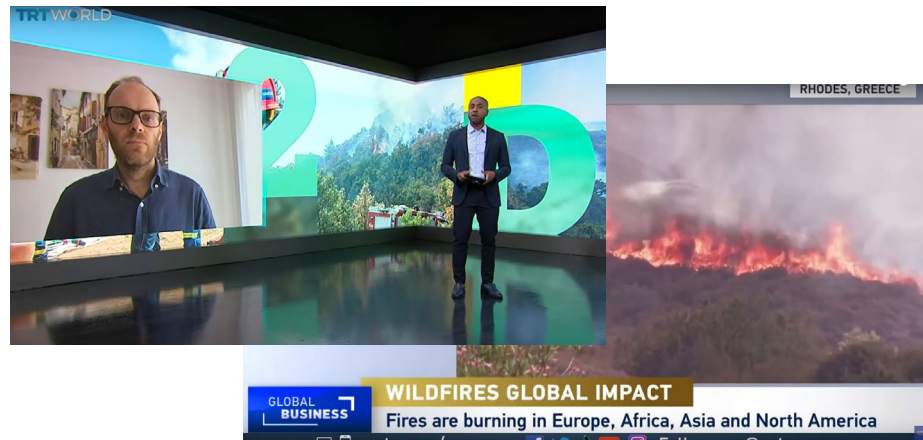
Media

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

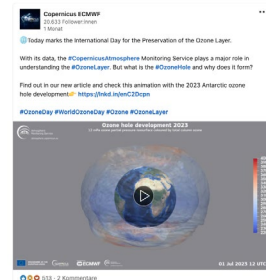
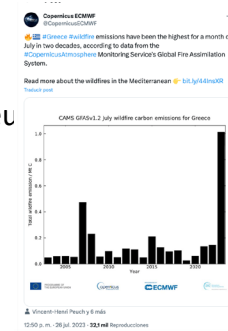
- **128k** page views
- **68.7k** users

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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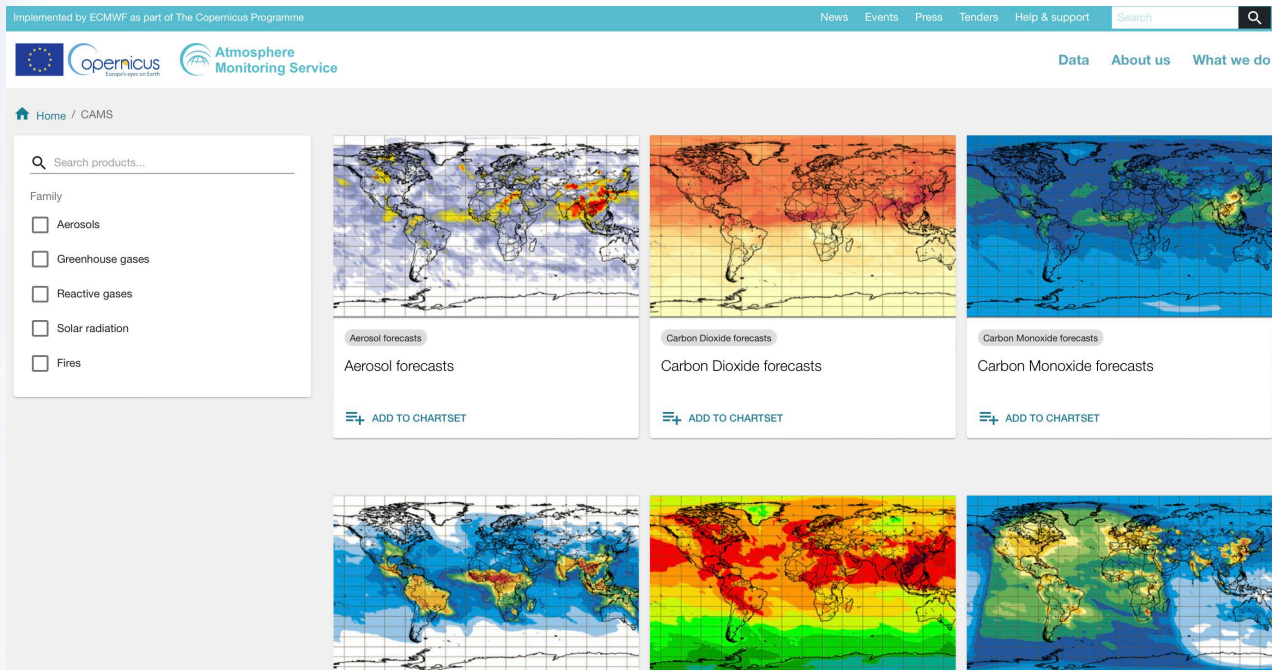


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<https://atmosphere.copernicus.eu/charts/packages/cams/>





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WHAT'S THE SITUATION TODAY?

Particulate matter forecasts

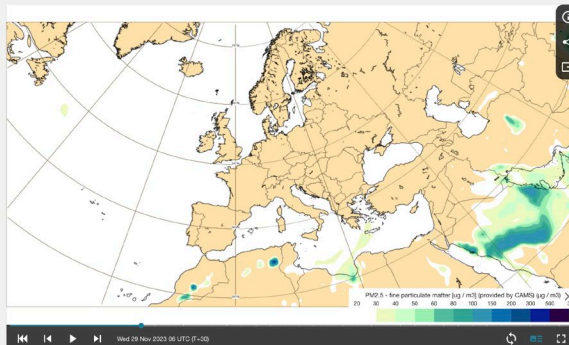
Forecasts

Base time
Tue 28 Nov 2023 00 UTC

Valid time
Wed 29 Nov 2023 06 UTC (T+30)

Area
Europe

Parameter
PM2.5



Ozone forecasts

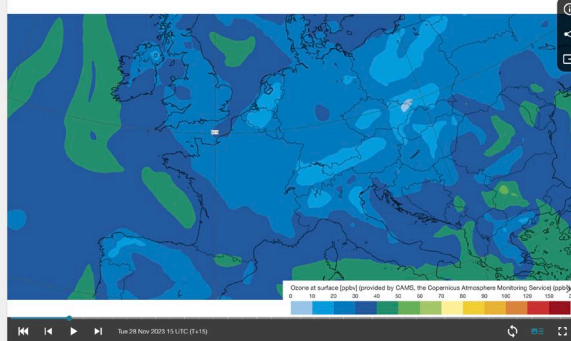
Forecasts

Base time
Tue 28 Nov 2023 00 UTC

Valid time
Tue 28 Nov 2023 15 UTC (T+15)

