CAMS

High-quality information about air composition in support of research on COVID-19

Atmosphere Monitoring

Vincent-Henri Peuch

Copernicus
Europe's eyes on Earth

European Commission

ECMWF

ECMWF | EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

http://atmosphere.copernicus.eu
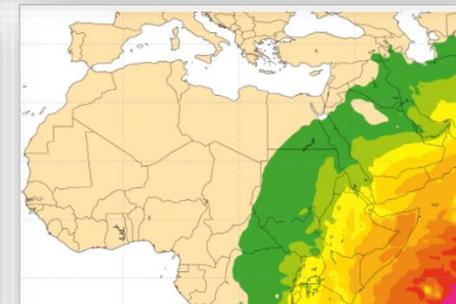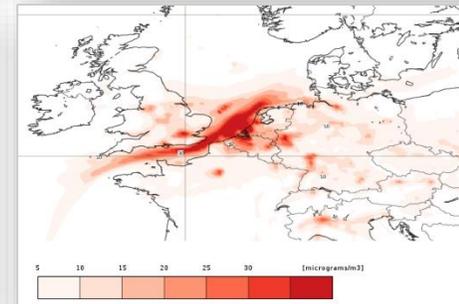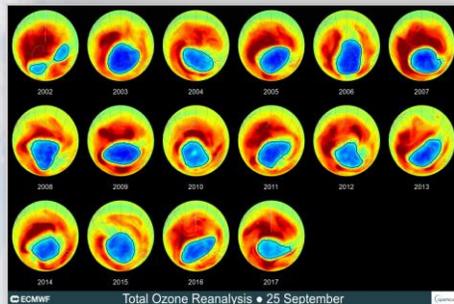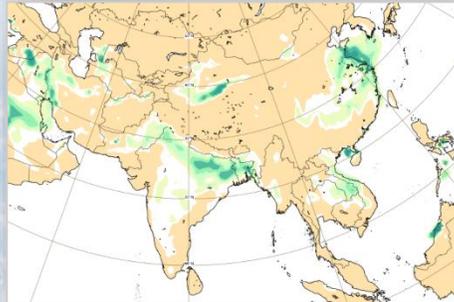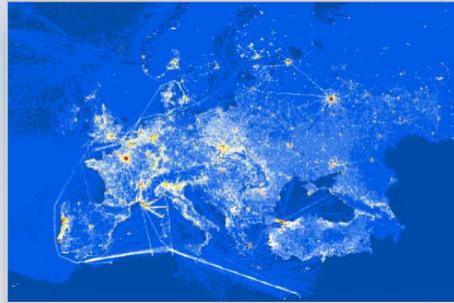
The CAMS portfolio includes Earth Observation based information products about:

- 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).

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

CAMS main operational data
assimilation and modelling systems

Earth Observation
from satellite (>75
instruments) and in-
situ (regulatory and
research)
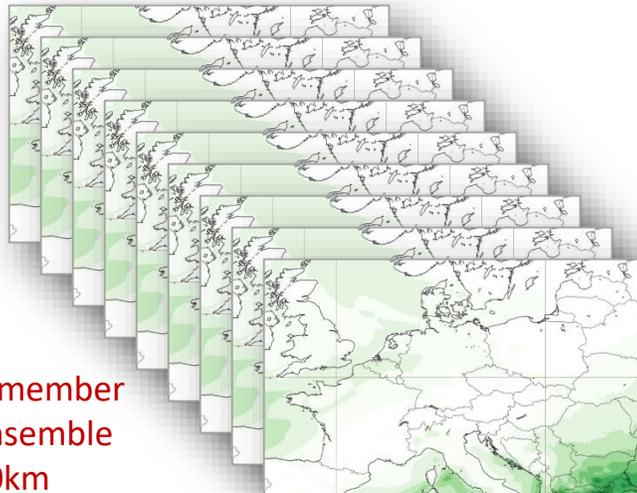
9-member
ensemble
10km
Europe

CAMS users

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PM2.5 (ug/m3) FC-OBS bias. Model versus AirNow.
907 sites in N-America. 15-18 Jul 2017. FC start hrs=00Z. T+6 to 24.

— 46r1   — 45r1

old

new

Perfect: forecast = observation

CAMS (ensemble) forecasts for 31 May 2020 0900 UTC

Mass concentration of Dust Particulate Matter (µg/m3)
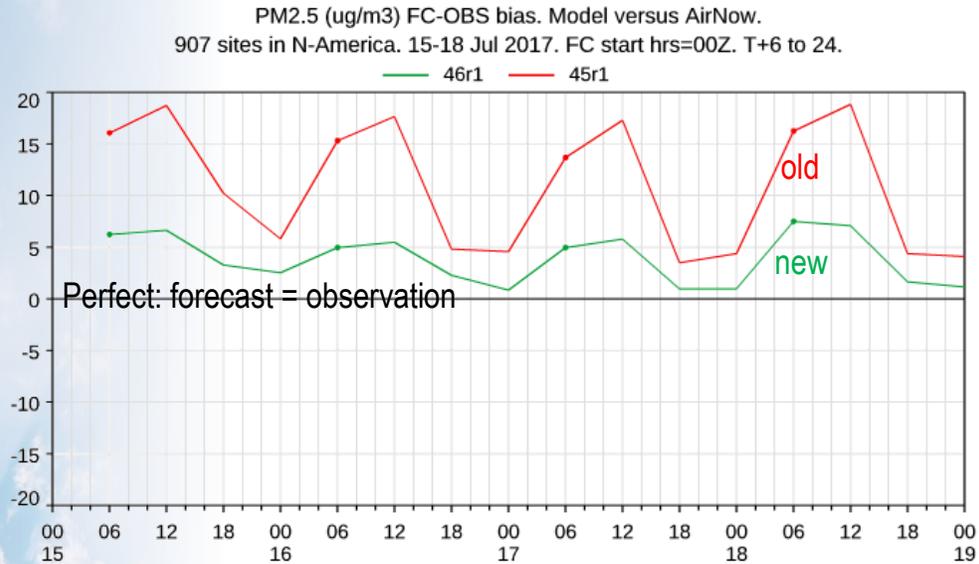
CAMS Global system upgrade (46r1, July 2019)

