Atmosphere Monitoring

CAMS

Consistent, quality-controlled information on atmospheric composition worldwide

Vincent-Henri Peuch (ECMWF)

IRS MAG, EUMETSAT, 17/05/2019

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www.copernicus.eu

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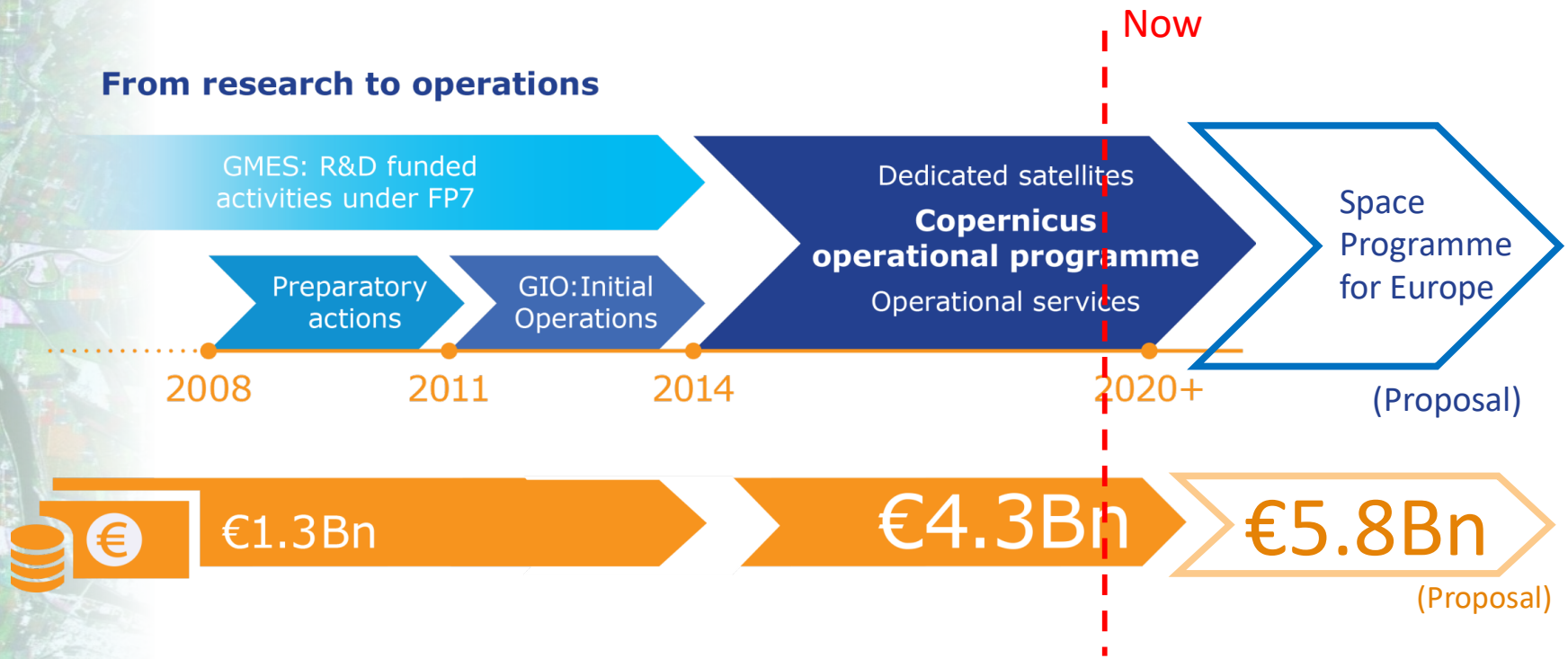
OUTLINE

- State-of-play with the implementation of the Copernicus Atmosphere Monitoring Service
- IRS “wish list” for CAMS (focusing especially on air quality)

PROGRAMME DEVELOPMENT



COPERNICUS SERVICES

Copernicus

Monitoring the State of the Earth System Environment ...

... Six cross-cutting Thematic Services

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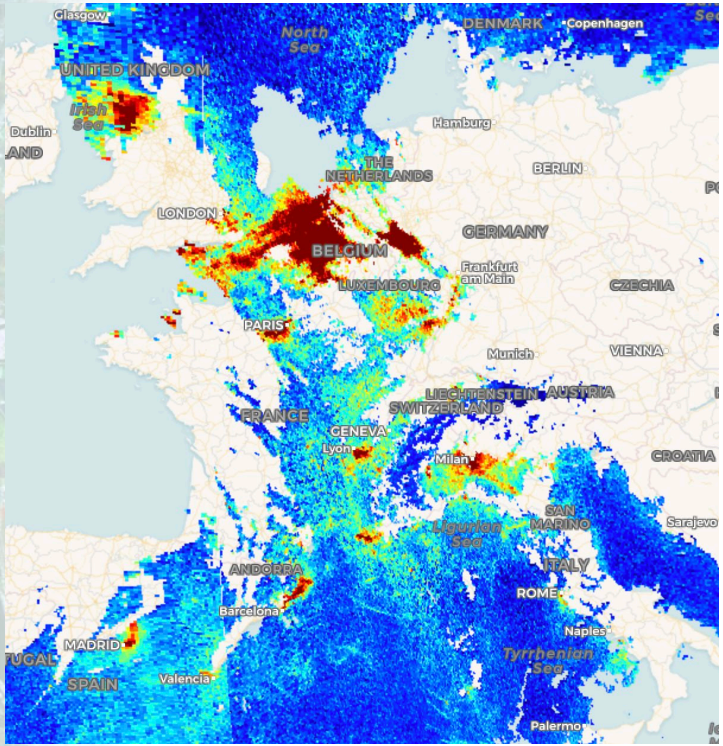
WHY INFORMATION SERVICES ARE NEEDED?



Example: NO_2 tropospheric column from Copernicus **Sentinel-5P** (16/05/2019, yesterday!)

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

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

What services do:

- blend observations (satellite and non satellite) with model to provide a consistent “picture”
- forecasts, some days ahead
- reanalyses over past years, decades

THE CAMS PORTFOLIO

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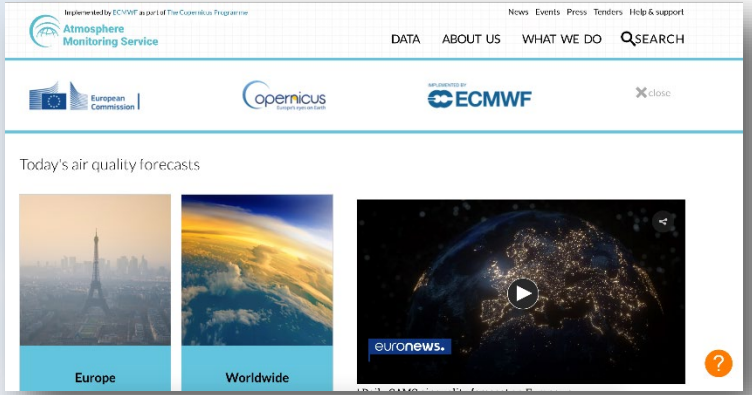
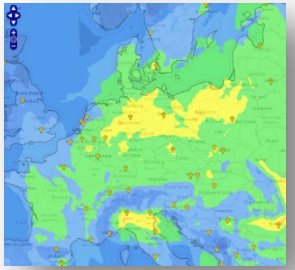
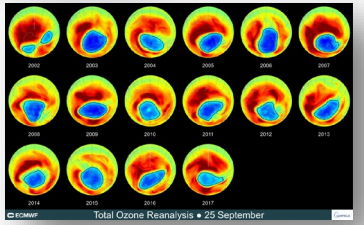


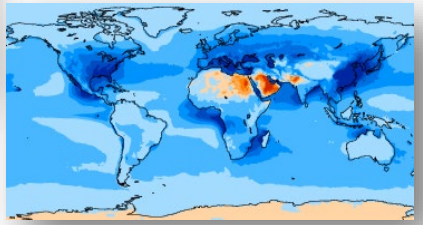


European Air Quality, pollen and products in support of policy users

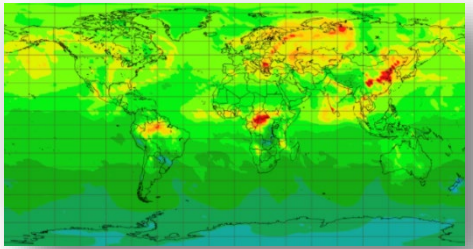
Ozone layer



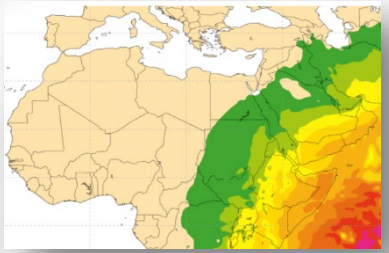
Radiative forcing



Bottom-up emissions and surface fluxes of greenhouse gases



Global analyses, forecasts and reanalysis (2003-2018)



