COPERNICUS MONITORING ENVIRONMENTAL INDICATORS

4 EXAMPLES FROM CAMS

Vincent-Henri Peuch (ECMWF)

Atmosphere Monitoring

Copernicus for SDGs, International Agreements and Convention, 24/01/2018

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REASONS TO CARE ABOUT ATMOSPHERIC COMPOSITION

Presentation by O. Tarasova

Local < 100km | Regional 100-1000km | Global > 1000km

D. Jacob

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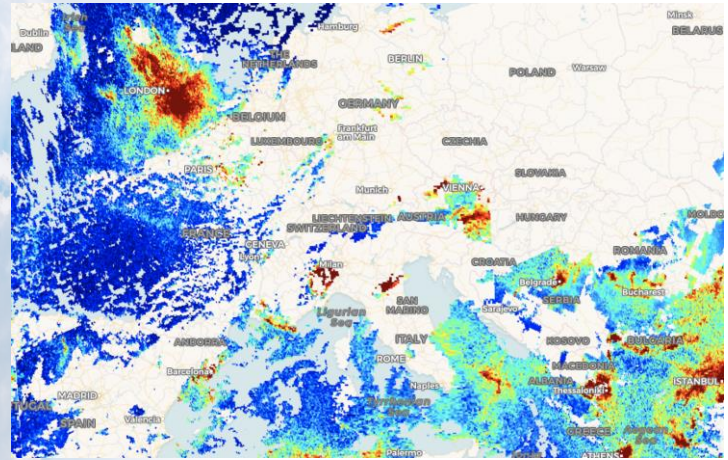
WHY INFORMATION SERVICES ARE NEEDED?

Exciting times for Earth Observation!



Example: NO_2 tropospheric column from Copernicus Sentinel-5P (17/01/2019)

Observations are essential, but direct use is limited:

- gaps in space and time
- observed quantities may not be directly relevant (vertical column vs nose-level concentration) or not representative (middle of a street…)

What services do:

- combine all observations with model to provide a consistent “picture”
- re-analyse observations from past periods with latest modelling tools
- Forecast/predict and provide additional info

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FOUR ACTUAL CAMS USE CASES

- 1. WMO, WHO and UNEP / on Air Quality and Health at the global scale
- 2. DG-CLIMA and WMO / on monitoring the ozone layer
- 3. DG-ENV, DG-JRC and EEA / on drivers of European air quality
- 4. WMO IG3IS and IPCC / on inverse modelling of surface fluxes of the main greenhouse gases

1. AIR QUALITY AND HEALTH

- WMO, WHO and UNEP / on Air Quality and Health at the global scale

- Exposure of population to fine particulate matter is assessed annually as part of the “Global Burden of Diseases” exercise.
- Work with Uni. Exeter (G. Shaddick, J. Salter et al.)

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WHY USING CAMS?

	Surface observations	Satellite observations	CAMS Reanalysis
Main Pro's	• Direct measurement of the relevant quantity (PM2.5 or PM10) • Precision & accuracy (if devices are well maintained though)	• Global spatial coverage (apart from clouds) • Temporal coverage, with a typical daily revisit cycle for Low-Earth-Orbiting satellites	• Global coverage • Hourly values • Combines optimally different source of observations using advanced modelling of atmospheric processes • Added model information
Main Con's	• Poor coverage in the developing world • Often only annual mean values are shared • Representativeness generally unknown • No source apportionment information • Lack of norms (height…)	• Indirect measurement (radiance), need for retrieval. And the geophysical quantity retrieved is generally integrated vertically (e.g. troposphere content) and it is very challenging to infer a near surface value from this • Precision & accuracy • Fairly low spatial resolution	• Low spatial resolution (currently 80km, NRT analyses 40km) • Influence of a priori information on emissions • Precision & accuracy

This work

- Downscale using population and land-use & elevation proxies
- Calibration using independent (non assimilated) surface observation

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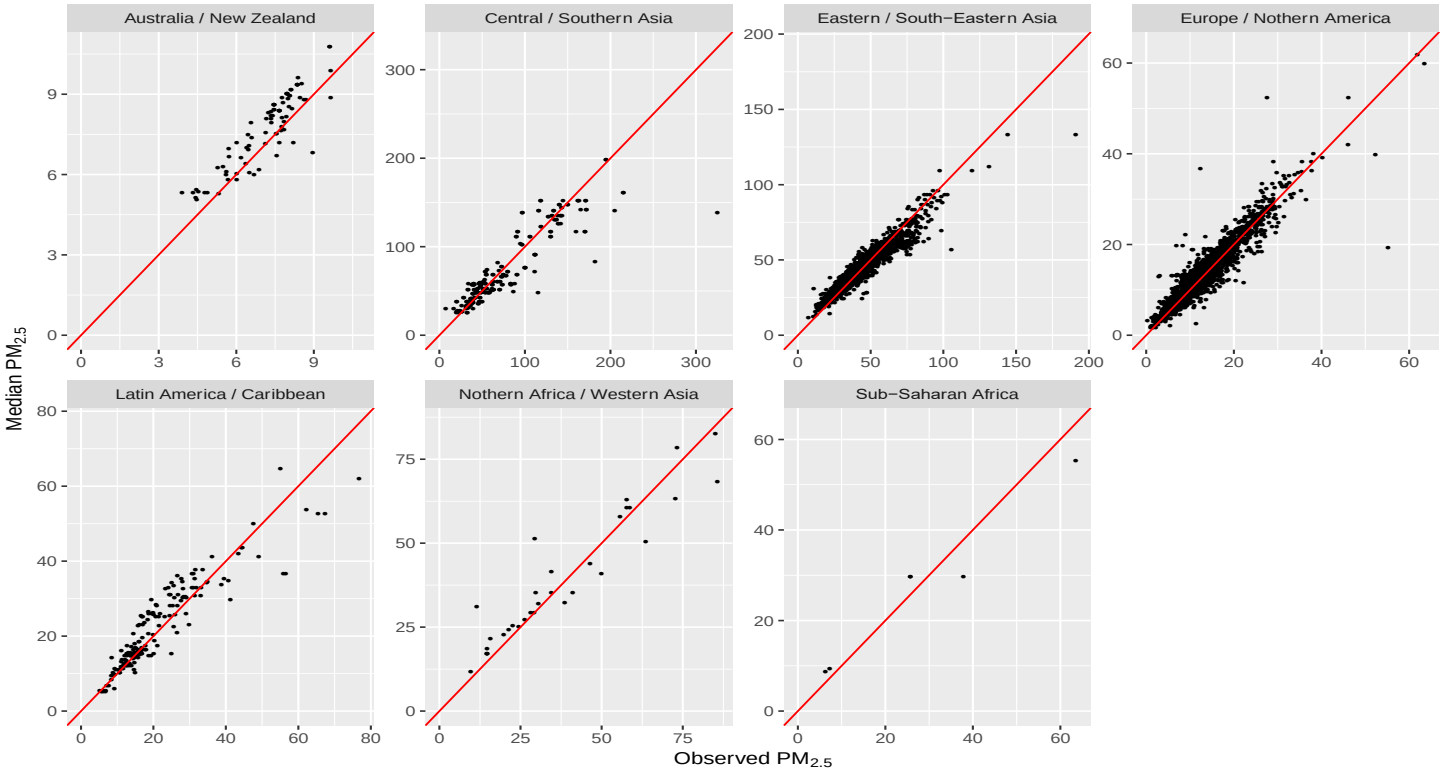
CALIBRATED CAMS AGAINST GROUND SENSORS