Area
Central Europe

Level
Surface

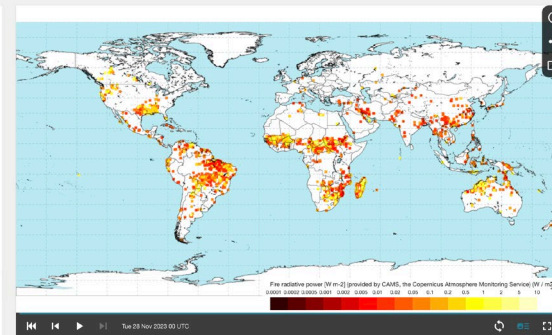


Fire activity analyses

Analyses

Time
Tue 28 Nov 2023 00 UTC

Area
Global



Aerosol forecasts

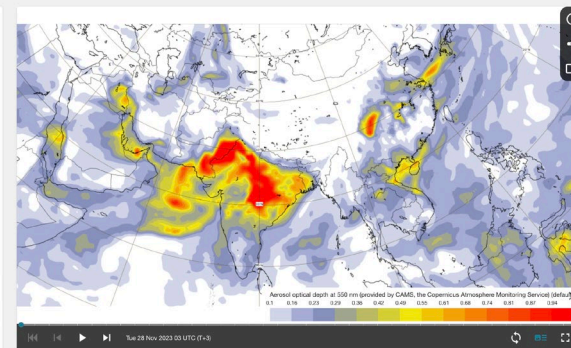
Forecasts

Base time
Tue 28 Nov 2023 00 UTC

Valid time
Tue 28 Nov 2023 03 UTC (T+3)

Area
Southern Asia

Aerosol type
Total aerosol



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A NEW INTERFACE UNVEILED FOR EUROPEAN AIR QUALITY

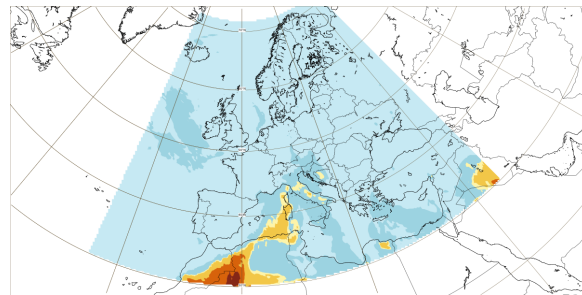
CAMS has introduced **a revamped interface for the European air quality forecasts**. The look and feel of the charts changes, with new intuitive navigation features in line with the global forecasts interface.

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.

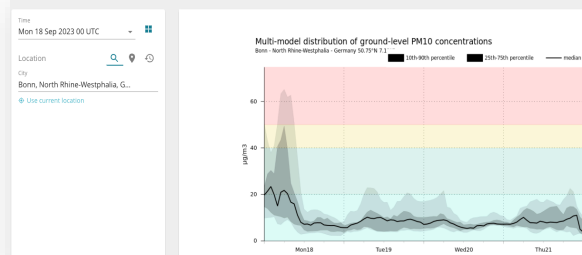
This is available here:

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

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



CAMS PM10 plume



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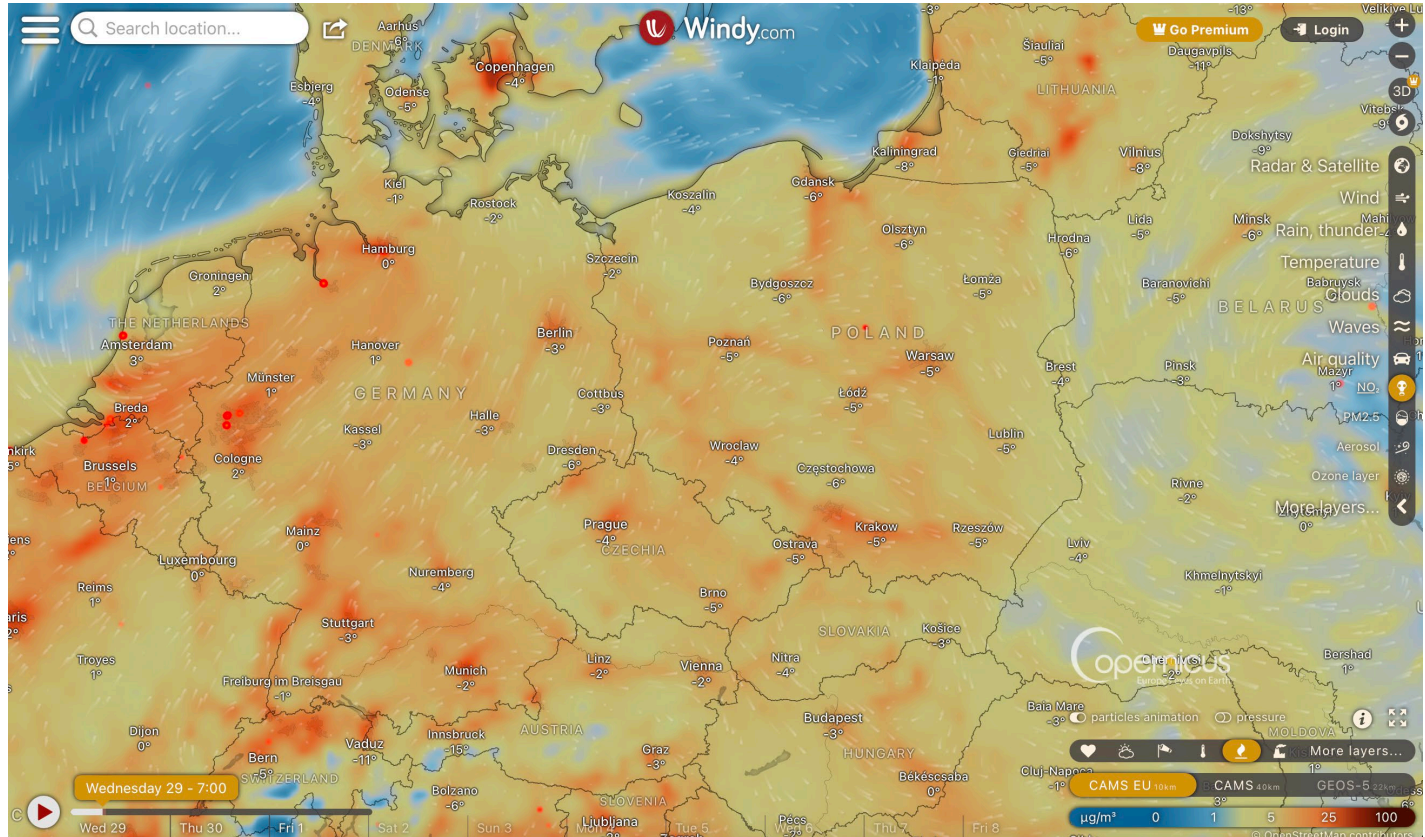




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CAMS INFORMATION IS AVAILABLE ON MANY PLATFORMS

<https://www.windy.com>





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TRAINING ACTIVITIES

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

CAMS Training

Search this book...