Solar radiation and UV index

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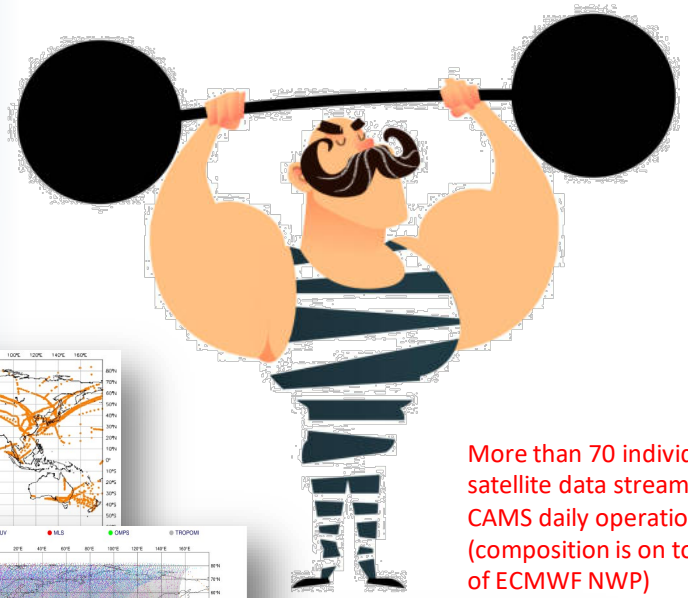
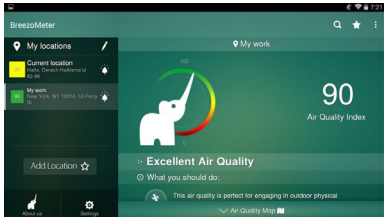
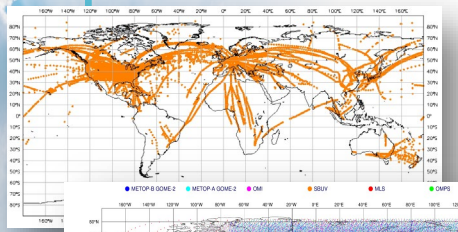
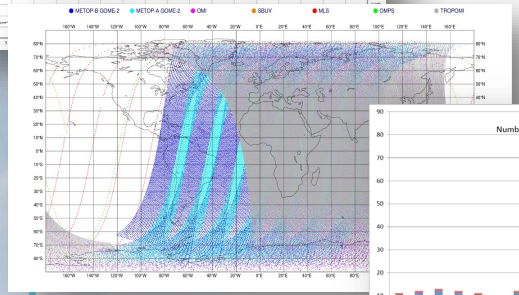
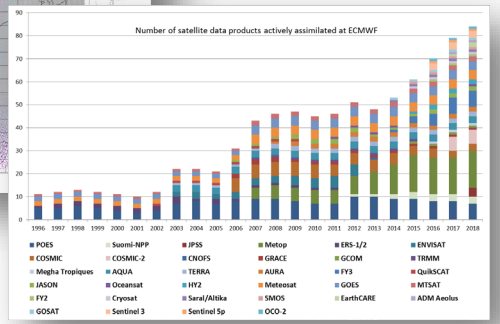
CONCEPT: LET CAMS DO THE "HEAVY WEIGHT LIFTING"



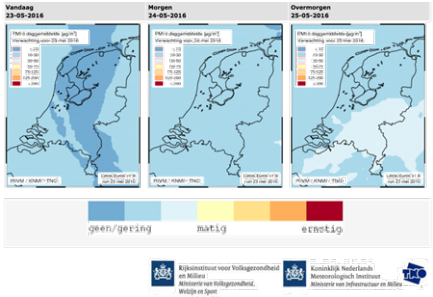








More than 70 individual satellite data streams in CAMS daily operations (composition is on top of ECMWF NWP)



AND PUBLIC/COMMERCIAL USERS RUN THE LAST MILE

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CAMS VALUE-ADDING CHAIN

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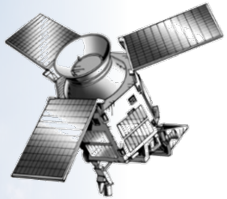
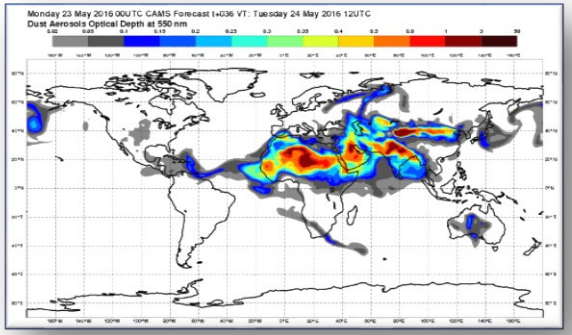
Satellite observations

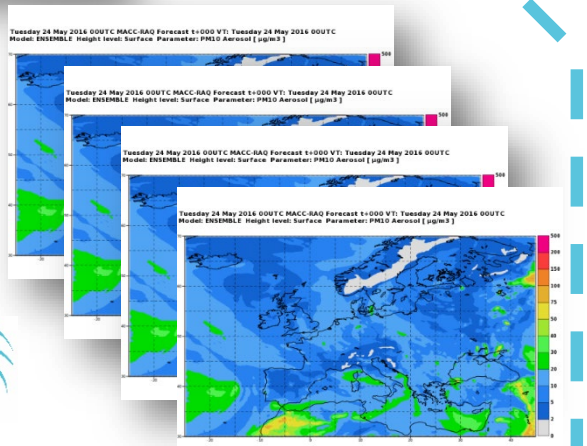




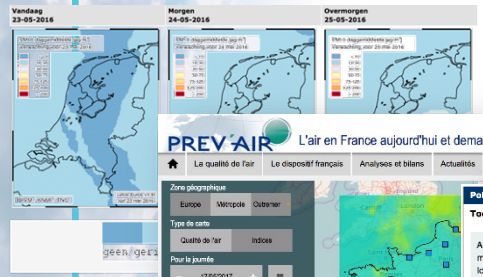
ECMWF/IFS

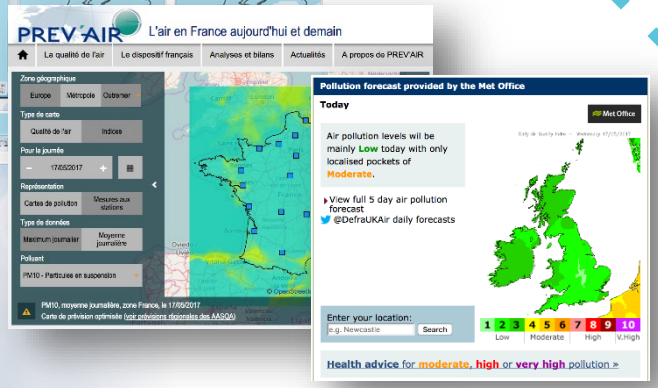
In-situ observations

9 regional CTMs



National scale





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OPERATIONAL MONITORING AND VALIDATION