(J. Salter et al.)

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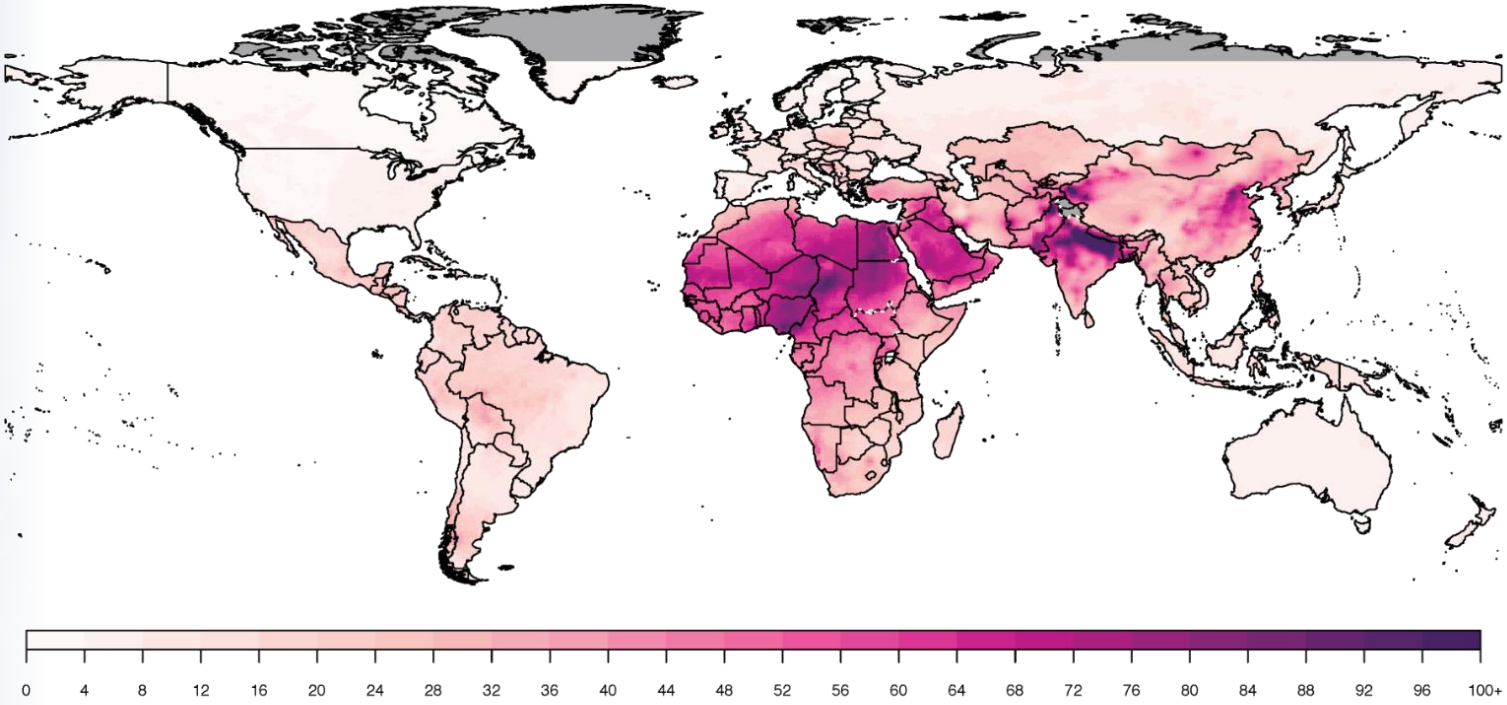
CALIBRATED CAMS 2016 MEAN PM2.5



(J. Salter et al.)