- Extension to 137 vertical levels (instead of 60), allowing better representation of vertical profiles;
- Nitrate and ammonium components of aerosol added, resulting in a major improvement of Particulate Matter (PM2.5 and PM10);
- New anthropogenic and natural emissions.
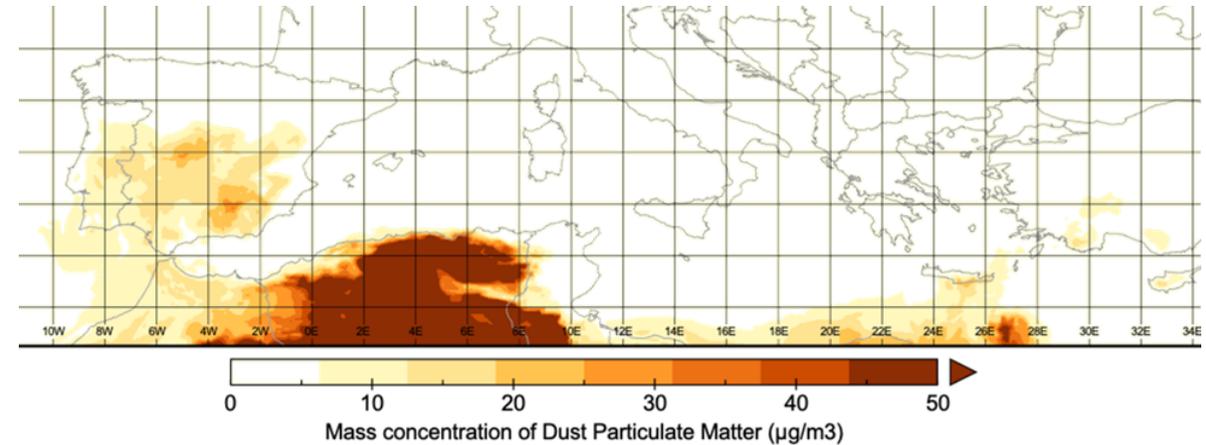
CAMS Regional systems upgrades

- **June 2019:** extension to 72ºN; 9 members of the ensemble (DEHM, DK; GEM-AQ, PL) instead of 7; dust and secondary inorganic particulate matter species added to the outputs.

- **January 2020:** 3 particulate matter species added to the outputs (wildfire, elemental carbon from fossil fuel, elemental carbon from residential wood burning)

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#SEETHEAIR

S. PAPATHANASIOU
@SFOTONIUM
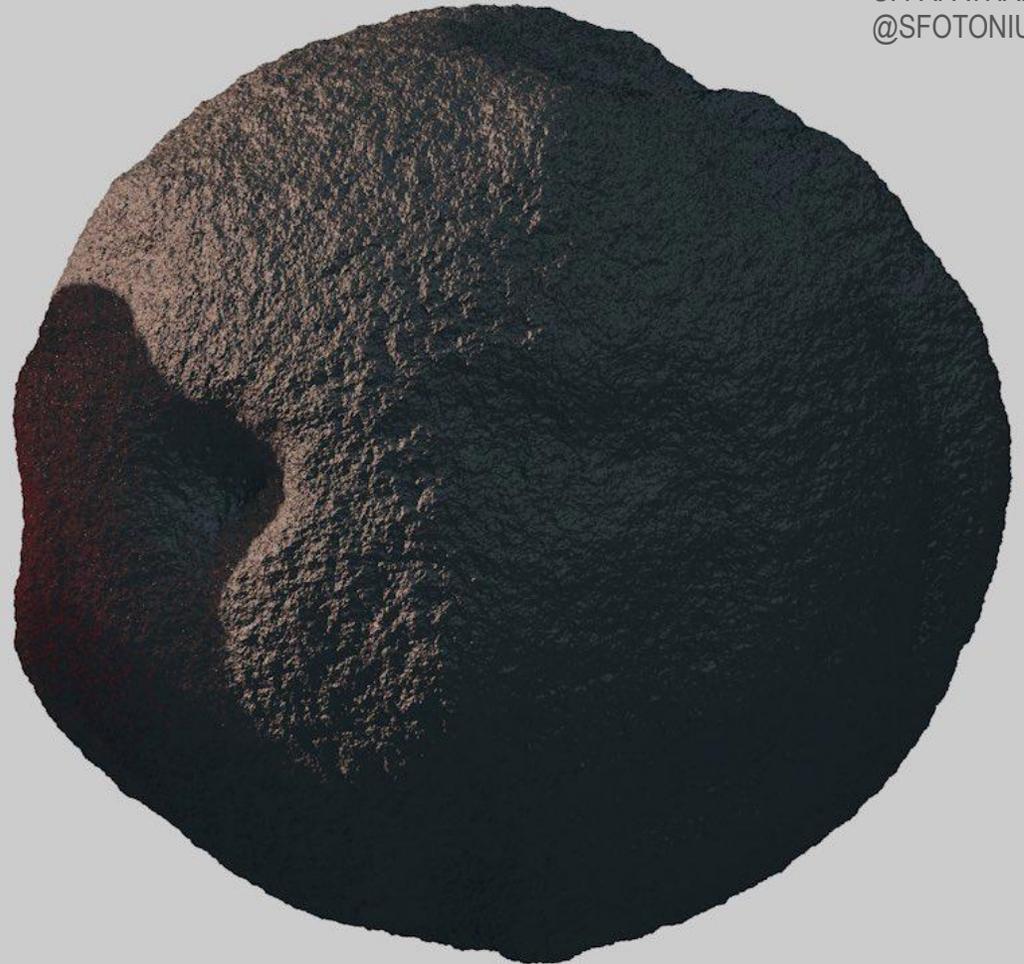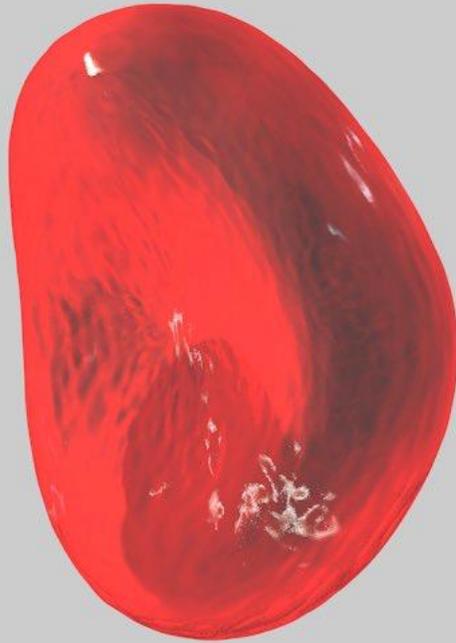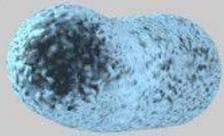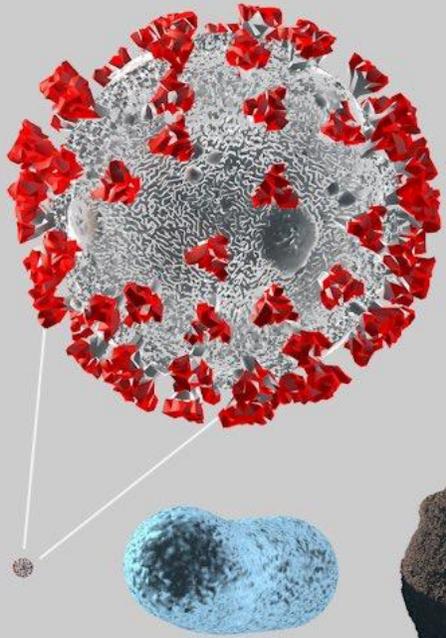
COVID-19   BACTERIA   PM2.5   RED BLOOD CELL   PM10

