Global Air Quality in 2020: Monitoring the Impacts of Wildfires and COVID-19



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COPERNICUS AND ECMWF

Atmosphere Monitoring



Observations feeding into value-added Services

Sentinels

Copernicus is the European Union's operational Earth Observation and Monitoring programme, looking at our planet and its environment for the ultimate benefit of all citizens.

User-driven with free and unrestricted data access

Service is implemented by ECMWF ECWMF is contributing to the Service





What the Copernicus Atmosphere Monitoring Service has to offer

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- The CAMS portfolio includes Earth Observation based information products about:
- past, current and near-future (forecasts) global atmospheric composition;
- the ozone layer;
- air quality in Europe;
- emissions and surface fluxes of key pollutants and greenhouse gases;
- solar radiation;
- climate radiative forcing.

This is delivered by a large European consortium (196 entities through 75 contracts).

https://atmosphere.copernicus.eu

opernicus European



Why is CAMS needed?



Example: NO₂ tropospheric column from Copernicus Sentinel-5P (31/10/2018)

Observations are essential, but **direct use** is generally **limited**:

- gaps in space and time
- observed quantities may not be directly relevant (vertical column vs surface concentration)
- can be complex and numerous

What CAMS does:

- blend observations (satellite and non satellite) with model to provide a consistent 3D state
- forecasts, a few days ahead
- reanalyses over past years or decades



CAMS Information Flow











IFS 40km (oper) / 80km (rean) Globe

CAMS main operational data assimilation and modelling systems





CAMS in action: Monitoring the Antarctic Ozone Hole



Reanalysis in action: 4 Decades of the Antarctic Ozone Hole

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42 years of Antarctic ozone hole data merging ERA-5 and CAMS Reanalysis data

Reanalysis



Using a combination of observations and computer models to recreate historical climate conditions.

ECON European Commission

CAMS in action: Monitoring Boreal and Arctic Wildfires

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Daily Total Fire Radiative Power for the Arctic Circle

June-August Total Wildfire CO₂ Emission for the Arctic Circle



mmission

- Global wildfires are monitored in near-real-time based on satellite observations of active fires (currently MODIS instruments on the NASA Terra and Aqua satellites).
- Daily total wildfire emissions were well above the 2003-2018 average throughout the summer north of the Arctic Circle - majority concentrated in Sakha Republic/Chukotka Autonomous Oblast, Russia.

Hemispheric smoke transport

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- CAMS provides information on a number of smoke-related tracers.
- Animation shows analyses (model + observations combined) of organic matter aerosol optical depth from 1 June to 30 September 2020.
- Smoke from wildfires in Siberia and within the Arctic Circle generally accumulated and recirculated over the region through the summer with some long-range transport across the north Pacific and Arctic Ocean.
- Note smoke from California and Colorado wildfires in September crossing North America and the North Atlantic.



Air quality impacts of high latitude wildfires

Atmosphere Monitoring CAMS global reanalysis of atmospheric composition: https://ads.atmosphere.copernicus.eu/cdsapp#!/dataset/cams-global-reanalysis-eac4?tab=overview



 Climatology of surface PM2.5 concentration shows very limited low impact of wildfires on air quality in Siberian Arctic.

European

• Anomalies for 2019 and 2020 show direct impact of high latitude wildfires on surface air quality as activity increases and expands poleward.



CAMS in action: CAMS COVID-19 Minisite

Atmosphere https://atmosphere.copernicus.eu/european-air-quality-information-support-covid-19-crisis

Maps and animations of the latest situation in Europe.

Forecast model estimate of reduction in air pollution is expected on a daily basis accounting for weather effects.



concentration may



Air pollution across Europe compared to 2017-2019 and as a function of lockdown measures.

How consistent are surface and satellite measurements?

CAMS currently contributes to a number of epidemiological studies trying to evaluate the links between air pollution and COVID-19 (effects of long- and short-term exposure; fine particulate matter as a potential vector in air for the virus?...)

曲 2020-05-11

NO2

Covid lockdow
Difference

Color scale upper limi

Reset cache

Reference Air Quality Simulation

CAMS regional air quality forecasts: Météo-France, Ineris (FR) CAMS COVID-19 scenario forecasts: Ineris (FR) CAMS website: ECMWF



S5P NO2 European Lockdown Overview

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Many extratropical storms and strong positive T anomaly in Feb-Mar 2020

European

c/o Jerome Barre (ECMWF)



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c/o Jerome Barre (ECMWF)

Impact of meteorology

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- Changes in satellite observed NO₂ tropospheric column sampled over urban areas (population > 0.5 M).
- 2020 minus 2019 for before (1 Feb -15 Mar) and during (16 Mar - 30 Apr) lockdown.

change (%) 50

25

Population

2 M

8 M

-25 d

-50 Q

- Strong reduction (up to -75%) in NO₂ during lockdown but also before lockdown when the meteorological conditions were very different.
 - Inter-annual variability in meteorology needs to be considered.
- Machine Learning algorithm (based on Jan-May 2019 meteorology and CAMS regional surface NO₂ analyses) to normalize metorology gives clearer picture of lockdown impact on European air quality.

European

Summary

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- ECMWF and the Copernicus Atmosphere Monitoring Service provides detailed information on global atmospheric composition and air quality.
- Combined information on wildfire activity, emissions and smoke transport monitors and provides context for pollution episodes in near-real-time.
 - 18 years of CAMS fire emissions and atmospheric composition reanalysis data help provide context for current wildfires.
 - The Arctic Circle has experienced increased number and duration of wildfires in 2019 and 2020 compared to previous years.
- Air quality analyses greatly benefit from combining meteorology and atmospheric composition.
 - Full understanding of changes in air quality due to COVID-19 restrictions requires detailed information on conditions.
- All Copernicus data are free and open for everyone to access.

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