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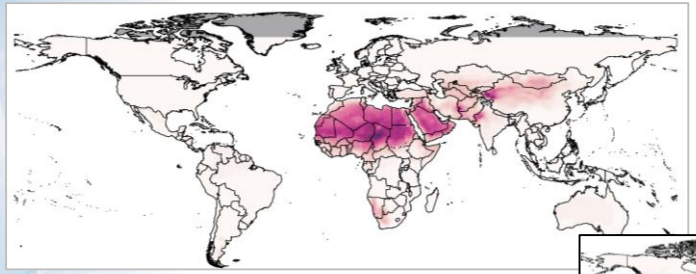
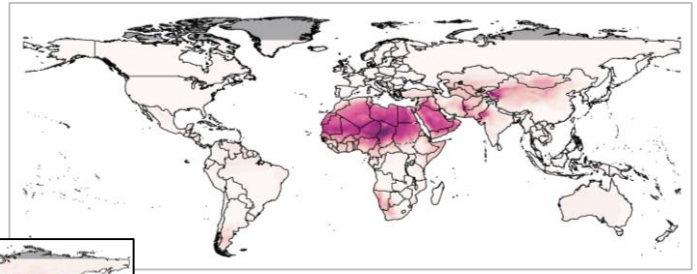
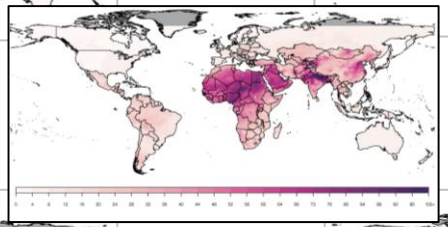
NEW (AND USEFUL) INSIGHTS ON PM

PM2.5 from dust

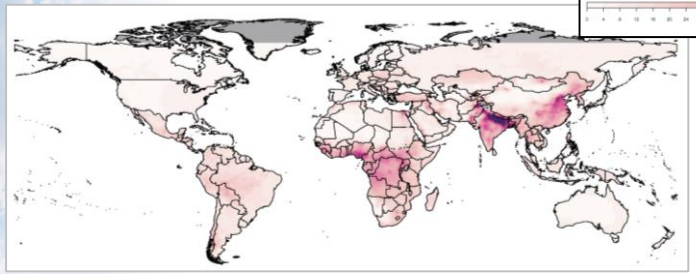


PM2.5 natural

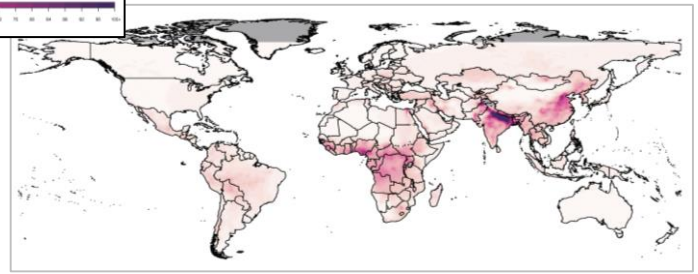




PM2.5 not from dust



PM2.5 anthropogenic



(J. Salter et al.)

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GLOBAL AIR QUALITY INFORMATION

nature

COMMENT

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PICTURE: ORSZAT

Smog envelopes Santiago in Chile.

Five steps to improve air-quality forecasts

A worldwide network for monitoring and modelling air pollution would reduce its dramatic toll on health and food production, urge **Rajesh Kumar** and colleagues.

Seven million people die every year from the effects of air pollution. More than 90% of such deaths are in developing countries[1]. Across southern Asia, levels of fine particulate matter ($PM_{2.5}$) and surface ozone exceed the World Health Organization (WHO) limits for much of the year[2]. Ozone damage to crops and plants — especially to soya beans, wheat and maize (corn) — results in 79 million to 121 million tonnes of lost produce globally, at a cost of US $11 billion to $18 billion3. India's crop losses alone would feed 94 million people[4]. All this costs the world's economy US$5 trillion per year[5].

But air pollution often goes unmonitored. Some of the fastest growing cities in Africa, including Lagos, Kinshasa, Abidjan and Dakar, have no air-quality alert systems. Governments can be reluctant to acknowledge the problem or lack the tools to address it. There is no international strategy for dealing with the issue. And few people are trained in how to collect and interpret air-quality data.

Improvements can take decades. It took the US city of Atlanta 15 years to reduce emissions from power plants by around 80% and from traffic by up to 90%, saving more than 50,000 hospital visits for asthma and lung diseases (ref. 6). Los Angeles took 50 years to reduce ozone levels by two-thirds[7].

Forecasts of hazardous air pollution are crucial to help reduce exposure. Vulnerable people can avoid strenuous outdoor ▶

6 SEPTEMBER 2018 | VOL 561 | NATURE | 27

The Weather Channel

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2. RECOVERY OF THE OZONE LAYER

- DG-CLIMA and WMO / on monitoring the ozone layer
- Vienna Convention, Montreal protocol
- Context: banned emissions of Ozone Depleting Substances (but needs to be enforced: CFC-11 detected in 2018…); climate change and ozone layer interactions
- Key strength of ECMWF/CAMS system (no equivalent regarding amount of data used)

MONITORING THE OZONE LAYER FOR THE EU

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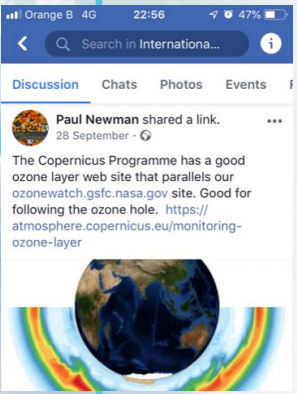
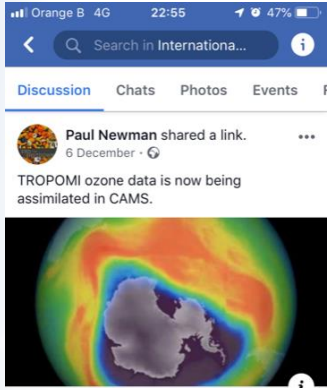
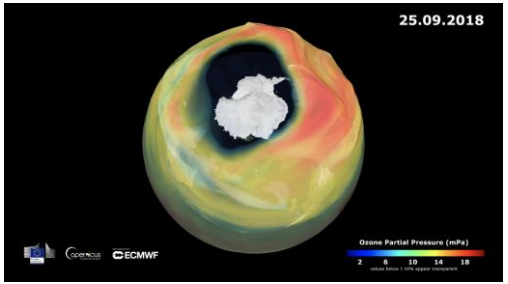
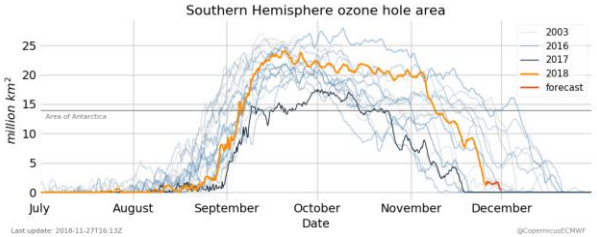
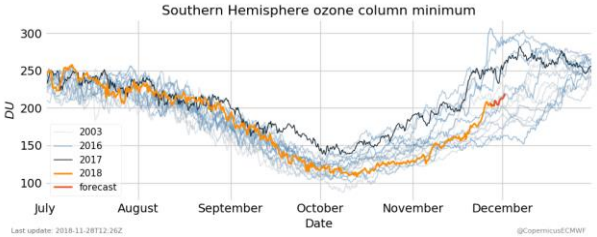
CAMS webpage in support of DG-CLIMA on the ozone layer