60–140nm   ~1μm   <2.5μm   ~7μm   ≤10μm

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- cause-effect relationship between long-term and short-term exposure to air pollution and COVID-19?

- can Particulate Matter act as a vector for the SARS-CoV-2 and can this play a role in COVID-19 transmission?

- what are the changes in emissions and concentrations of key pollutants and greenhouse gases induced by lockdown measures?

- have temporary changes in concentrations had an impact on reducing morbidity and mortality due to air pollution?
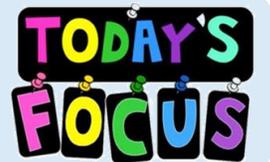
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Sentinel-5P / Tropomi NO_2 Total Column

Mid-March to mid-April 2019
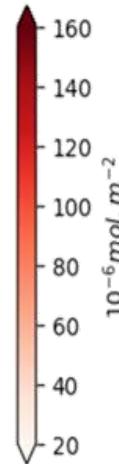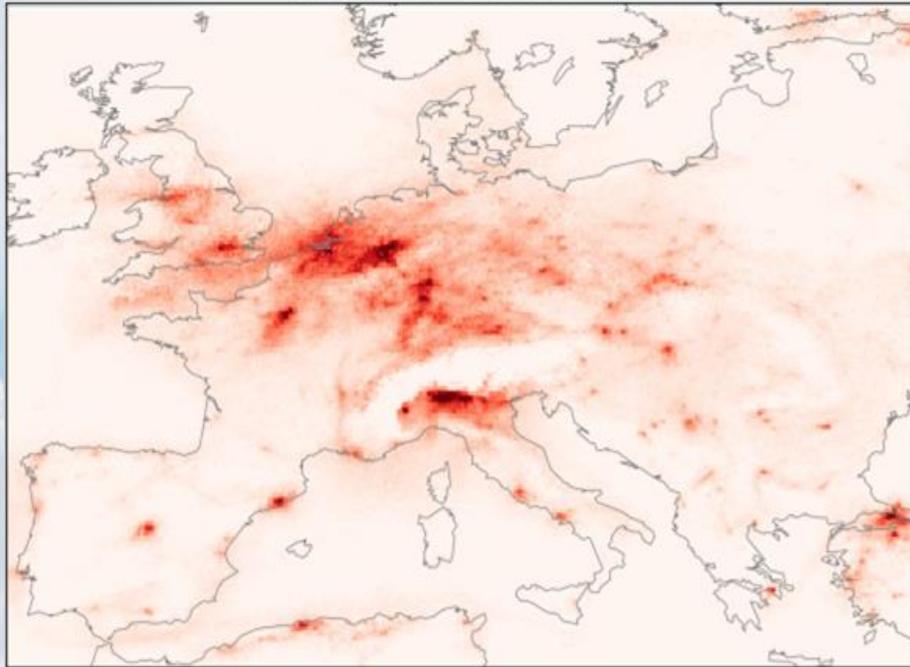
Mid-March to mid-April 2020
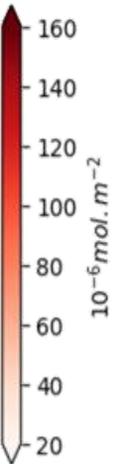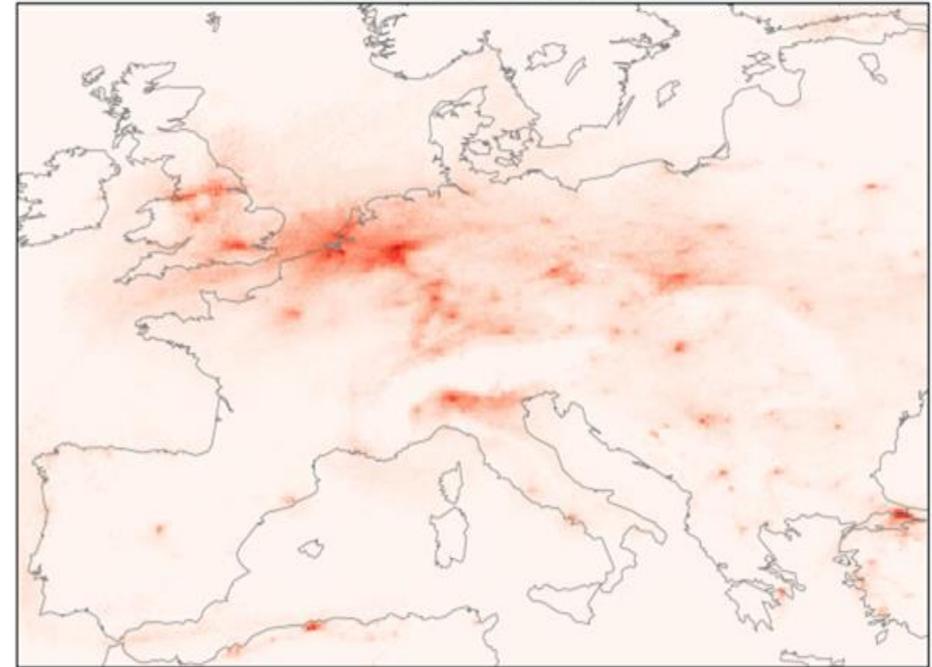
Satellite images from TROPOMI have had an extraordinary impact in the media. In the lot, there has been quite a lot of wrong interpretation as well (too short periods and role of weather, expected seasonal changes, misuse of quality flags…).