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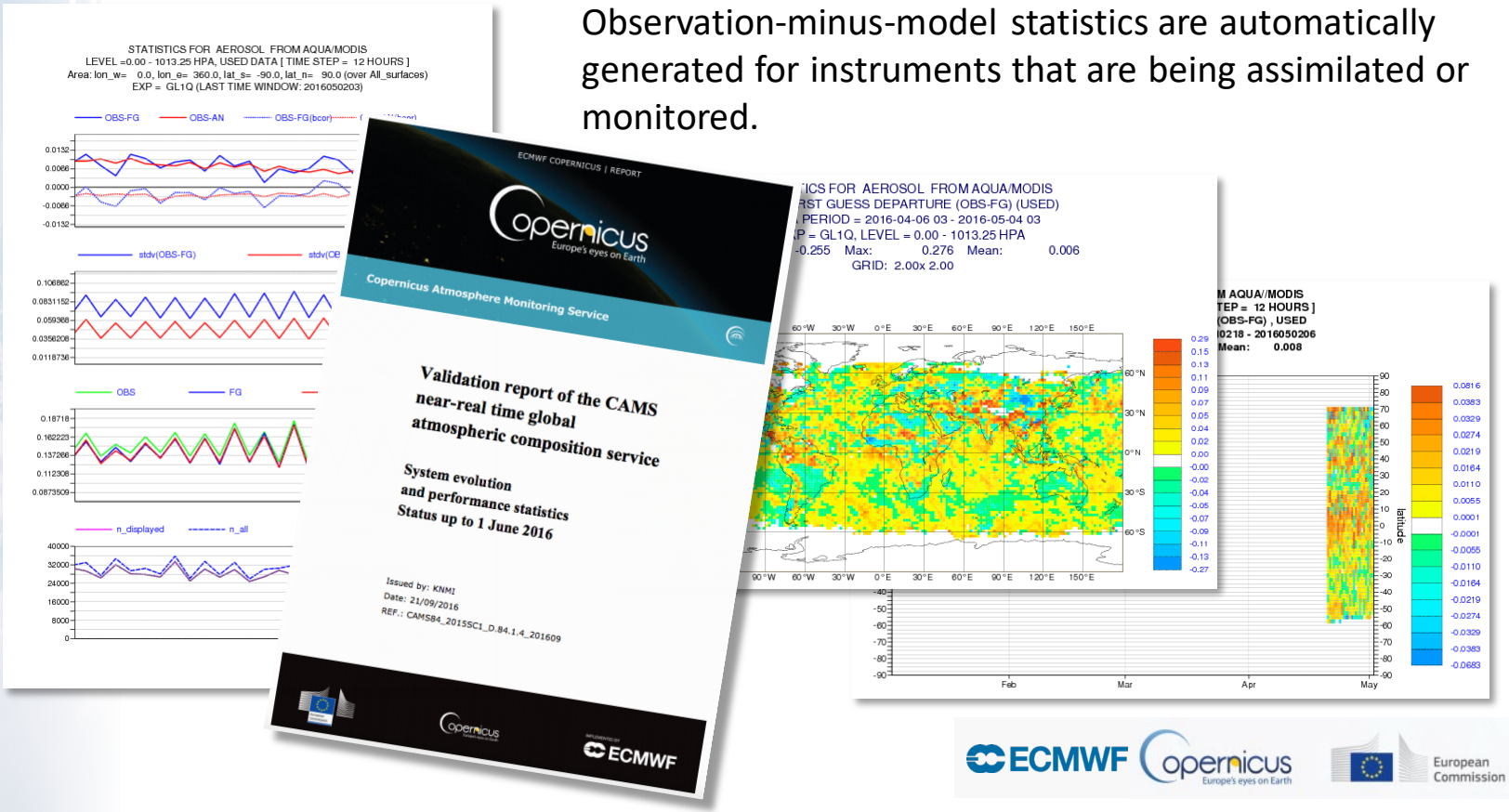
Observation-minus-model statistics are automatically generated for instruments that are being assimilated or monitored.



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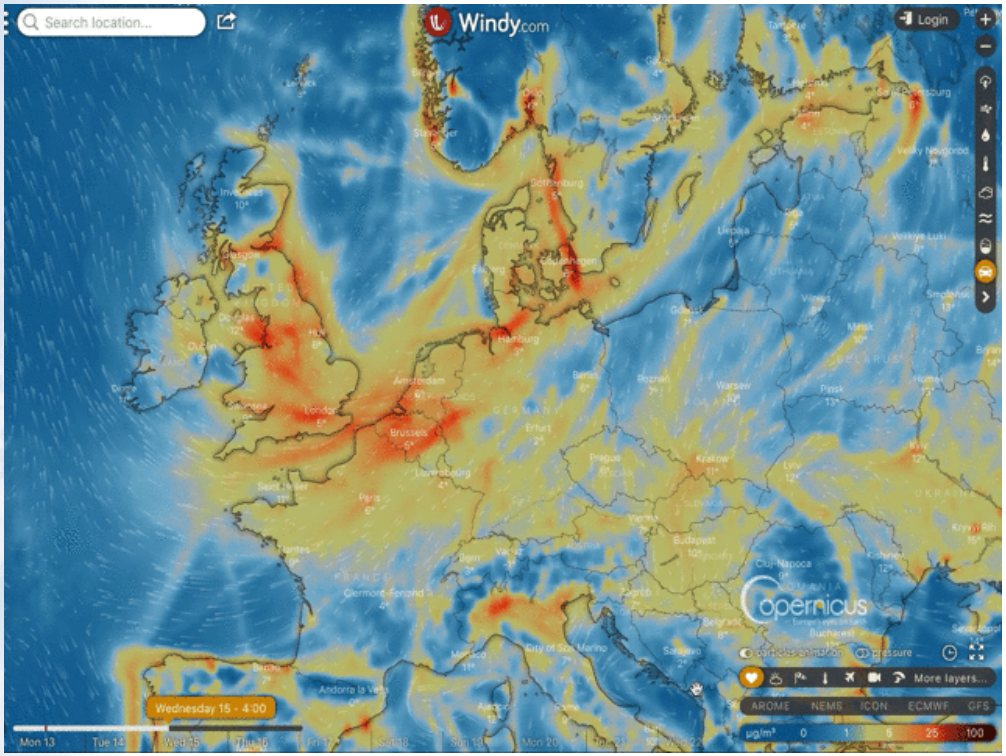
CAMS GLOBAL AND REGIONAL FORECASTS



CAMS regional forecasts seen in the highly successful Windy app and website (operational service starting next month!).

- Twice daily (based 00, 12) NRT global analyses and forecasts up to +120h, 40km resolution
- Daily (based 00) NRT European analyses and forecasts up to +96h, 10 km resolution
- Delayed mode (4 day behind) global analyses and forecasts of CO_2 and CH_4, 9km

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MONITORING THE OZONE LAYER FOR THE EU

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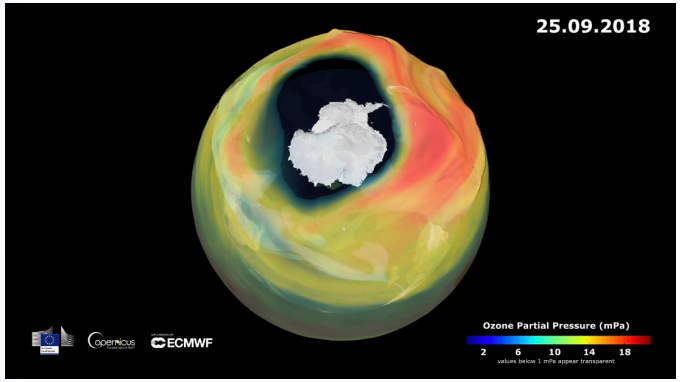
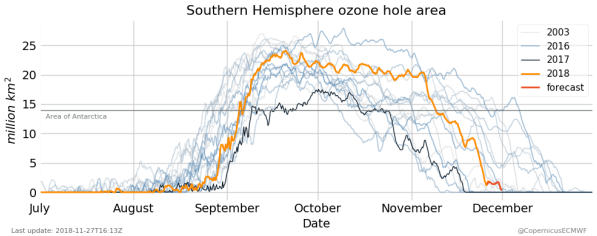
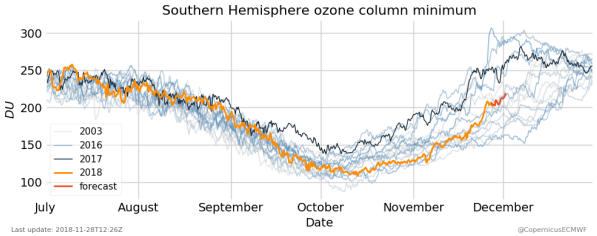
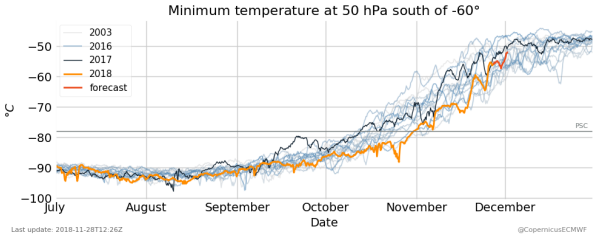
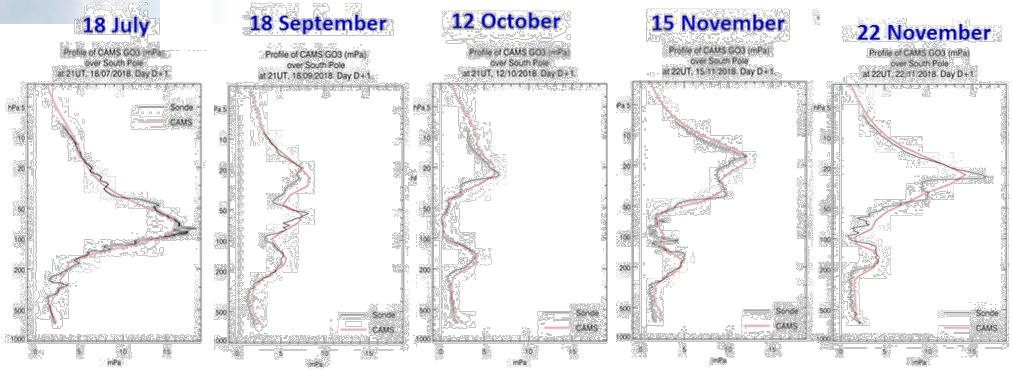
CAMS opened in September 2018 a webpage following request from DG-CLIMA to provide ozone layer monitoring information for the EU (previously they were using NASA).