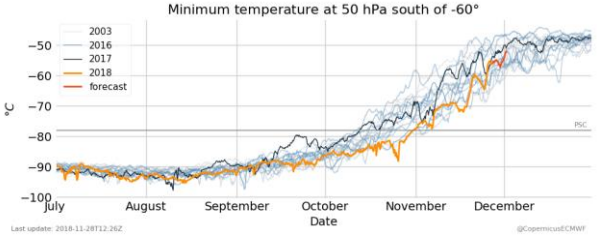


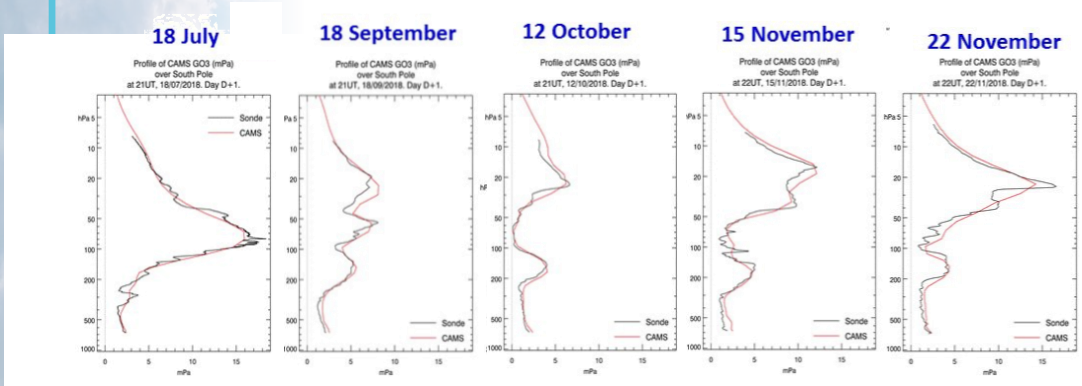












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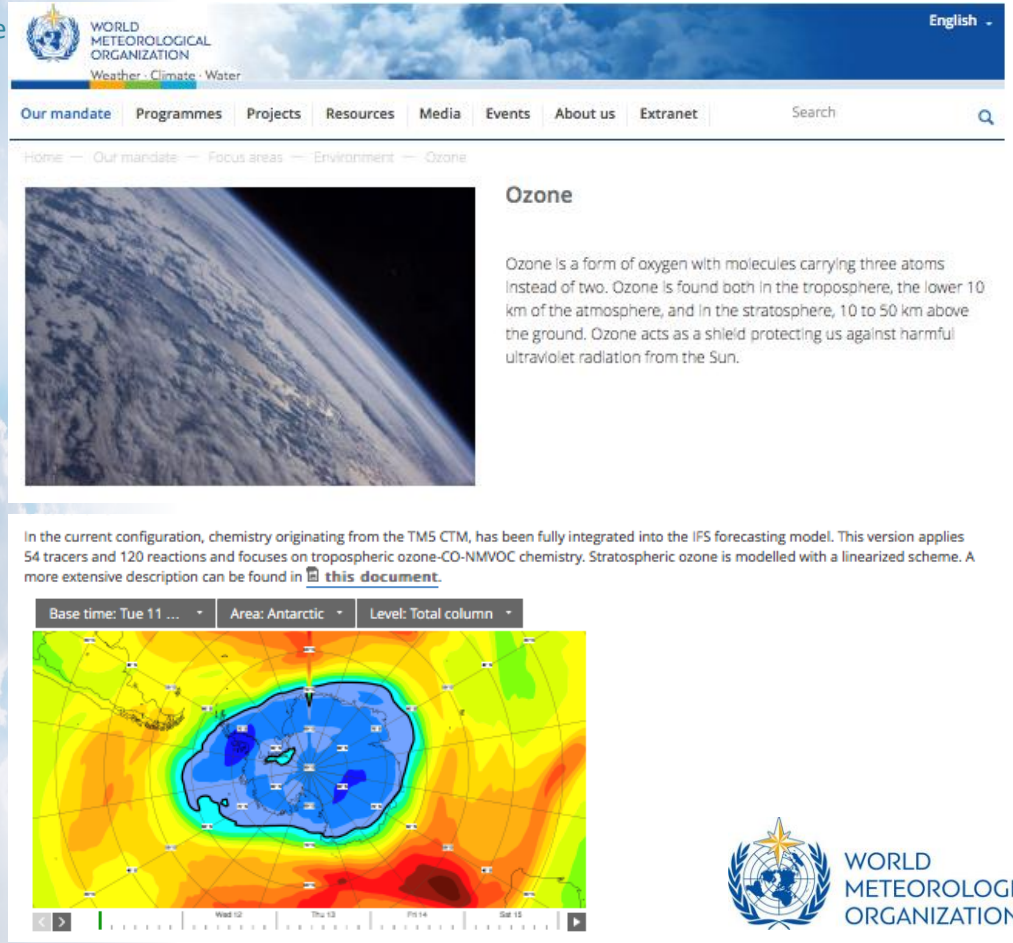
CAMS WORKS WITH WMO



https://public.wmo.int/en/our-mandate/focus-areas/environment/ozone

WMO's public website features some headline CAMS daily operational products (including ozone layer) since July 2018.