S-5P NO_2 total column provision: ESA, KNMI (NL)
S-5P NO_2 total column processing: ECMWF

esa   ECMWF   Copernicus   European Commission

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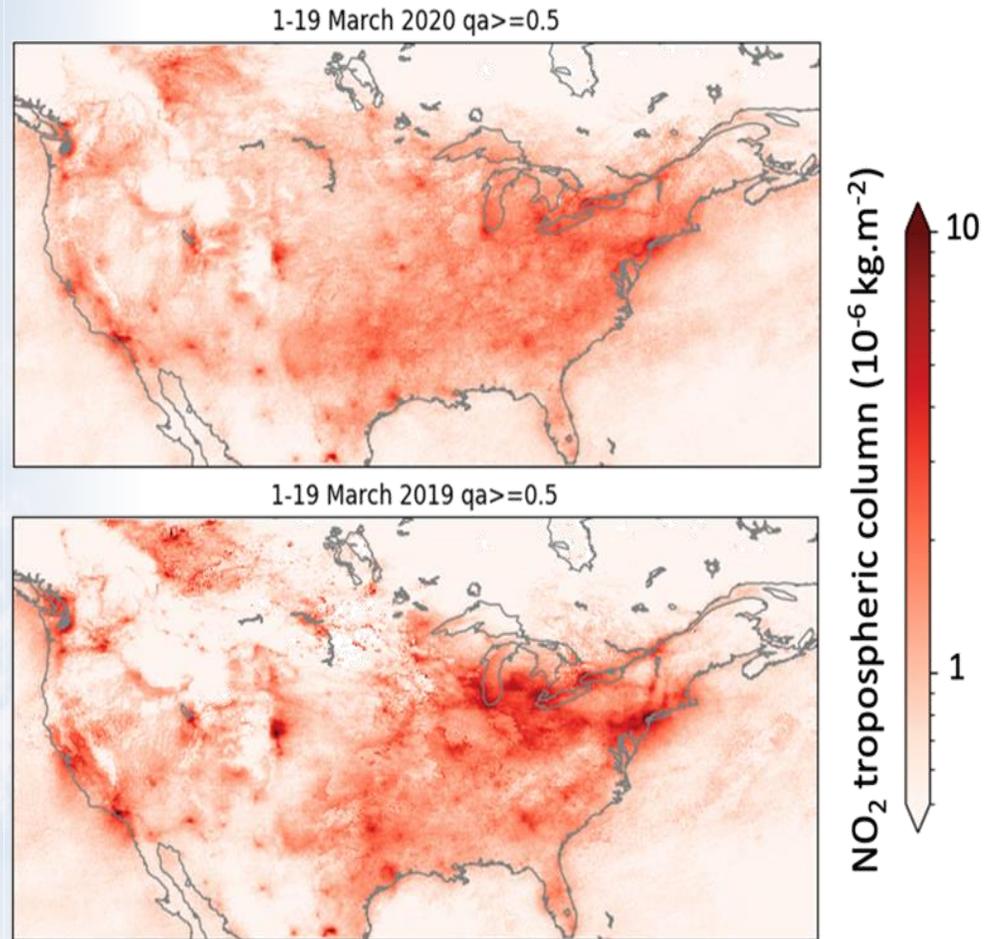
In the last week of March, images similar to the above made a big splash in the news, showing (after China, Europe) that there were already substantial reductions in NO$_2$ all over the US... while there were restriction measures in place in only few areas...

S-5P NO$_2$ total column provision: ESA, KNMI (NL)
S-5P NO$_2$ total column processing: ECMWF

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1-19 March 2020 qa>=0.5

1-19 March 2019 qa>=0.5

1-19 March 2020 qa>=0.75

1-19 March 2019 qa>=0.75

NO_2 tropospheric column (10^{-6} kg.m^{-2})