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THE CAMS REANALYSIS

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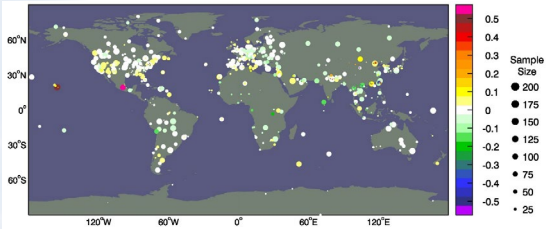
The dataset covers the period 2003 to end 2017. This **reanalysis** is a marked improvement over our previous datasets (**MACC reanalysis** and **CAMS interim reanalysis**).

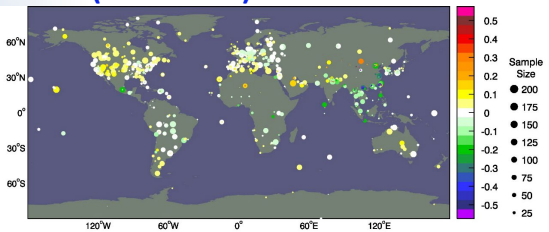
Evaluation of Aerosol Optical Depth

AERONET

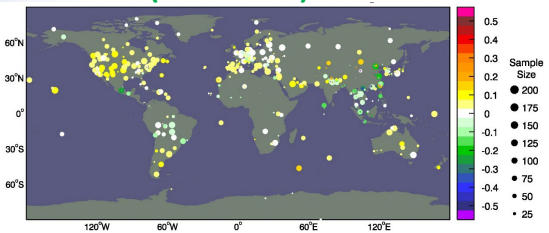
CAMSRA (2003-2016)



CIRA (2003-2016)



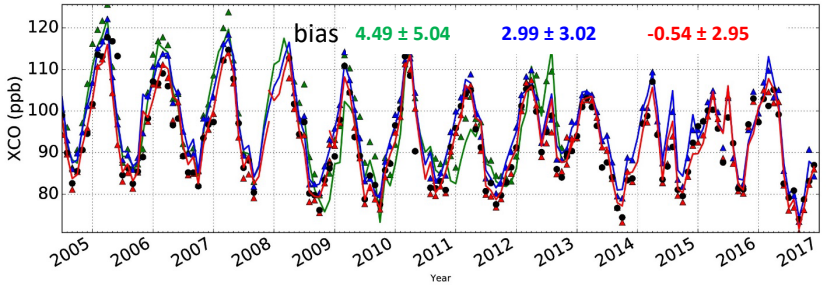
MACCRA (2003-2012)



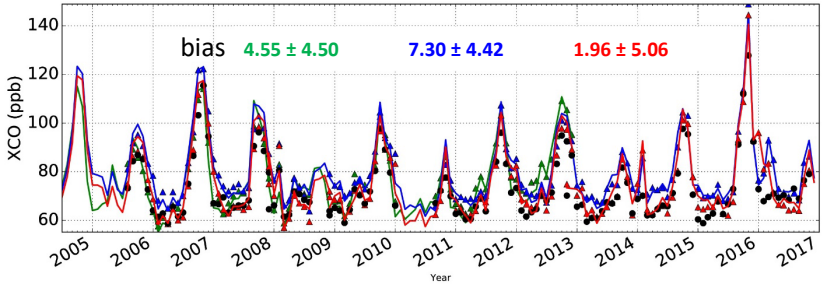
Evaluation of total column CO

TCCON total carbon column observing network

Parkfalls



Darwin



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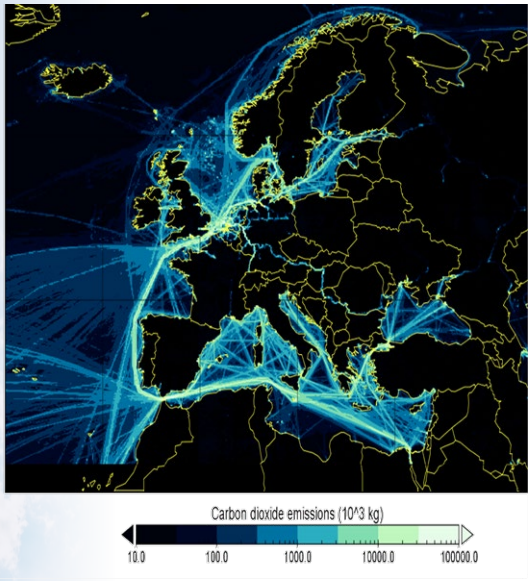
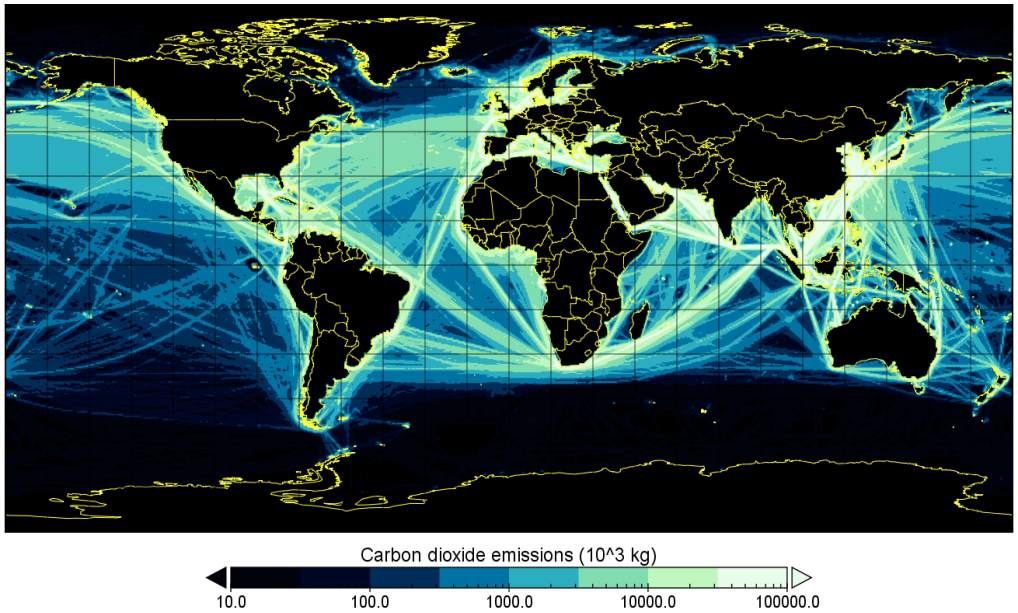
CAMS BOTTOM-UP EMISSIONS





Emissions are both an input to CAMS global and regional systems and a popular product. Entirely new datasets have been released covering 2003 to 2019 (extrapolation). Example: CO_2 emissions from shipping activities (provider: FMI, Finland).