WORLD METEOROLOGICAL ORGANIZATION

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3. DRIVERS OF EUROPEAN AIR QUALITY

- DG-ENV, DG-JRC and EEA / on drivers of European air quality
- CLRTAP and European Air quality Directives
- Aims: operational management and information to the public; support Member States for performing their reporting duties; provide operational source apportionment information
- Work with Météo-France, INERIS (FR), Met Norway and many others

NO BORDERS FOR AIR POLLUTION

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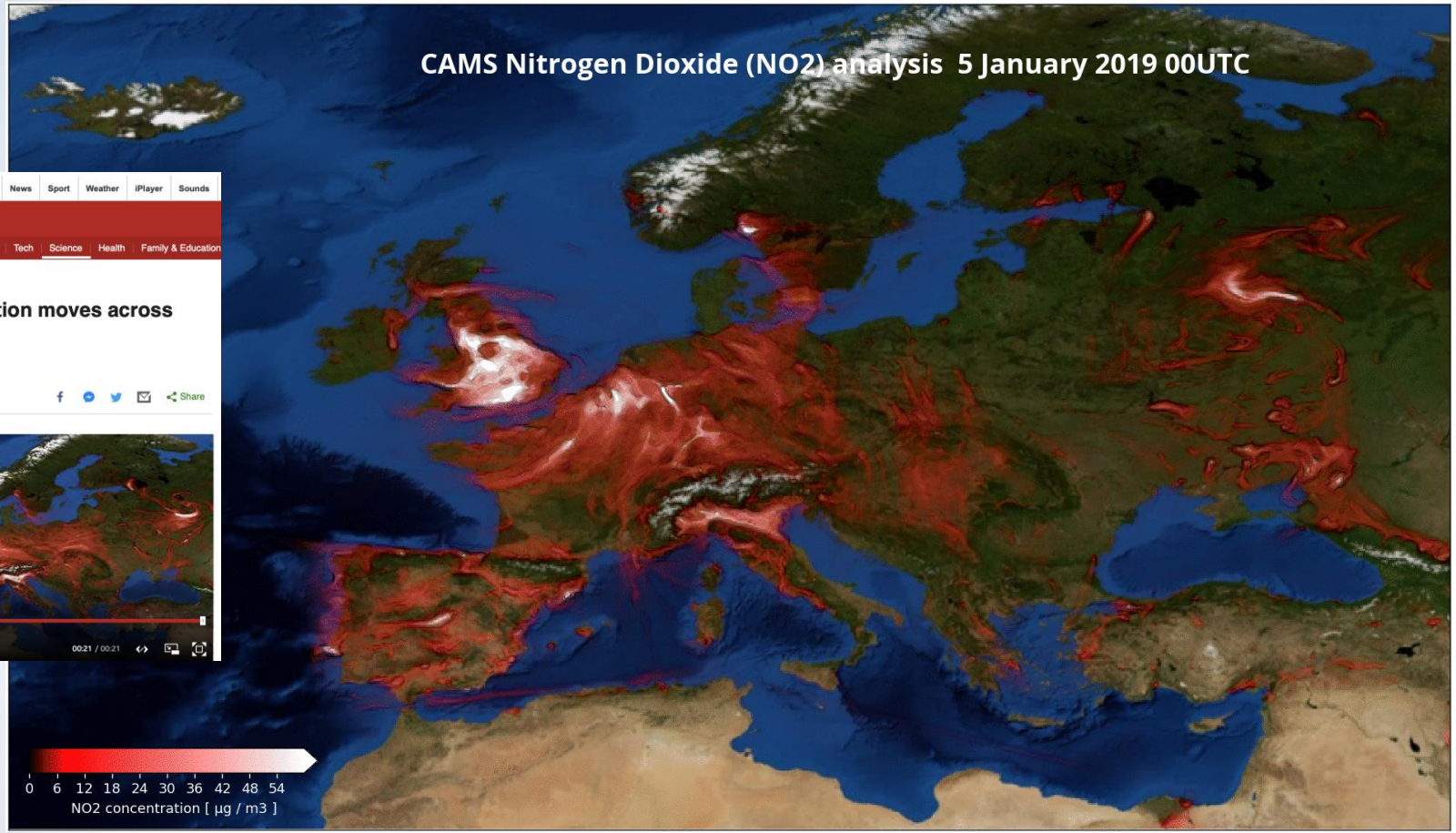
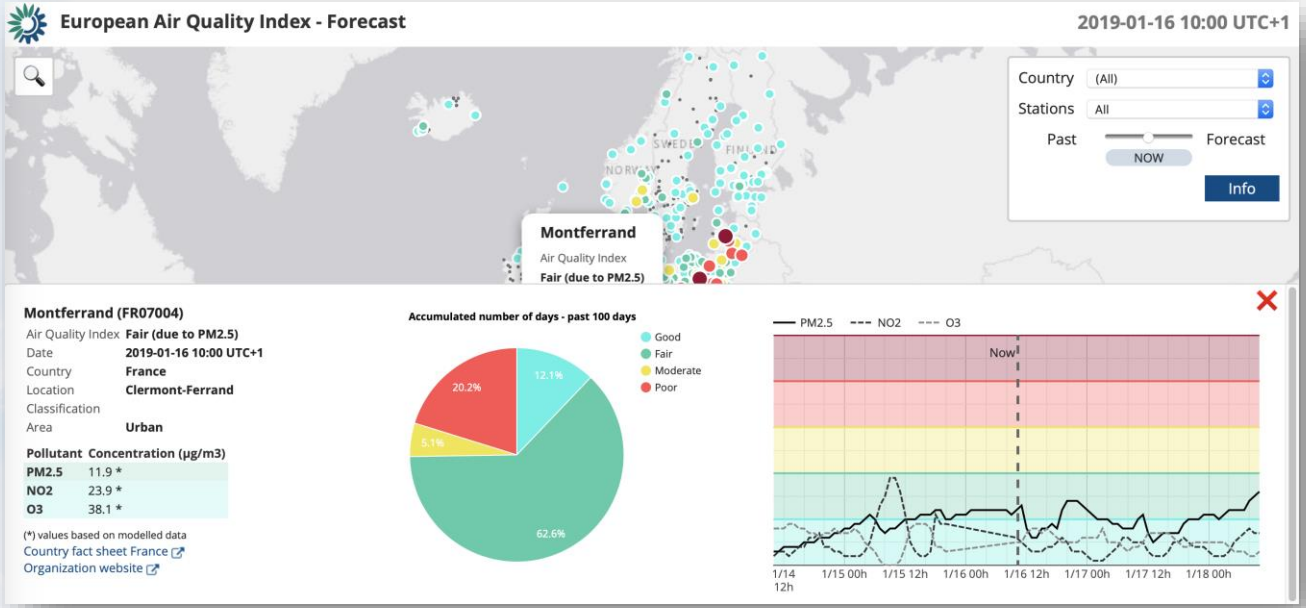