Copernicus Atmosphere Monitoring Service (CAMS) Data Tutorials

DATA ACCESS TUTORIALS

Atmosphere Data Store (ADS) Tutorial

Import, Reduce, Export

DATA VISUALISATION TUTORIALS

Maps

Animations

Time Series

Profile Plots and Zonal Means

DATA PROCESSING TUTORIALS

European Air Quality Index Calculation

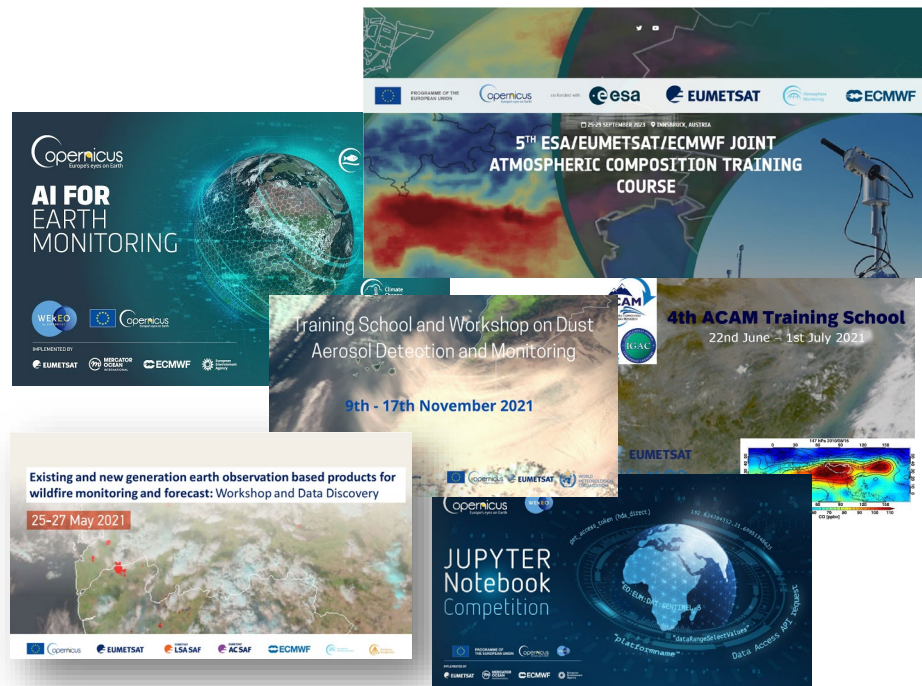
Antarctic Ozone Hole Monitoring

CLIMATE DATA PROCESSING

Tutorials from the Copernicus Climate Change Service (C3S) &

Powered by Jupyter Book

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)

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

The screenshot shows the homepage of the Atmosphere Data Store (ADS). At the top, there is a navigation bar with logos for the European Union, Copernicus, ECMWF, and the Atmosphere Monitoring Service. Below the navigation bar, the text "Atmosphere Data Store" is displayed. A green message states: "To improve our service, we need to hear from you! Please complete this very short survey or, Thank you." The main content area features a large heading "Welcome to the Atmosphere Data Store" followed by a subheading "Dive into this wealth of information about the Earth's past, present and future Atmosphere." Below this, a paragraph explains that the ADS is freely available and functions as a one-stop shop to explore Atmosphere data, with a link to "Register for free" to obtain access. It also mentions that the ADS is constantly improving and adds new datasets, with a link to "watch the posts on the CAMS forum or." A search bar is located below the text, with the placeholder "Enter search term(s)", a dropdown menu set to "All", and a "Search" button. At the bottom, there are three featured links: "Atmosphere Data Store API" (with a code snippet), "Access the ECMWF Support Portal" (with a blue brain icon), and "Access the CAMS website" (with a dandelion icon and a quote about providing essential and quality-controlled information related to air pollution and health, solar energy, greenhouse gases and climate forcing, everywhere in the world).

Home Search Datasets Support

Atmosphere Data Store

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

Welcome to the Atmosphere Data Store

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

It is freely available and functions as a one-stop shop to explore Atmosphere data. [Register for free](#) to obtain access to the ADS.

We are constantly improving the services and adding new datasets. For latest announcements, watch the posts on the [CAMS forum](#) or.

Enter search term(s) All Search

Atmosphere Data Store API

Access the ECMWF Support Portal

Access the CAMS website



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ADS: AVAILABLE DATA SETS



Home Search Datasets Support

Search results

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



All Datasets

Sort by

Relevancy


Title


Product type


Variable domain


Spatial coverage


Temporal coverage


 **CAMS global emission inventories**
This data set contains gridded distributions of global anthropogenic and natural emissions. Natural and anthropogenic emissions of atmospheric pollutants and greenhouse gases are key drivers of the evolution of the composition of the atmosphere, so an accurate representation of them in forecast models of atmospheric composition is essential. CAMS compiles inventories of emission data that serve as...


 **CAMS global greenhouse gas reanalysis (EGG4)**
This dataset is part of the ECMWF Atmospheric Composition Reanalysis focusing on long-lived greenhouse gases: carbon dioxide (CO₂) and methane (CH₄). The emissions and natural fluxes at the surface are crucial for the evolution of the long-lived greenhouse gases in the atmosphere. In this dataset the CO₂ fluxes from terrestrial vegetation are modelled in order to simulate the variability across a ...


 **CAMS global greenhouse gas reanalysis (EGG4) monthly averaged fields**
This dataset is part of the ECMWF Atmospheric Composition Reanalysis focusing on long-lived greenhouse gases: carbon dioxide (CO₂) and methane (CH₄). The emissions and natural fluxes at the surface are crucial for the evolution of the long-lived greenhouse gases in the atmosphere. In this dataset the CO₂ fluxes from terrestrial vegetation are modelled in order to simulate the variability across a ...

 **CAMS global radiative forcings**
This dataset provides geographical distributions of the radiative forcing (RF) by key atmospheric constituents. The radiative forcing estimates are based on the CAMS reanalysis and additional model simulations and are provided separately for... carbon dioxide methane tropospheric ozone stratospheric ozone interactions between anthropogenic aerosols and radiation interactions between anthropoge...

 **CAMS global radiative forcing - auxilliary variables**
This dataset provides aerosol optical depths and aerosol-radiation radiative effects for four different aerosol origins: anthropogenic, mineral dust, marine, and land-based fine-mode natural aerosol. The latter mostly consists of biogenic aerosols. The data are a necessary complement to the "CAMS global radiative forcings" dataset (see "Related Data"). The calculation of aerosol radiative forcing...