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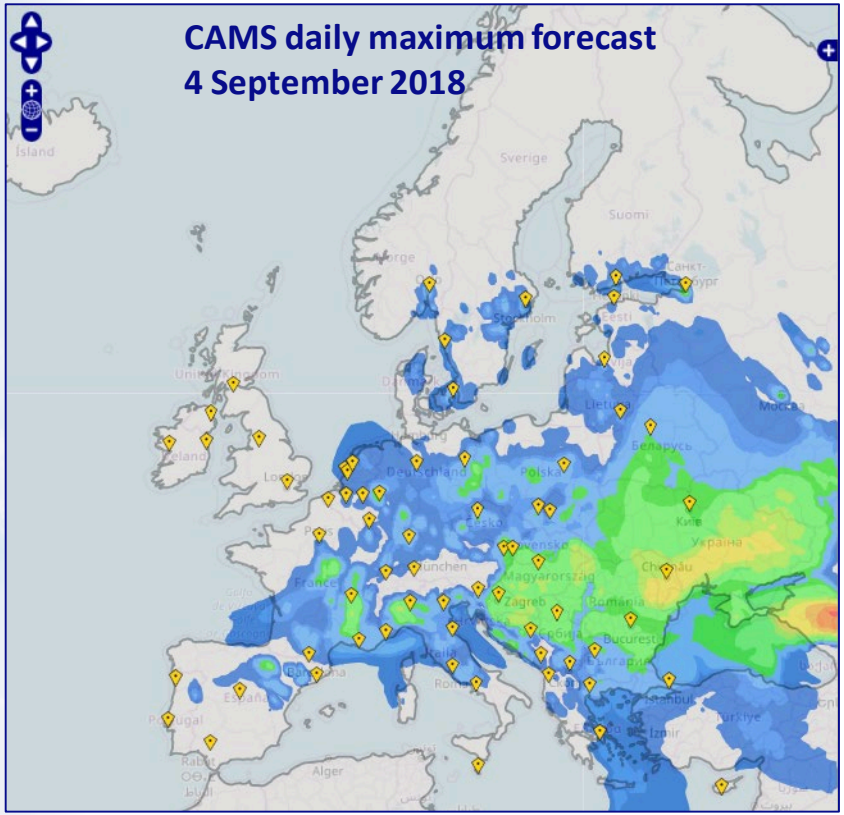
BEYOND AIR POLLUTION: POLLEN FORECASTS



While many people regard spring as prime pollen season, one type of pollen wreaks havoc in the late summer and fall. Ragweed pollen usually reaches peak levels in mid-September; this type of pollen can cause seasonal allergic rhinitis.

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THE CAMS AIR CONTROL TOOLBOX

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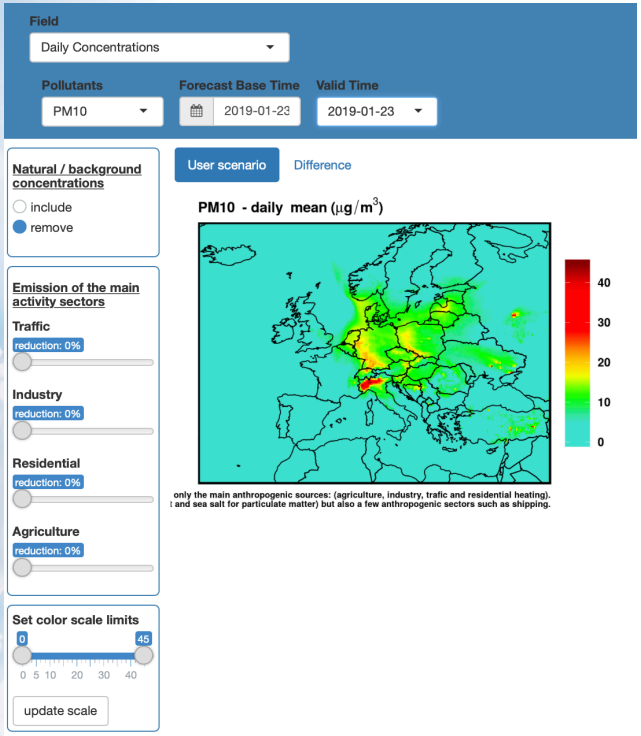
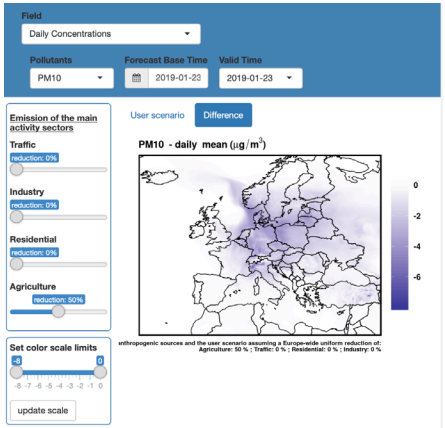
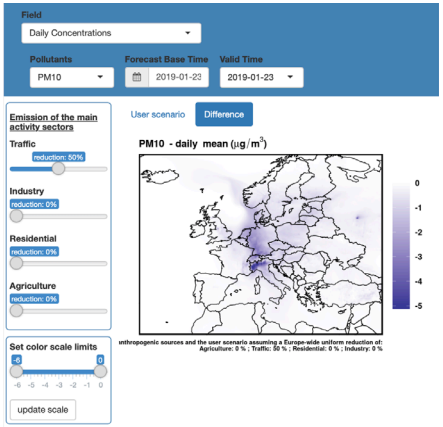




What happens today if emissions from traffic are cut by 50%

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



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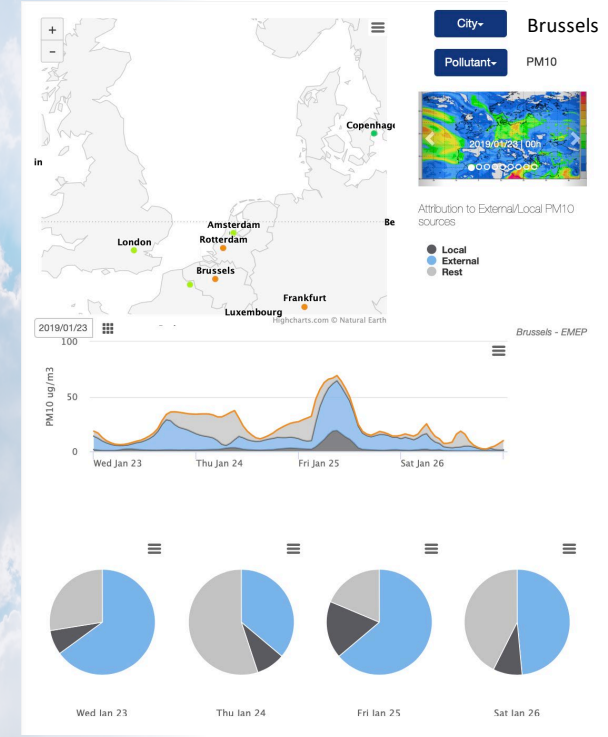
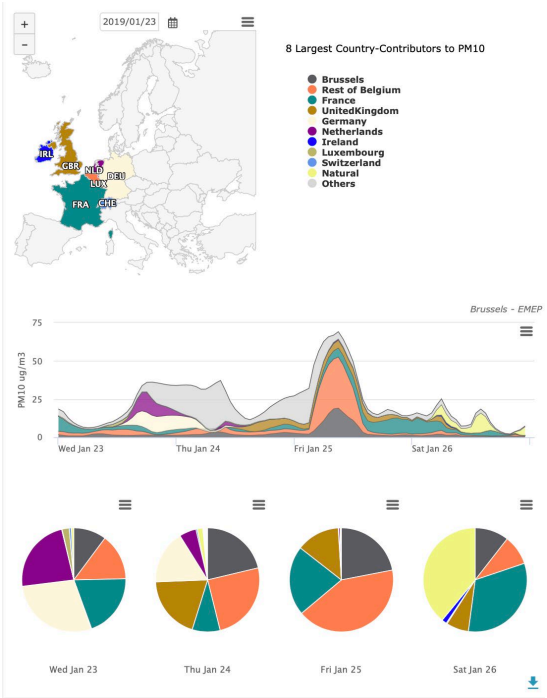
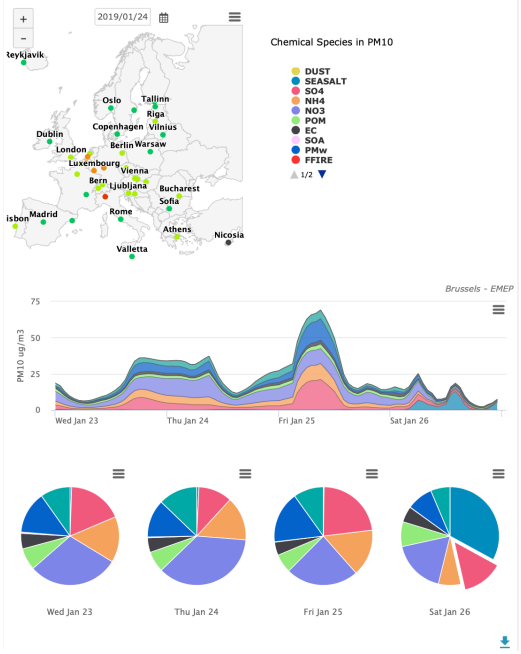
DAILY SOURCE APPORTIONMENT INFORMATION

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?