CAMS WORKS WITH THE EEA

The EEA provides information about air quality observed across Europe in the last 48h and forecast from CAMS for the next 72h. Seamless integration in progress.



http://discomap.eea.europa.eu/map/AQI/ViewerCAMS/

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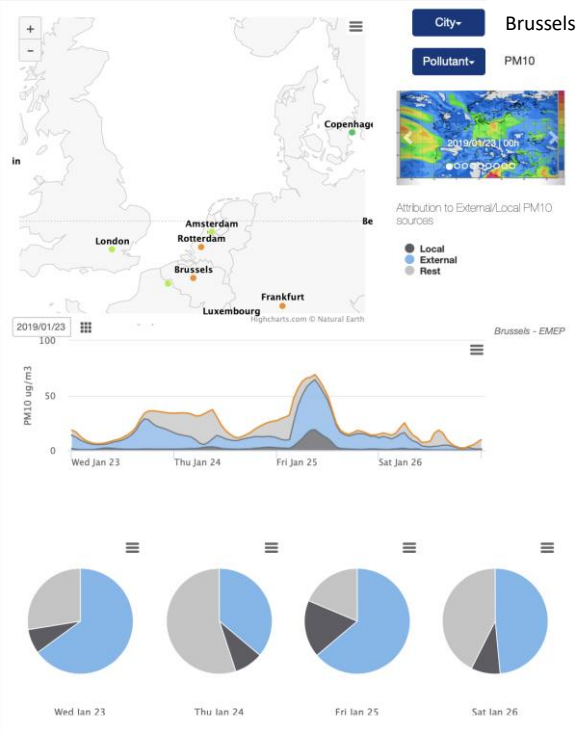
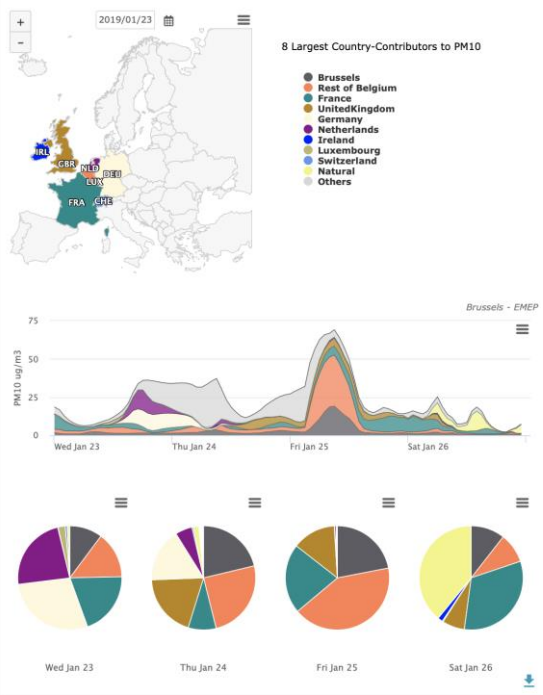
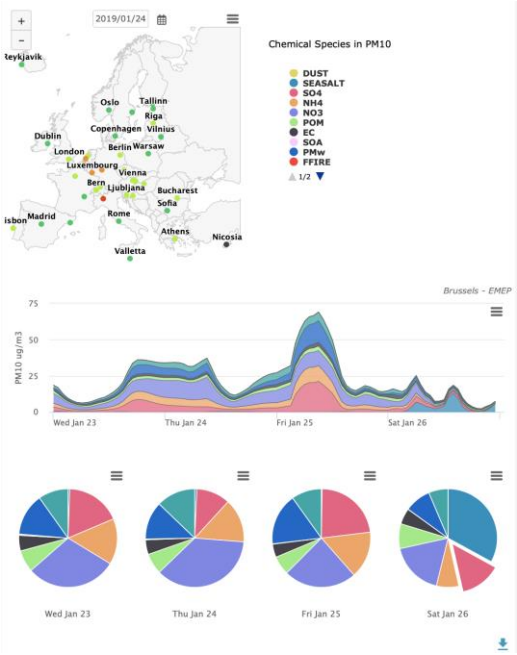
SOURCE APPORTIONMENT INFORMATION

For the European capitals, daily analysis of local versus large scale contribution to air pollutant concentrations. Where does pollution come from? What is the chemical composition of PM?







(M. Gauss et al.)