 **CAMS global reanalysis (EAC4) monthly averaged fields**
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 numer...

 **CAMS global reanalysis (EAC4)**
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 numer...

 **CAMS global inversion-optimised greenhouse gas fluxes and concentrations**
This data set contains net fluxes at the surface, atmospheric mixing ratios at model levels, and column-mean atmospheric mixing ratios for carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O). Natural and anthropogenic surface fluxes of greenhouse gases are key drivers of the evolution of Earth's climate, so their monitoring is essential. Such information has been used in particular as par...



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ADS: DATASET DESCRIPTION



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CAMS global reanalysis (EAC4)

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[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



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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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CAMS global reanalysis (EAC4)

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Overview Download data Documentation

- CAMS Reanalysis data documentation**
Overall description of CAMS Reanalysis dataset.
- Known issues**
Information about known issues found within the CAMS global reanalysis dataset
- Evaluation and quality assurance (EQA) reports**
Detailed validation reports
- Data citation**
Inness et al. (2019), <http://www.atmos-chem-phys.net/19/3515/2019/>

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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:DATA DOWNLOAD

The screenshot displays the ADS:DATA DOWNLOAD interface for the CAMS global reanalysis (EAC4) dataset. The page includes a header with logos for the European Union, Copernicus, ECMWF, and the Atmosphere Monitoring Service. A navigation bar contains links for Home, Search, Datasets, and Support. The main content area is titled "CAMS global reanalysis (EAC4)" and includes a message: "To improve our service, we need to hear from you! Please complete this very short survey or. Thank you." Below this, there are tabs for Overview, Download data, and Documentation. A "Fast vs slow data" section provides a warning: "PLEASE NOTE: any data labelled as 'slow access' is stored on tape instead of disk. Retrieval of this data will be MUCH SLOWER than disk-resident data. You should not select any tape-resident data unless absolutely required for your purposes." The "Surface data" section states: "To obtain surface values of three dimensional (multi-level) variables, select the variable required and model level 60." The "Variable" section has a dropdown menu with options: Single level, Multi level, and Slow access. The "Pressure level" section has a grid of checkboxes for various pressure levels: 1 hPa, 2 hPa, 3 hPa, 5 hPa, 7 hPa, 10 hPa, 20 hPa, 30 hPa, 50 hPa, 70 hPa, 100 hPa, 150 hPa, 200 hPa, 250 hPa, 300 hPa, 400 hPa, 500 hPa, 600 hPa, 700 hPa, 800 hPa, 850 hPa, 900 hPa, 925 hPa, and 950 hPa. The "Model level" section has a dropdown menu. On the right side, there is a "Contact" section with links for ECMWF Support Portal, Licence, and Licence to use Copernicus Products. Below this is a "Publication data" section. A "mass concentration of pm2p5 ambient aerosol in air" plot is shown, displaying a map of Europe with a color scale from 0 to 30. The plot is titled "mass concentration of pm2p5 ambient aerosol in air" and has a color bar labeled "CB_Red5_08.cpt".

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



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AND IF YOU NEED VIRTUAL MACHINES... THERE IS WEKEO

<https://www.wekeo.eu>

The screenshot shows the WEkEO website homepage. The header is dark blue with the European Union flag and Copernicus logo on the left, and navigation links (SERVICES, DATA, COMPUTING, USE CASES, SUPPORT, REGISTER, SIGN IN, and a search icon) on the right. The main banner features a satellite image of a coastal area with the text "Copernicus and Sentinel data at your fingertips" and three buttons: "Explore data", "Our services", and "Expert support". On the right side, there are two news items: "Events: WEkEO – Hydrology studies in a Changing Climate" dated Mar. 14th 14:00 CET, and "News: How users help shape WEkEO and its products offer: an introduction to the Champion User Advisory Group (CUAG)" dated April 13, 2023.



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USER SUPPORT

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 >



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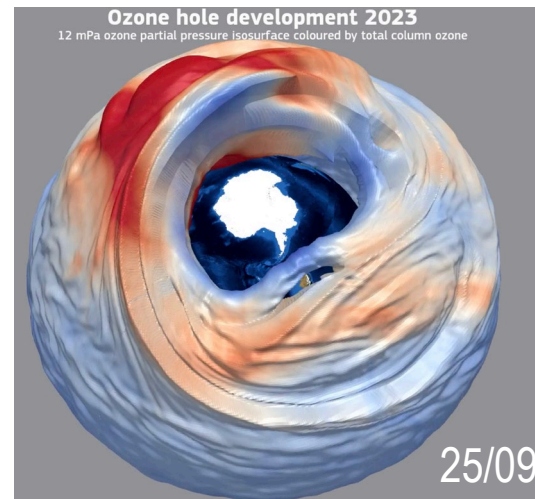
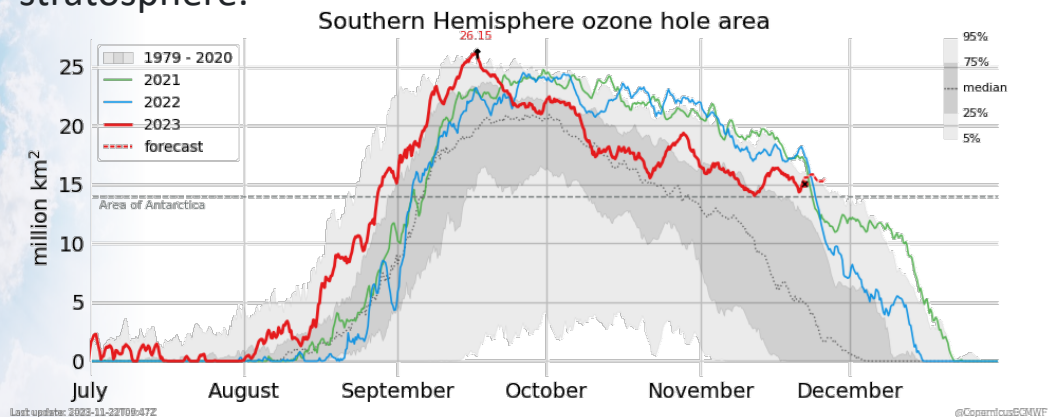
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TWISTS AND TURNS OF THE 2023 OZONE HOLE

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:

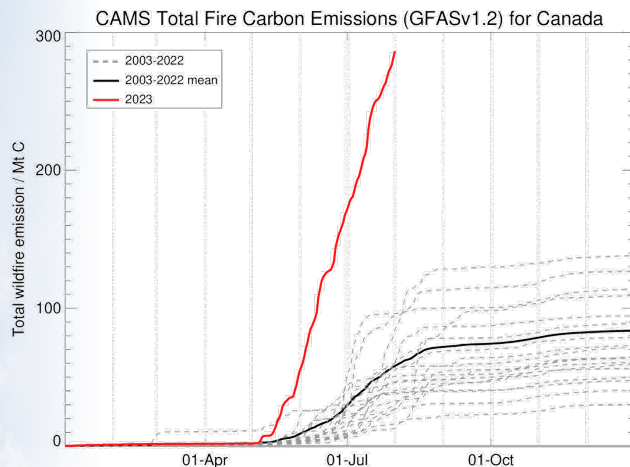
<https://atmosphere.copernicus.eu/twists-and-turns-2023-southern-hemisphere-ozone-hole>