CAMS PARTNERS WITH KEY INSTITUTIONS

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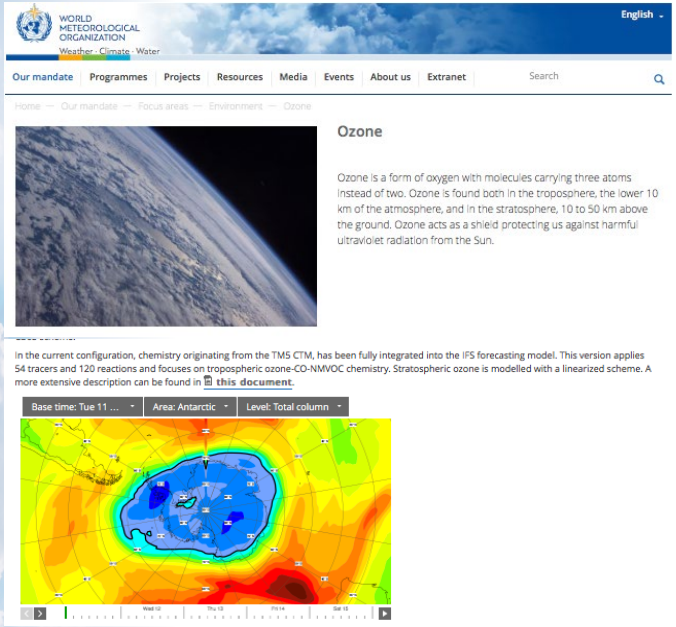
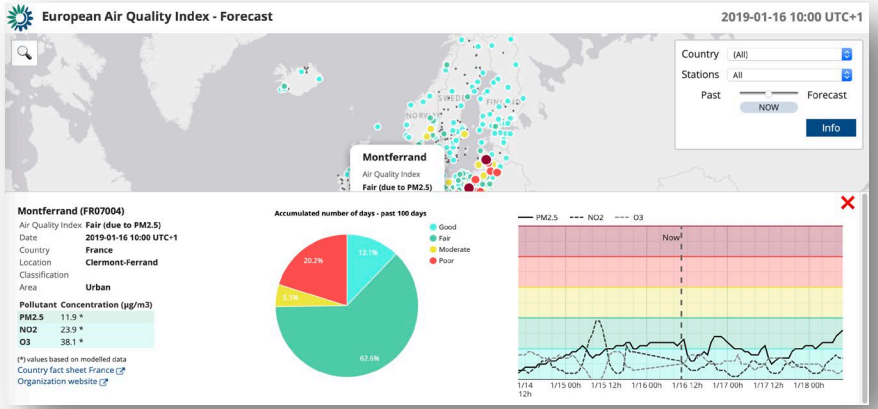
https://public.wmo.int/en/our-mandate/focus-areas/environment/ozone



WMO's public website features some headline CAMS forecasts since July 2018.

EEA provides information about air quality observed by Member States across Europe in the last 48h and forecast from CAMS for the next 48h.



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

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2018: CAMS HAS BECOME A MAINSTREAM INFO SOURCE

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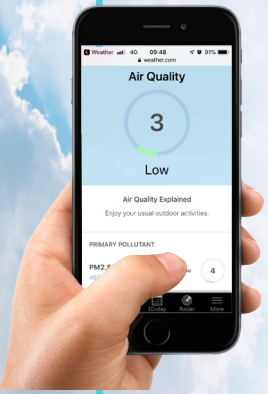
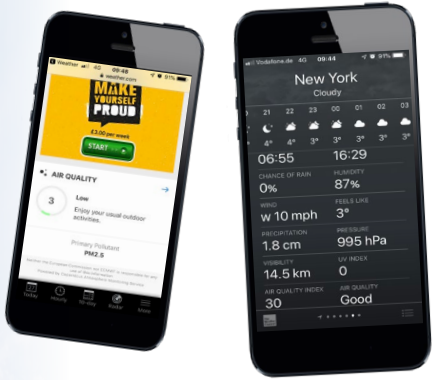
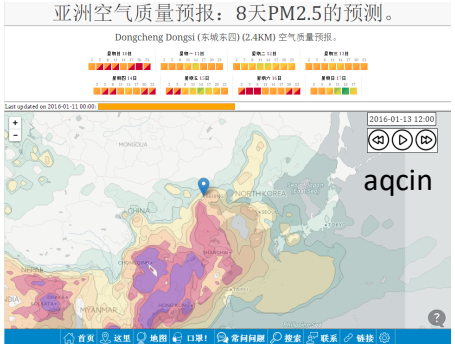
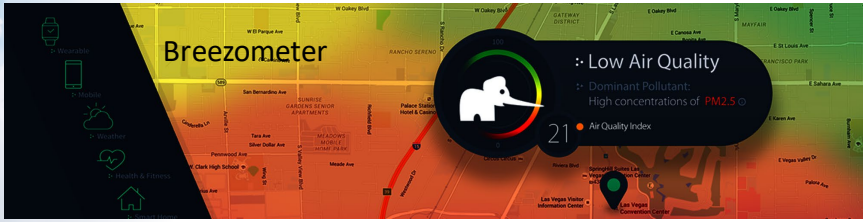
CAMS products are now reaching >100 million people worldwide

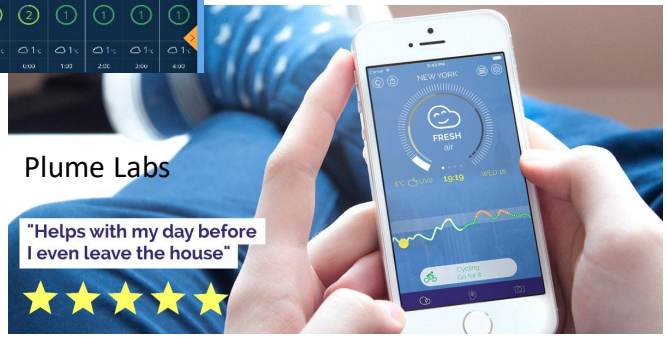






The Weather Channel





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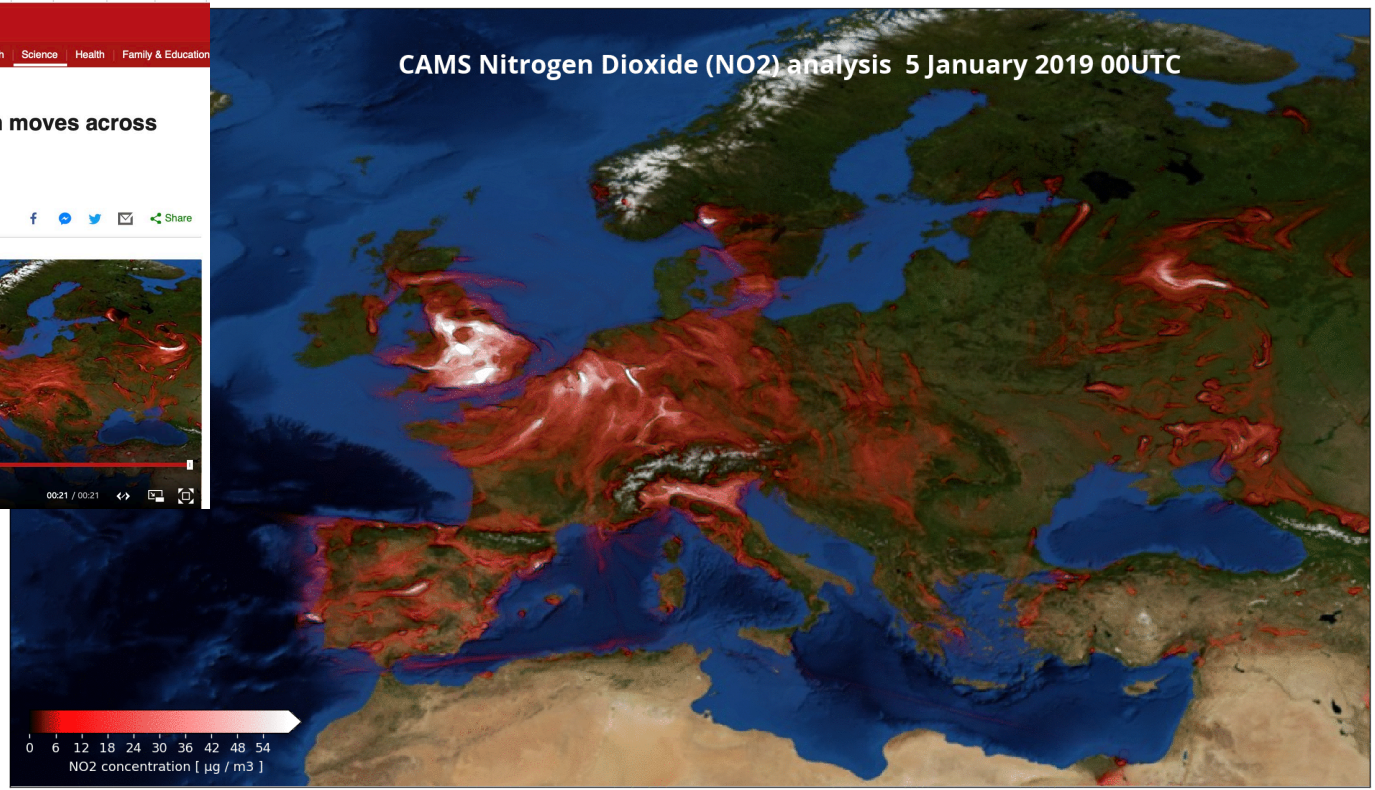
Science & Environment