10

1
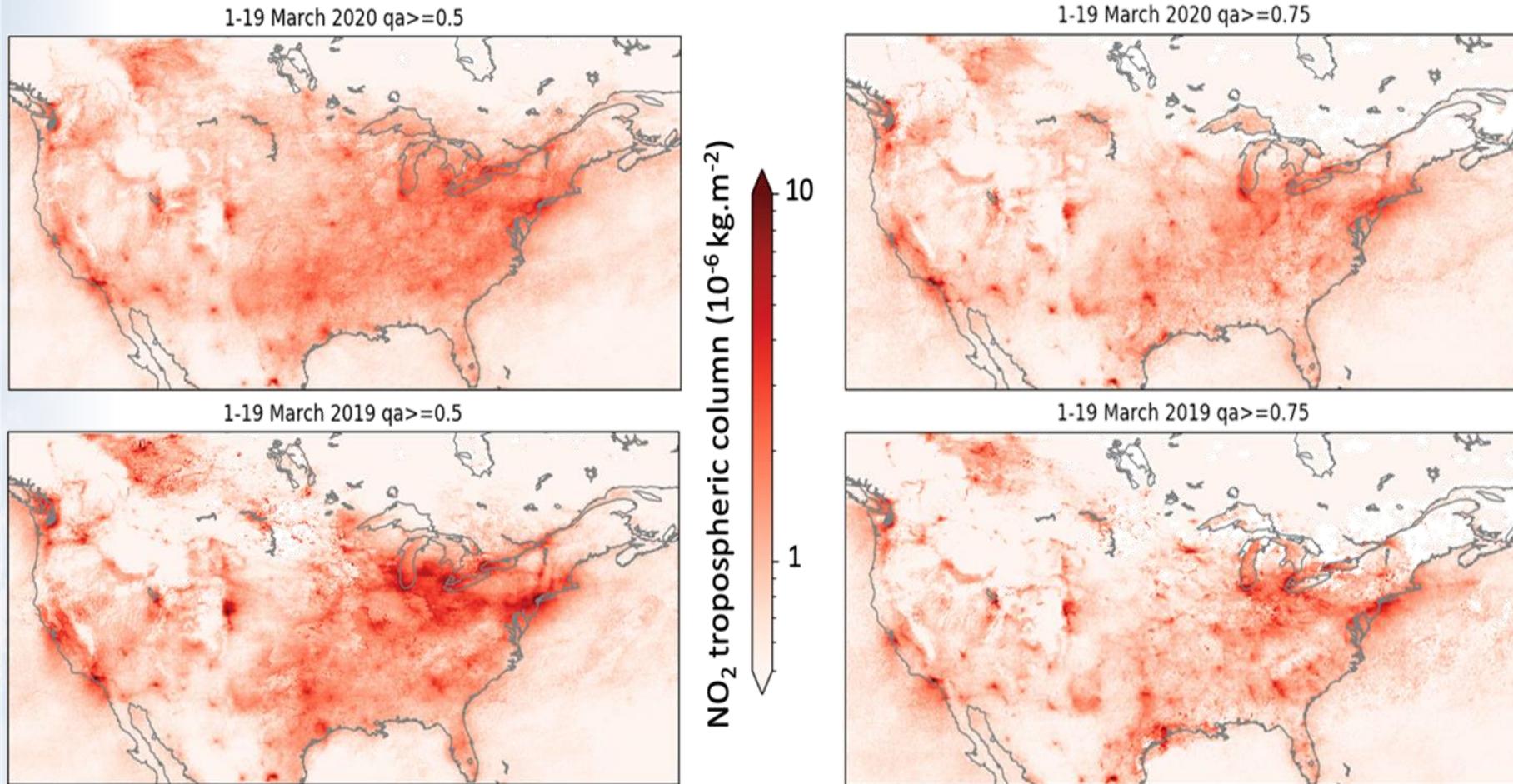
"Good" data only

But when following ESA's recommendation to focus on less cloudy data (qa_value > 0.75), the fairly striking differences vanish to a large extent…

S-5P NO_2 total column provision: ESA, KNMI (NL)
S-5P NO_2 total column processing: ECMWF

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Athens NO2 CAMS Surface (12:30 UTC) and S5P Total Columns 2020

Vertically integrated NO$_2$ column (Sentinel-5P, ~5km)

Surface NO$_2$ (CAMS analyses, ~10km)
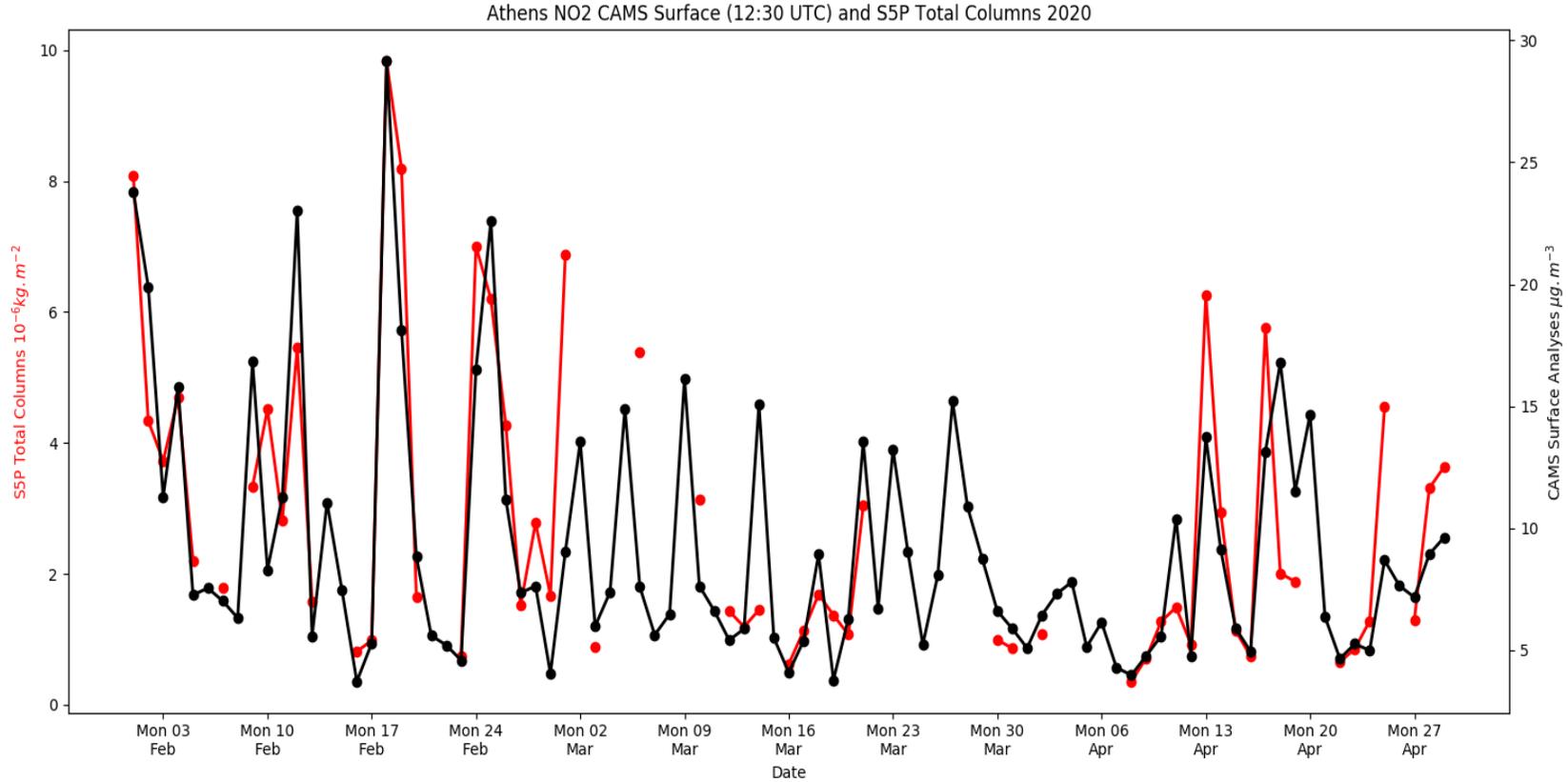
The two fully independent (and different) variables taken at the satellite overpass time are remarkably and almost unexpectedly consistent. Similar results are found in other parts of the world.