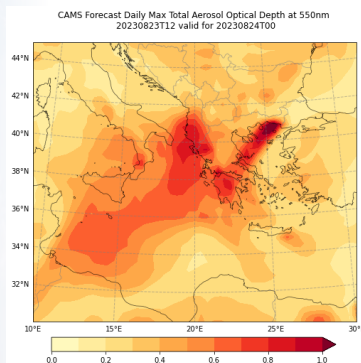


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RECORD-BREAKING BOREAL WILDFIRE SEASON 2023



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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 CO₂ 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 led to a number of interviews (including live ones).

See details here:

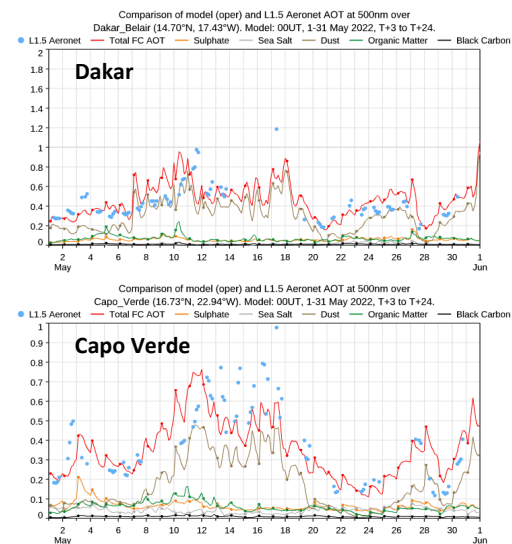
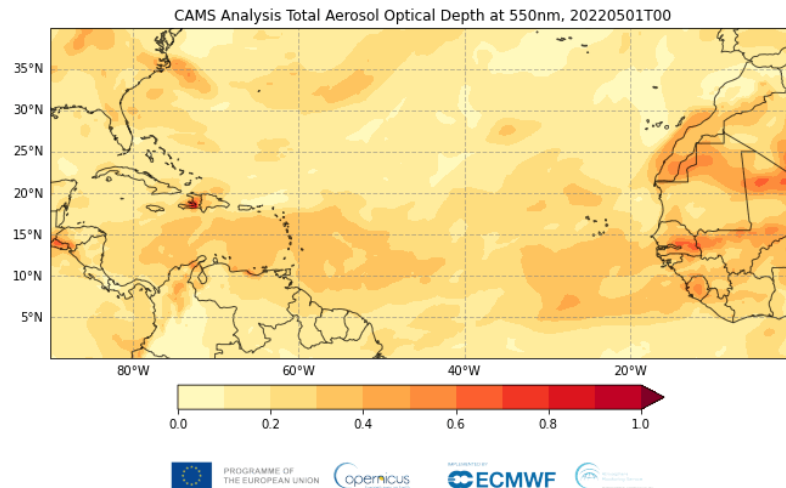
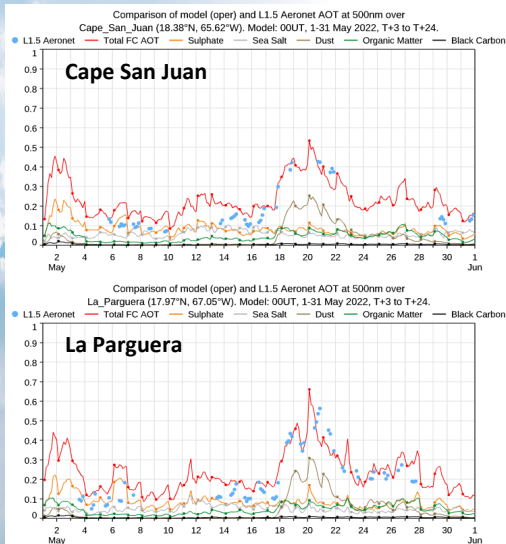
<https://atmosphere.copernicus.eu/record-breaking-boreal-wildfire-season>

and: <https://atmosphere.copernicus.eu/august-wildfires-ravage-northern-central-greece>



EX. SAHARAN DUST EVENTS (MAY 2022)

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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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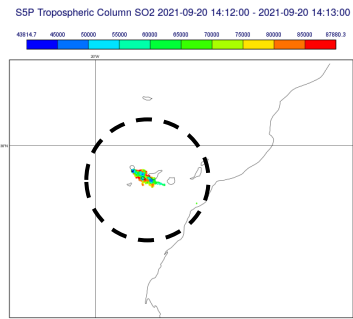
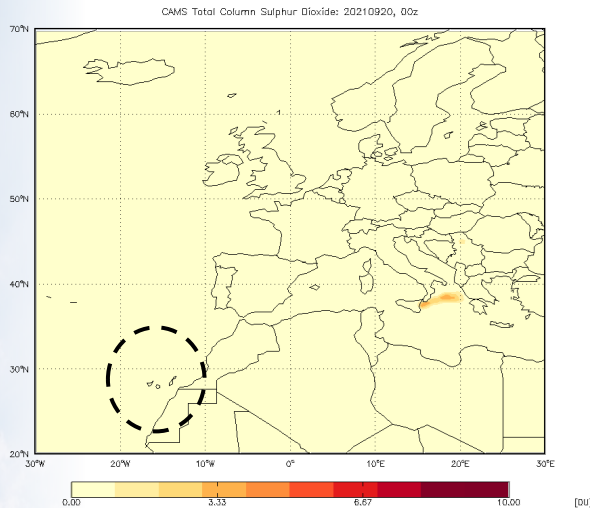


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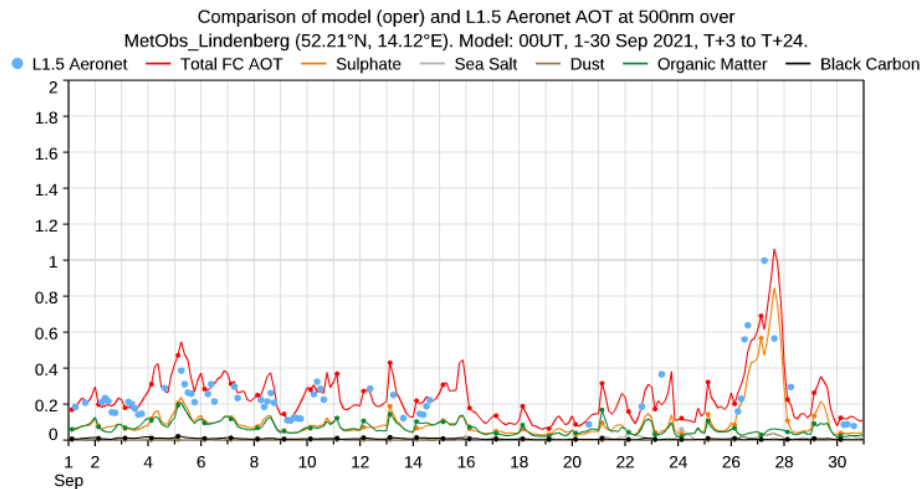