Watch how air pollution moves across Europe

By Jonathan Amos
BBC Science Correspondent

31 minutes ago Share



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CAMS: BIG DATA FOR LOCAL APPLICATIONS

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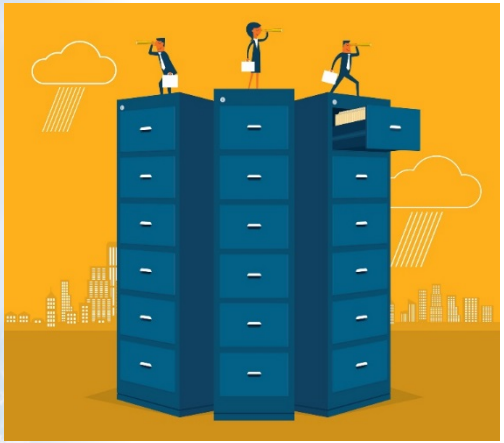
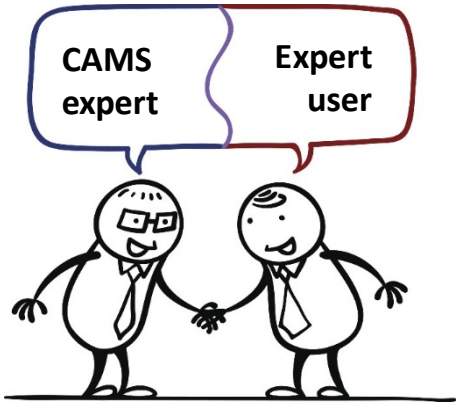


CAMS provides big data with the corresponding technical and scientific expertise to support expert users.
In doing so, we allow the CAMS information to reach millions of users in and outside Europe.



Downstream applications

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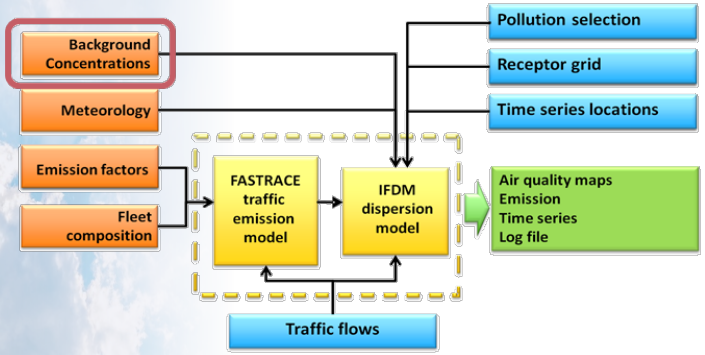
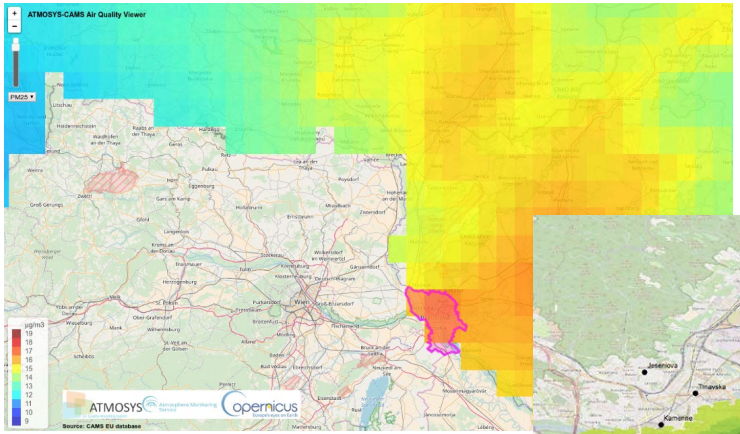
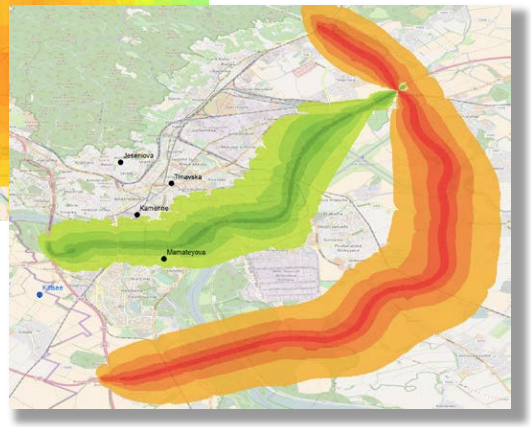
SUCCESFUL USE CASES BECOME LIVE: EXAMPLE #1

ATMOSYS

Air Quality Modelling System







VITO developed a web application for the Flemish Environmental Agency to calculate road traffic emission scenarios in support of regional air quality management. Using CAMS air quality data, they can implement their service in other parts of Europe.

vito vision on technology

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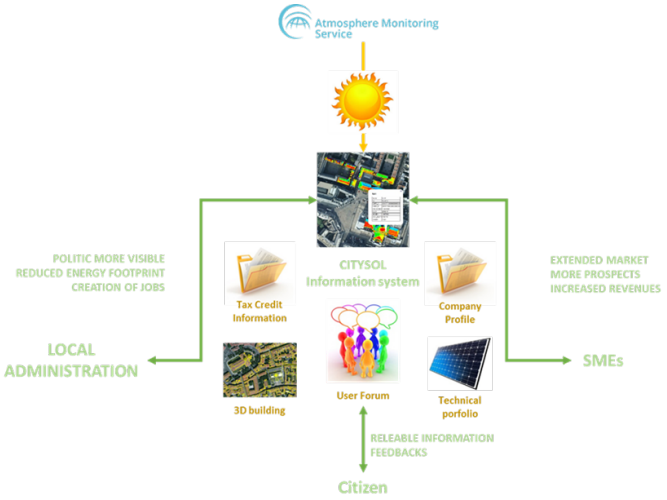
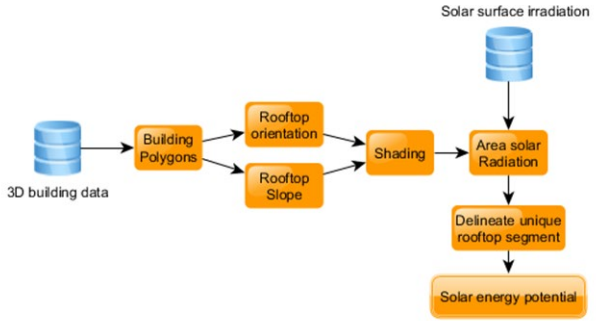
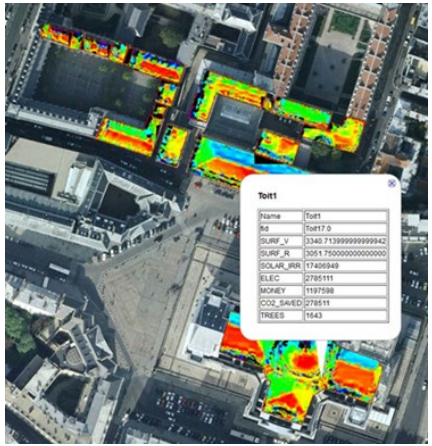
Atmosphere Monitoring

SUCCESFUL USE CASES BECOME LIVE: EXAMPLE #2







NOVELTIS

(France)

"Mon Toit Solaire" provides a web-based decision support system for the development of rooftop photovoltaic solar panels. CAMS provides the satellite-based time series of available solar radiation for the specific location, taking into account the amount of clouds and aerosols.