S-5P NO$_2$ total column provision: ESA, KNMI (NL)
S-5P NO$_2$ total column processing: ECMWF

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Weather and air quality are tightly connected. It is thus very challenging to detect signals due to changes in emissions unambiguously.

Madrid NO2 CAMS Surface daily_mean

CAMS forecasts (business as usual emissions)

NO$_2$ is going down with season
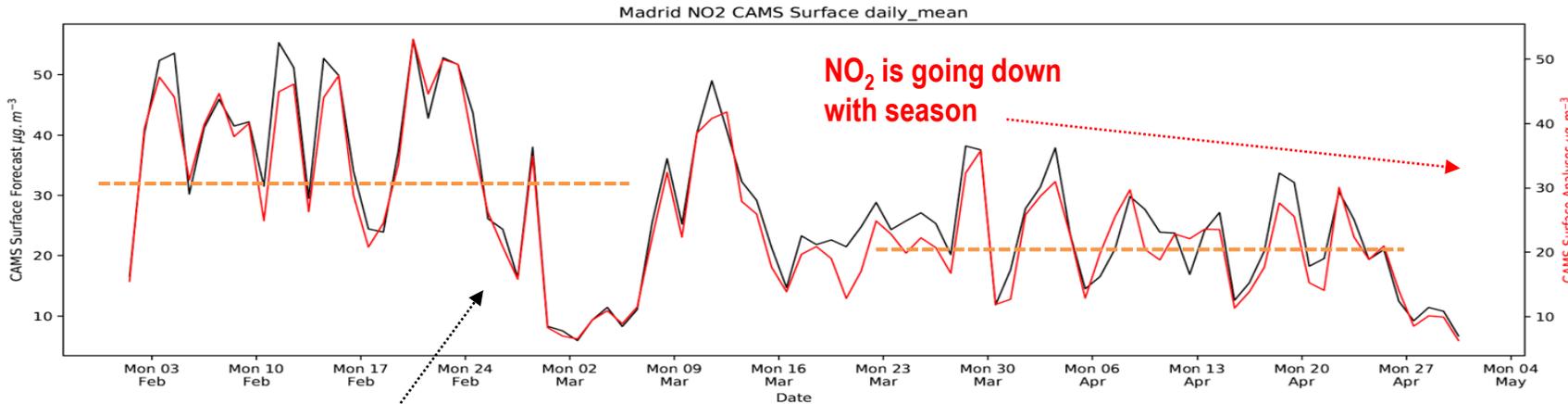
CAMS analyses (includes observations)

Planetary Boundary layer height

Madrid ECMWF NWP daily_mean

Major influence of weather on synoptic timescales

…and on seasonal scales: PBL height is going up

Wind speed

ECMWF Copernicus Europe's eyes on Earth European Commission

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

CAMS NO2 daily mean analysis Turin 19 Apr 2020
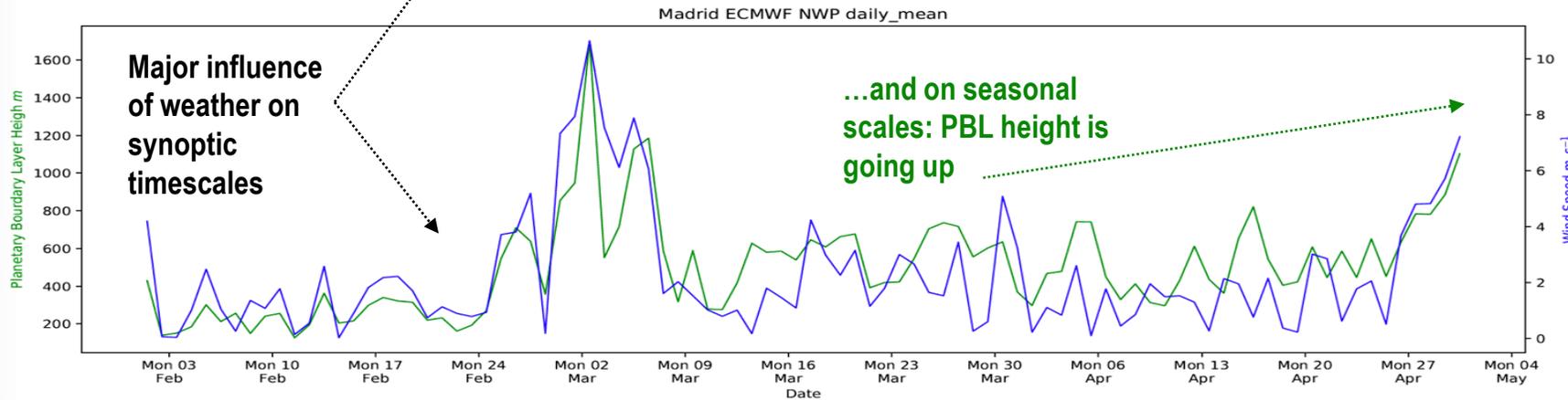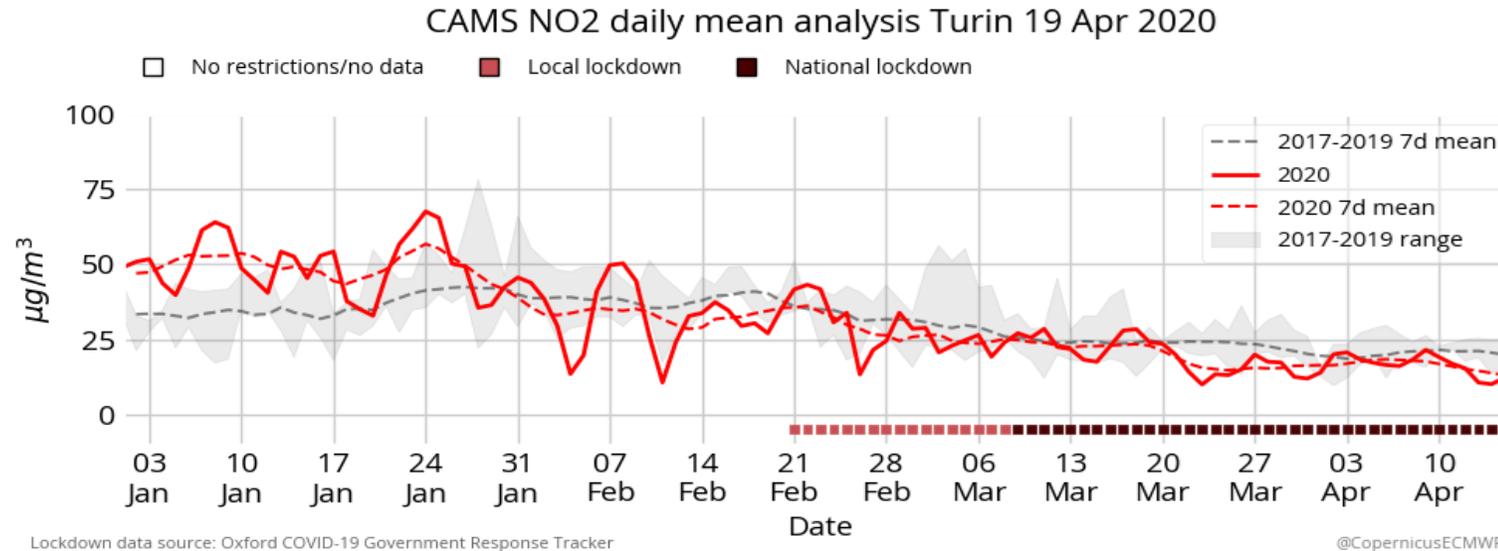
CAMS provides resources to address this complex "changes" question in complementary ways:

- climatological anomalies (2020 vs 2019, 18…): **is this year different?**
- data assimilation increments (analysis vs control run): **what observations tell that is not in BAU models?**
- daily scenario runs (BAU emissions vs COVID emissions): **estimate emissions and run models to compute delta's**

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NO2 levels are lower than usual in most European cities

weekly NO2 levels compared to 2017-2019 average

lower · · · · · · higher

	Jan	Feb	Mar	Apr	May
Amsterdam					
Athens					
Barcelona					
Belgrade					
Berlin					
Bern					
Bratislava					
Brussels					
Bucharest					
Budapest					
Copenhagen					
Dublin					
Helsinki					
Lisbon					
Ljubljana					
London					
Luxembourg					
Madrid					
Milan					
Oslo					
Paris					
Prague					
Riga					
Rome					
Stockholm					
Tallinn					
Turin					
Vienna					
Warsaw					
Zagreb					
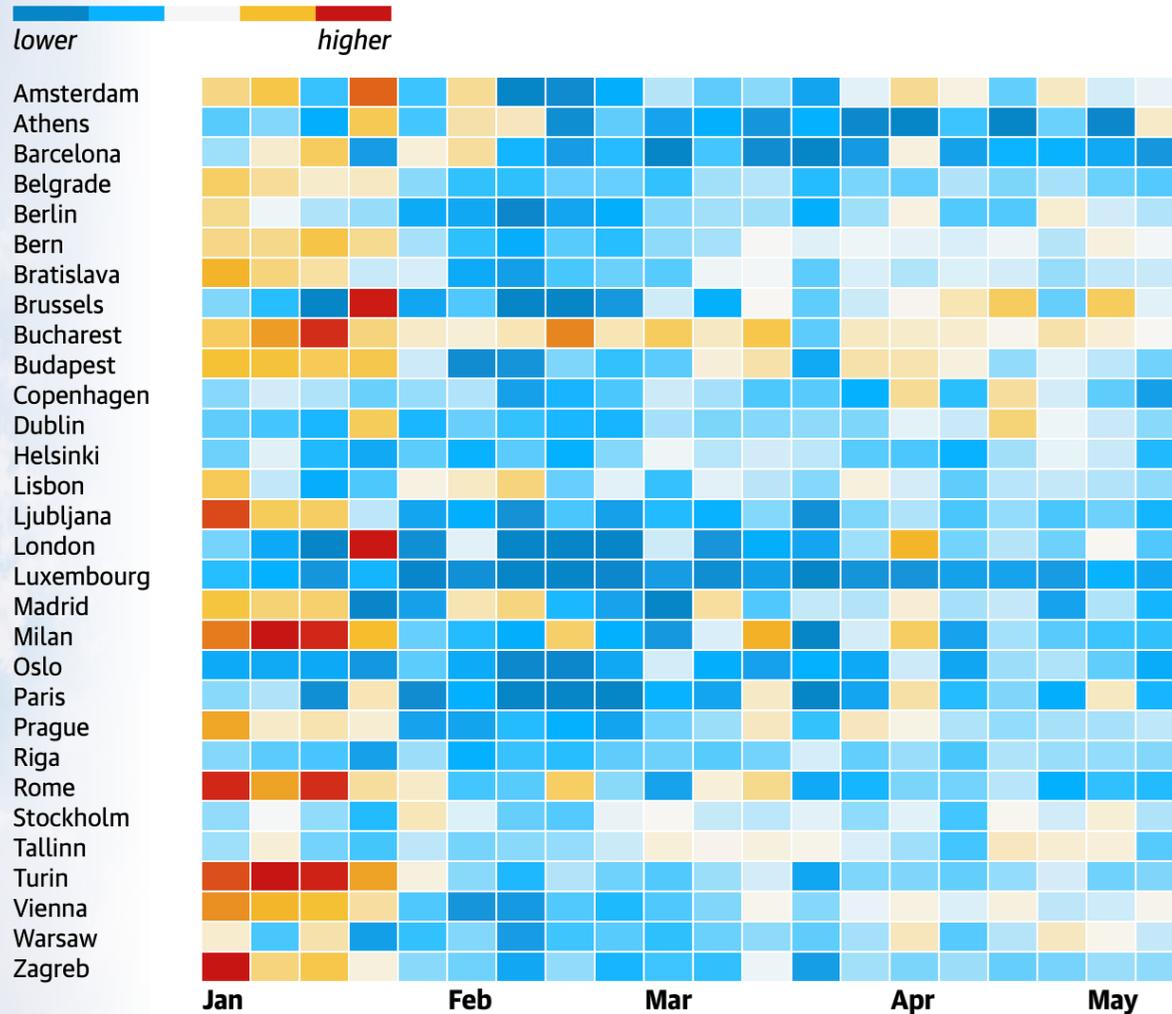
Source: Copernicus Atmospheric Monitoring Service

Air pollution in China back to pre-Covid levels and Europe may follow

Cleaner skies were a silver lining of pandemic but data indicates air quality receding as lockdowns eased