EX. VOLCANIC ERUPTIONS (SEPTEMBER 2021)



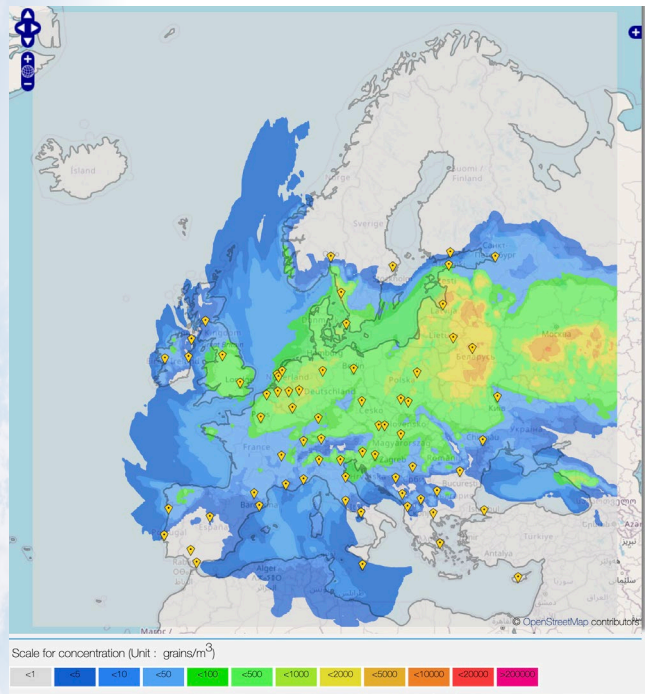
- Cumbre Vieja volcano on La Palma erupted on 19 September 2021 for first time since 1971
- First SO₂ detections from **GOME-2** & **S-5P** assimilated in IFS at 06z on 20 September (layer height ~550 hPa)
- Initial transport to the NW across N Africa, Europe and Mediterranean



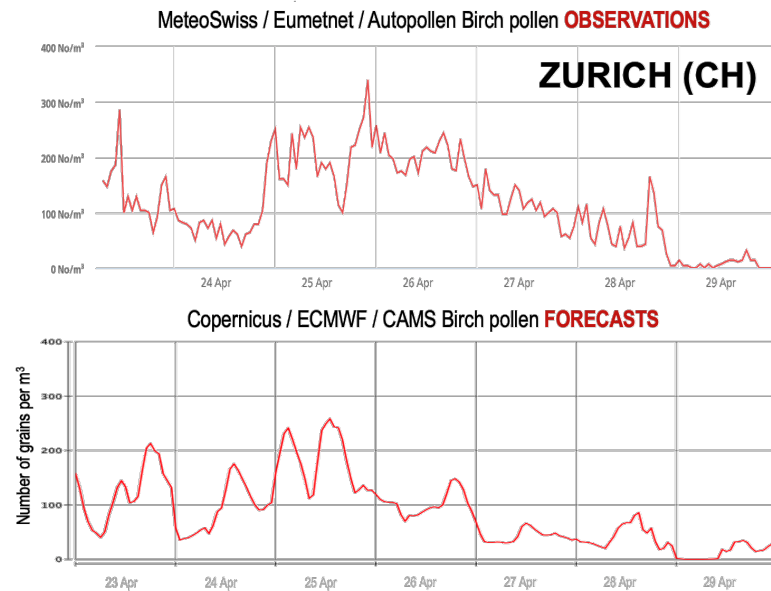


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POLLEN FORECASTS & NEAR-REAL-TIME EVALUATION



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



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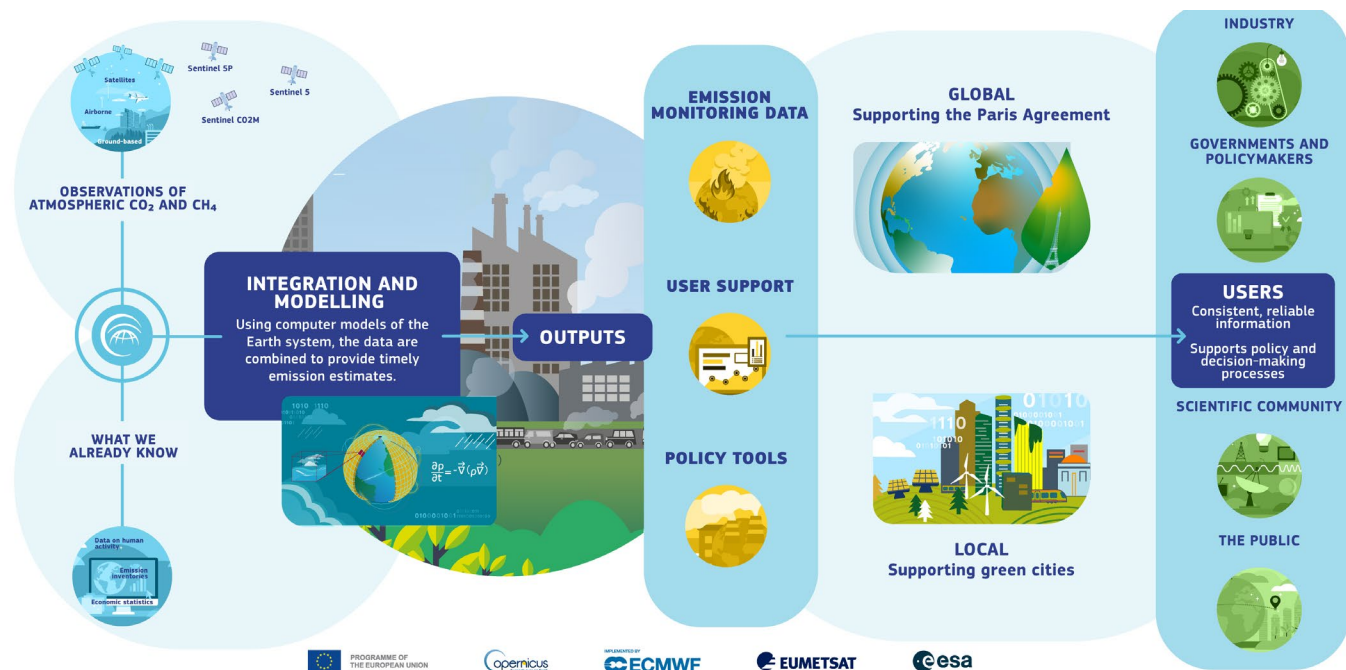