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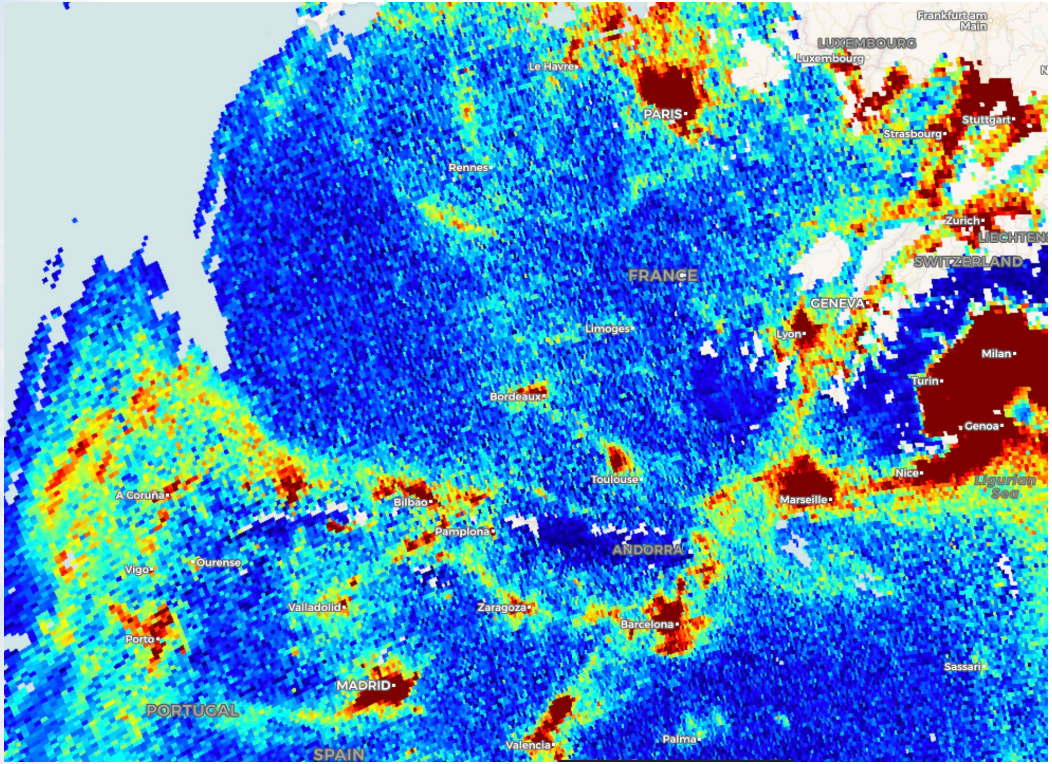
CAMS: a truly European effort
133 entities from 28 EU/ECMWF countries, 48 contracts
350 million observations inserted in the CAMS global system every 12h
> 100 million end users, 12.5k registered idirect users, 2.6k daily users, 42k unique website visitors per month
> 10-year R&D heritage (GEMS, MACC/MACC-II/MACC-III…)

Atmosphere Monitoring

ANNO S-5P: BEFORE AND AFTER



Example: 13/02/2019, tropospheric NO_2

- Some “overselling” in the past
- S-5P is triggering an entirely different attitude among air quality professionals
- Horizontal resolution and coverage are key
- Somewhat over enthusiastic (column vs surface values, temporal resolution)

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ASSET FOR GEO: HIGH TIME SAMPLING!

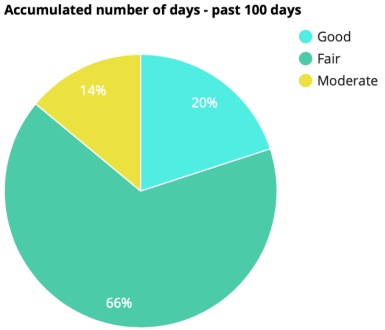
Atmosphere Monitoring

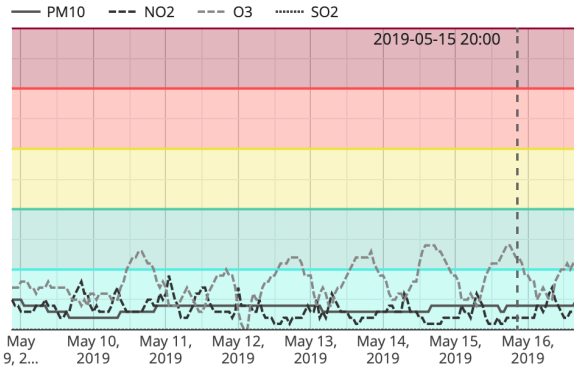
Darmstadt (DEHE001)

Air Quality Index	**Fair (due to O3)**
Date	**2019-05-15 20:00 UTC+2**
Country	**Germany**
Location	**Darmstadt**
Classification	**Background**
Area	**Urban**

Pollutant	Concentration (µg/m3)
PM10	7.4
NO2	7.4
O3	89.9
SO2	<1.0

Country fact sheet Germany
Organization website





"Entangled" processes:

- Emissions
- Vertical mixing
- Transport
- Dry deposition

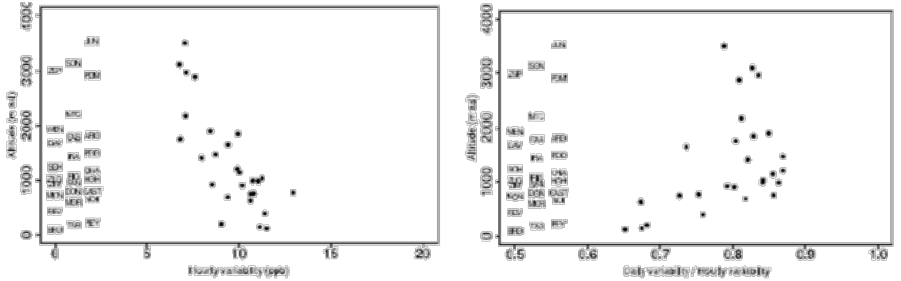


Fig. 3.2: Surface O_3 data from various European stations, over the period 2001-2004. Left, hourly variability (standard deviation, ppb); right, daily / hourly variability. Note hourly variability is larger than daily variability. (Chevalier et al., 2007.)

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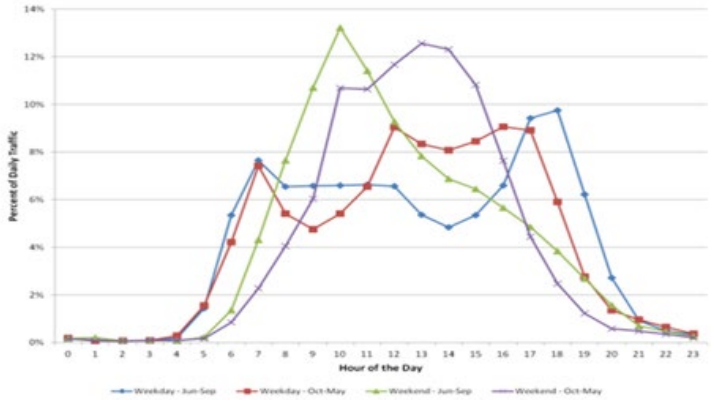
AIR QUALITY REQUIREMENTS

1. Near surface (ideally “nose-level” concentrations, 0-2km/0-3km at maximum = lowermost troposphere)
2. Specific pollutants and precursors: PM10/2.5/1, O3, NO2, SO2 + CO (as tracer of combustions), NH3 (as PM precursor), VOCs (but very complex)…
3. High temporal resolution is essential
4. Key interest is for concentrations AND emissions
5. Getting beyond the “obvious” (where cities are, that week days and weekend days are different…)

Ex.: traffic emissions



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"WISHLIST" FOR IRS

Species:

- Lowermost troposphere CO (really useful for emissions, especially if S-4 provides NO_2)
- Aerosol (speciated as far as possible: dust, volcanic ash…)
- NH_3 (emissions and precursor of aerosol)
- Lowermost troposphere Ozone (combined product with S-4 most probably required)
- PAN, C_2H_4, CH_3OH, HCOOH, CH_3COOH, HCN… (fires and transport of poll.)
- Not air quality but strong interest for CO_2, CH_4 and N_2O

Resolution:

+ real-time availability

- Temporal: 1h, 3h max
- Spatial: as fine as possible to approx. 10kmx10km max

Value of night observations to be assessed but in principle extremely interesting (less deposition and turbulence)

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