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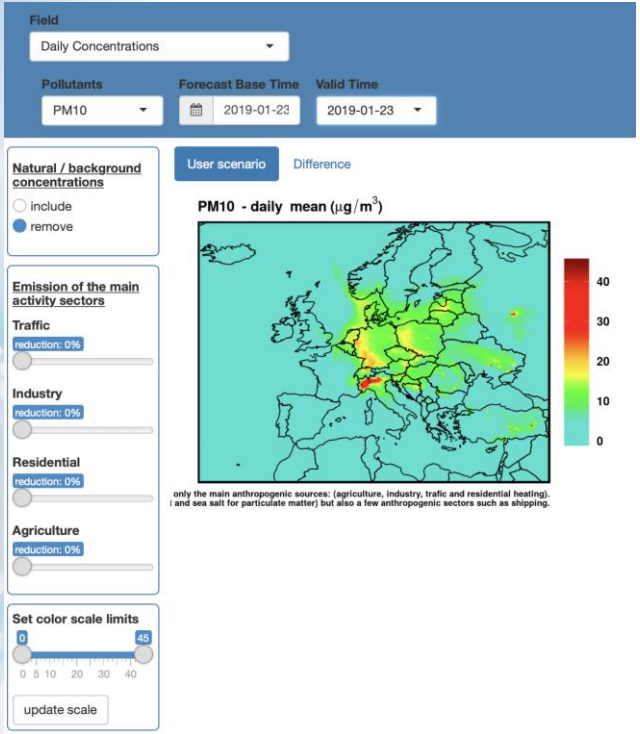
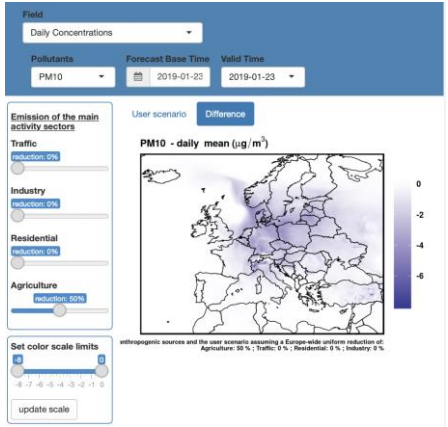
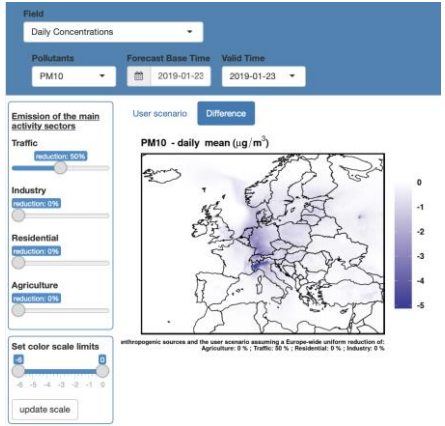
THE CAMS AIR CONTROL TOOLBOX





What happens today if emissions from agriculture are cut by 50%



What happens today if emissions from traffic are cut by 50%

(A. Colette et al.)

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4. SURFACE FLUXES OF GREENHOUSE GASES

- WMO IG3IS and IPCC / on inverse modelling of surface fluxes of the main Greenhouse gases (CO_2, CH_4, N_2O)

- Inverse modelling of atmospheric observations.
- Help to close the loop at national level? The next challenge: disentangling human emissions (proposed Copernicus CO2 emissions service)
- Work with CEA (FR), NO (NL), NILU(NO)

MONTHLY GLOBAL SURFACE FLUXES

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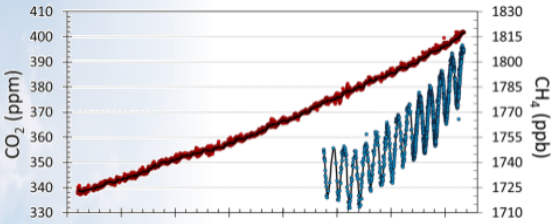

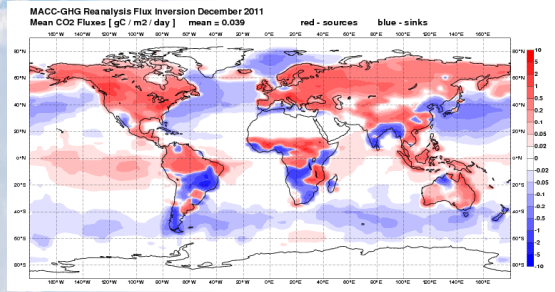

apps.ecmwf.int/datasets/data/cams-ghg-inversions/

Rechercher

About
- Conditions of use
- Documentation

Other CAMS datasets
- MACC GHG flux inversions
- CAMS near-real-time
- CAMS Global Fire Assimilation System (GFAS)
- MACC reanalysis

See also...
- CAMS web site
- User Support

Navigation
- Home
- Public Datasets
- Job list

See also...
- Access Public Datasets
- General FAQ
- WebAPI FAQ
- Accessing forecasts
- GRIB decoder

CAMS Greenhouse Gases Flux Inversions

Copernicus

Please login before retrieving data from this dataserver.

Select an interval between 1979-01-01 and 2015-12-31

1979-01 — 2015-12

Reset

Select parameter

☐ Carbon dioxide ☐ Methane ☐ Nitrous oxide

Select All or Clear

Select datatype

☑ Reanalysis

Select All or Clear

Select version

☐ v11r1 ☐ v14r1 ☐ v15r1 ☐ v15r2 ☐ v15r4

Select All or Clear

Species	Version	Producer	Description
CH4	v11r1_ra	TNO-SRON	Atmospheric CH4 inversion using surface air-sample measurements for years 2000-2015
CO2	v15r2_ra	LSCE	Atmospheric CO2 inversion using surface air-sample measurements for years 1979-2015
CO2	v15r4_ra	LSCE	Atmospheric CO2 inversion using surface air-sample measurements for years 1979-2015
N2O	v14r1_ra	NILU	Atmospheric N2O inversion using surface air-sample measurements for years 1996-2014
N2O	v15r1_ra	NILU	Atmospheric N2O inversion using surface air-sample measurements for years 1996-2015