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CAMS NEW FRONTIER: OBSERVATIONS BASED EMISSIONS

Main target is anthropogenic CO₂, 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

*From expert groups through
dedicated research funding,
to operational services*



Sentinel 5p

CO₂ TASK FORCE
GUIDANCE DOCUMENTS



2015



2017



2019

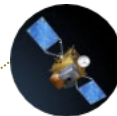
2018



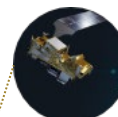
2017



SATELLITE MISSIONS



Sentinel 4



Sentinel 5



CO₂ Mission

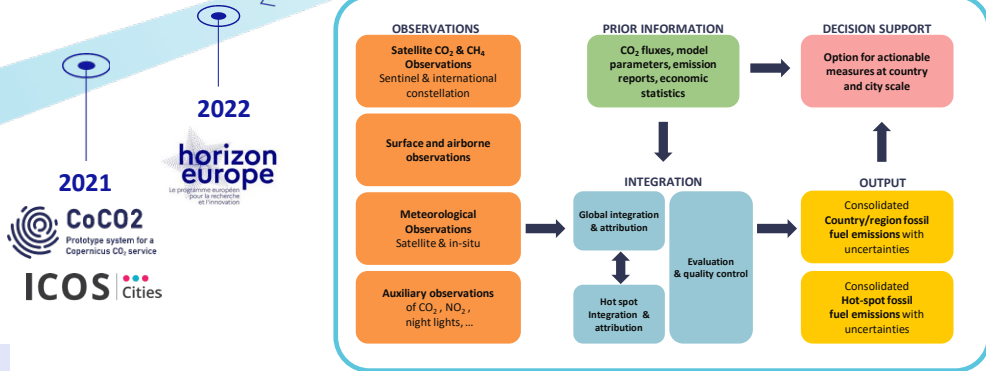
Air Quality emissions
2025

Operational
ramp-up in CAMS

SERVICE
COMPONENTS

2026

CO₂ Monitoring & Verification Support (CO₂MVS)



2022



2021



RESEARCH AND
PREPARATORY
PROJECTS



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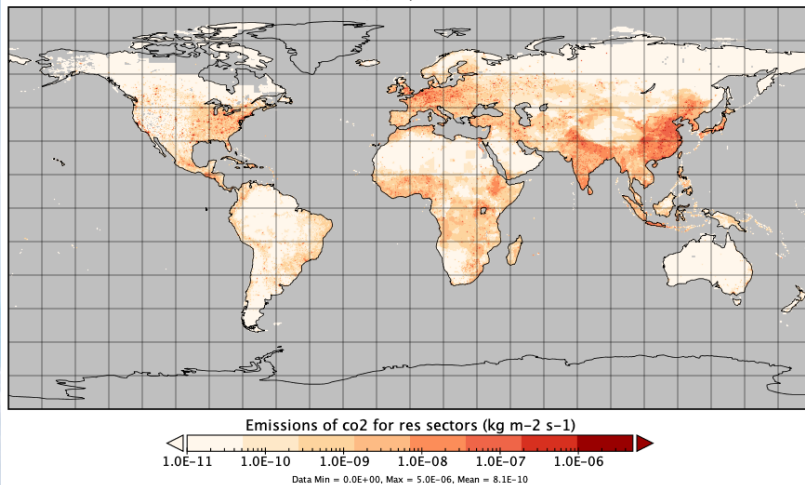
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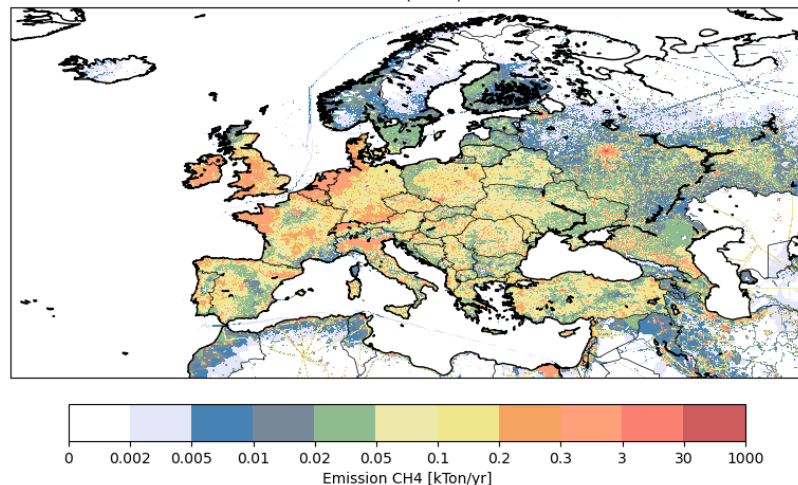


CAMS CURRENT PRODUCTS: EMISSION INVENTORIES

Emissions of CO₂ for residential, commercial, and other combustion sectors
January 2020



Total (2021)



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).



CARBON MONITOR NOW CONTRIBUTES TO CAMS

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Carbon Monitor provides **one of the most advanced and CO₂ 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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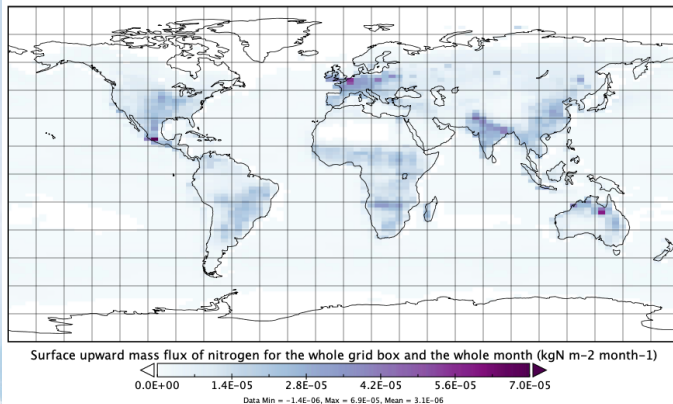




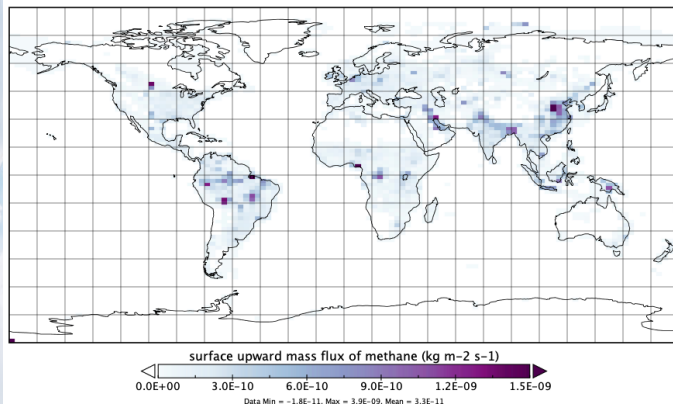
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CAMS CURRENT PRODUCTS: ATMOSPHERIC INVERSION DATA

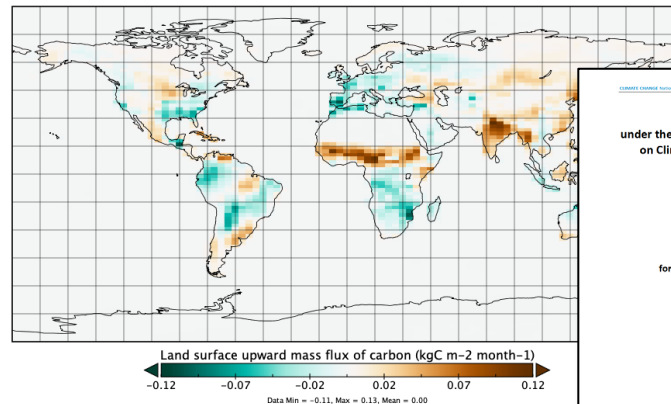
Surface upward mass flux of nitrogen



Surface upward mass flux of methane



Land surface upward mass flux of carbon without fossil fuel



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



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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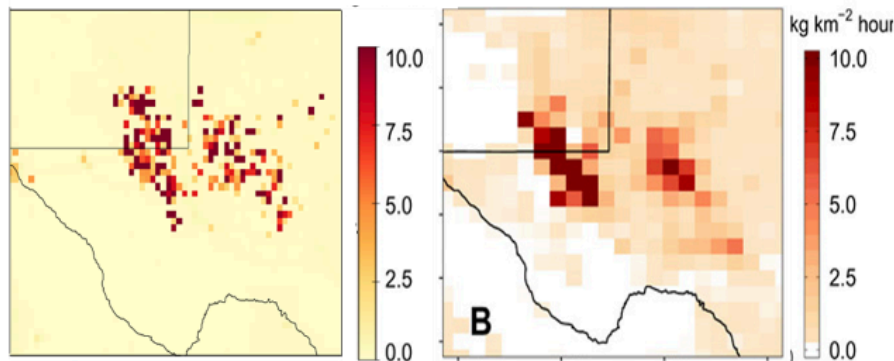
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PROGRESS WITH OBSERVATIONS-BASED EMISSIONS

CH₄ inversion over Permian Basin IFS posterior Zhang et al.

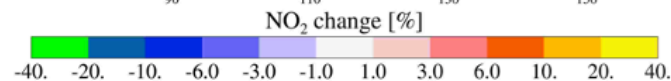
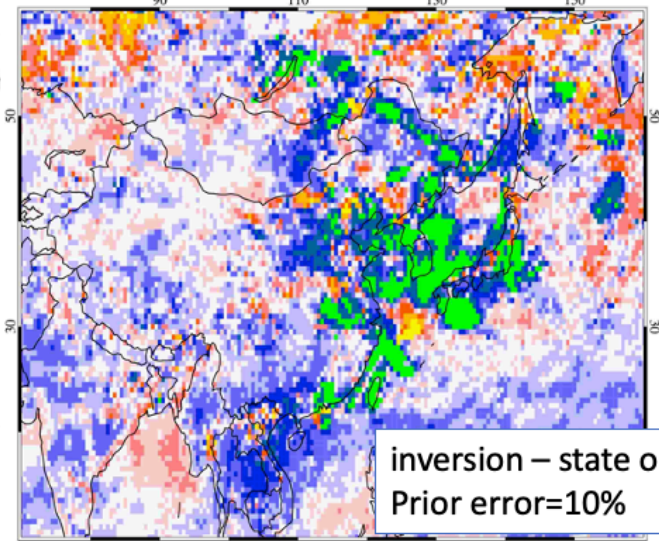


- CH₄ inversion results in agreement with previous studies.
- NO_x inversion results show small improvements over Southeast Asia (ongoing prior errors sensitivity tests).

CoCO2 – Prototype system for a Copernicus CO₂ service

NO_x inversion (04/2020)

% rms change for i1fb (std=0.1) vs hyl8 (ctrl)



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





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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>



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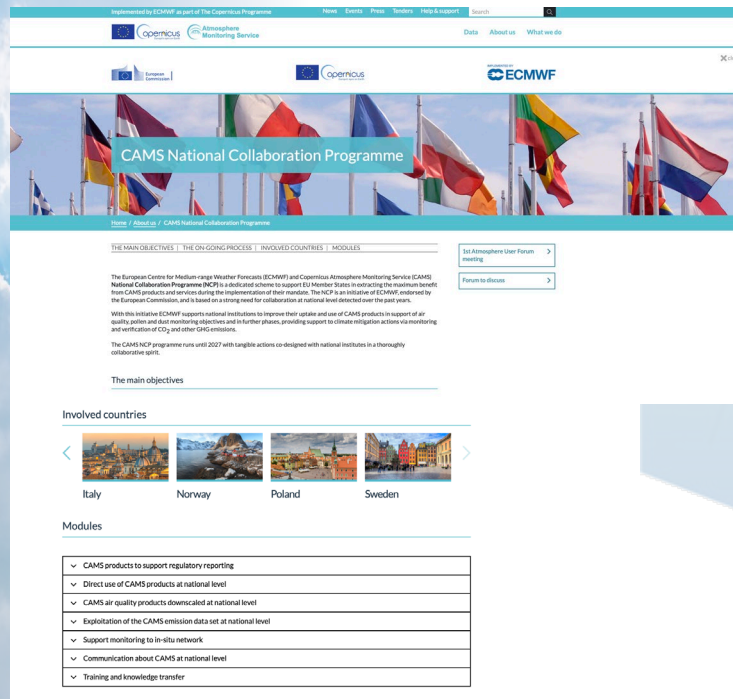
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CAMS NATIONAL COLLABORATION PROGRAMME (NCP)



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 different topics

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



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LOOKING BACK AT CAMS 1.0

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 Bousset, 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 Marcella, 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 CO₂ 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

<https://doi.org/10.1175/BAMS-D-21-0314.1>

Corresponding author: Vincent-Henri Peuch, vincent-henri.peuch@ecmwf.int

In final form 15 August 2022

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BAMS

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DECEMBER 2022, E2650

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.

<https://doi.org/10.1175/BAMS-D-21-0314.1>



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