Select frequency

☐ 3 hourly ☐ Monthly average

Select All or Clear

Select quantity

☐ Concentration ☐ Surface flux ☐ Total column

Select All or Clear

cea TNO NILU SRON Netherlands Institute for Space Research ECMWF Copernicus Europe's eyes on Earth European Commission

EVALUATION AGAINST INDEPENDENT DATA

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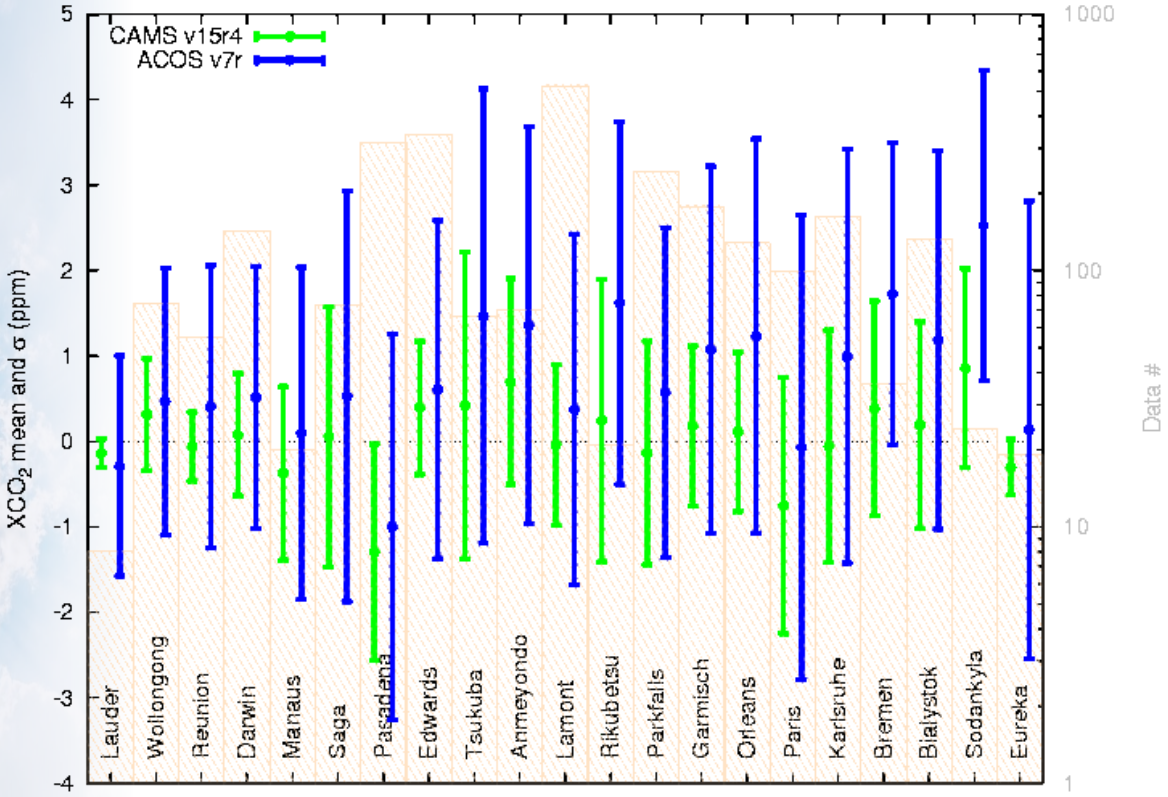
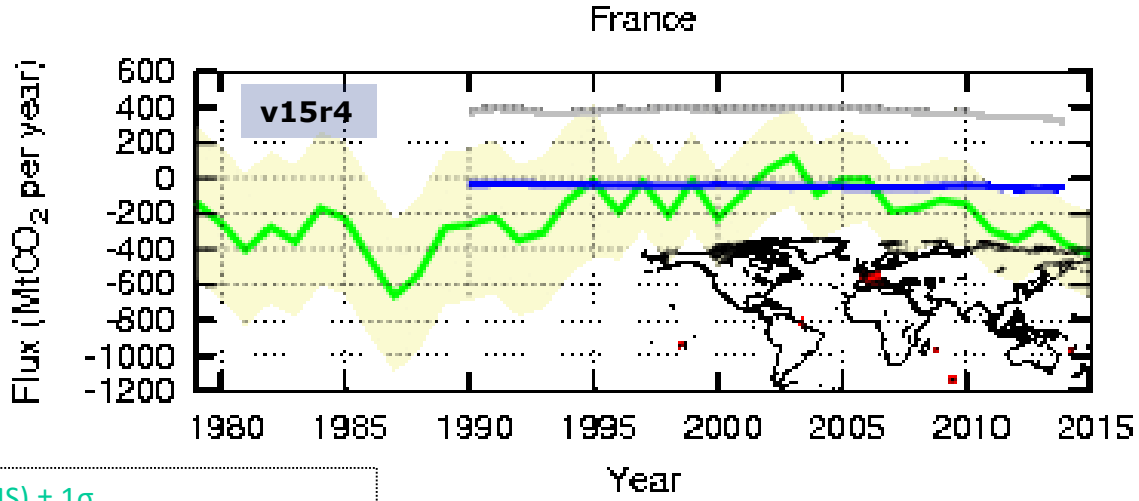


CAMS XCO_2 and OCO-2 ACOS XCO_2 (NASA/JPL) nadir-mode retrievals vs. independent TCCON ground-based observations, year 2015

(F. Chevallier et al.)

SURFACE FLUXES OF CO2

Case of France (2001-2010). Interannual variability is linked to large-scale climate patterns over the Atlantic (Bastos et al., 2016).



Total natural flux (CAMS) ± 1σ
Land use, land use change and forestry (UNFCCC)
Fossil fuel (UNFCCC)

(F. Chevallier et al.)

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