● **Coronavirus – latest updates**
● **See all our coronavirus coverage**

Damian Carrington *and* **Niko Kommenda**

Wed 3 Jun 2020 09.18 BST

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Satellite data used
(MODIS, NASA)
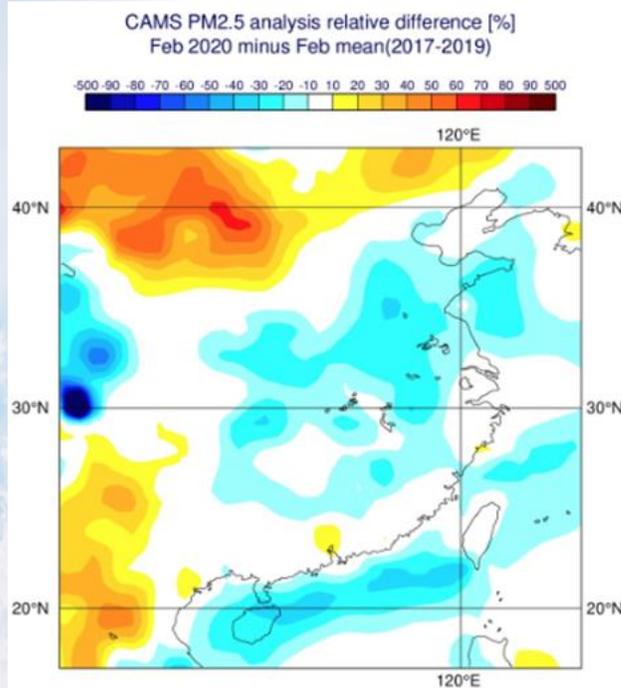
Model only
(business as usual emissions)

CAMS PM2.5 analysis relative difference [%]
Feb 2020 minus Feb mean(2017-2019)

CAMS PM2.5 control relative difference [%]
Feb 2020 minus Feb mean(2017-2019)
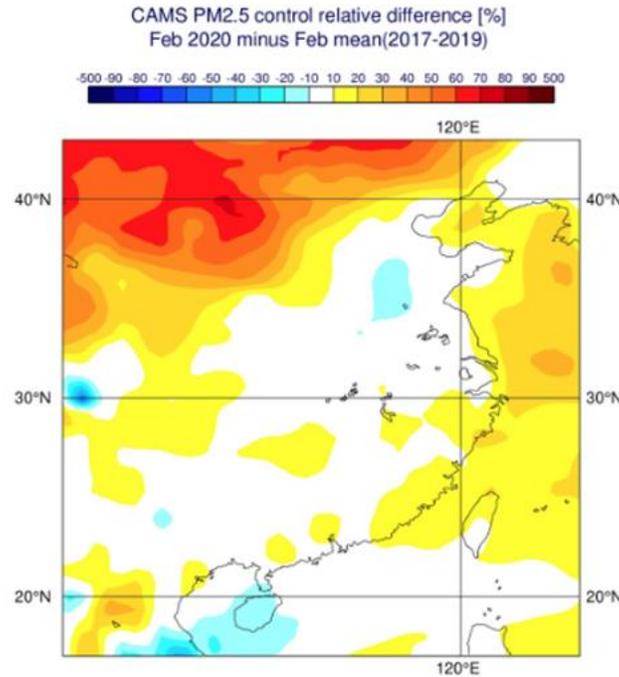
Percentile difference of PM2.5 levels at the surface for February 2020 relative to the February mean over the years 2017-2019.

CAMS could quantify that levels of fine particulate matter for almost all of China were 20 to 30% below what would be expected with "business as usual" emissions.

CAMS global reanalysis (2003-present) and CAMS daily global analyses: ECMWF

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Lobelia Earth (Spain) & KNMI (The Netherlands)

https://www.lobelia.earth/covid-19
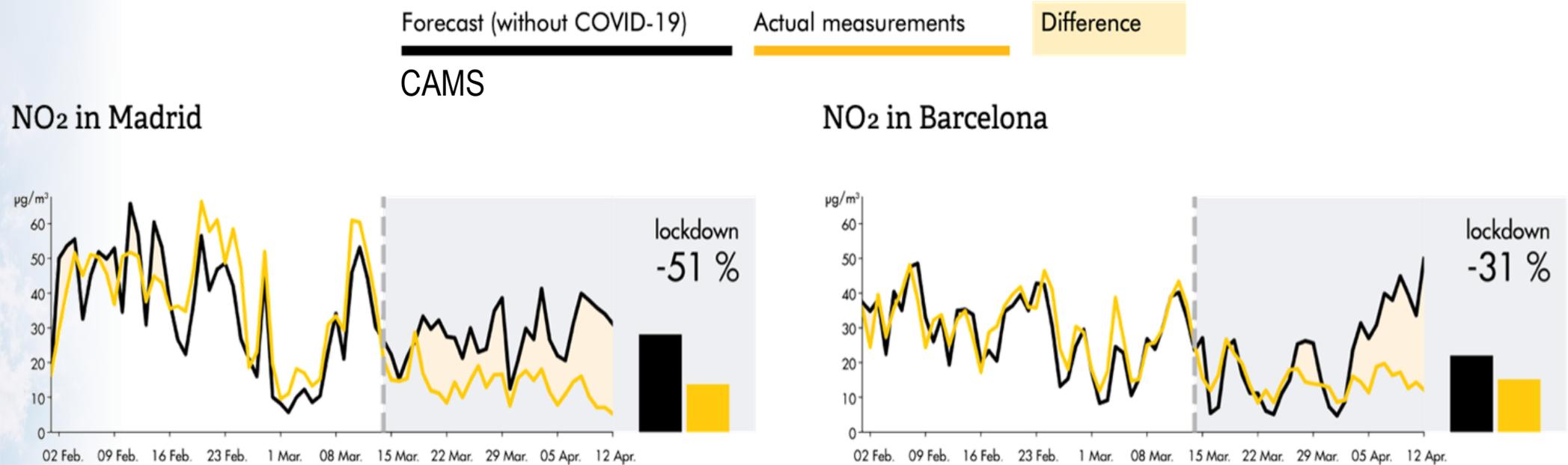
Using the fact that CAMS forecasts are generally very accurate and that they are run with "business as usual" emissions: forecast error is interpreted as emissions changes (for NO_2).

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Barcelona Super computing Centre (Spain)

Country emissions reduction factors (road transport)
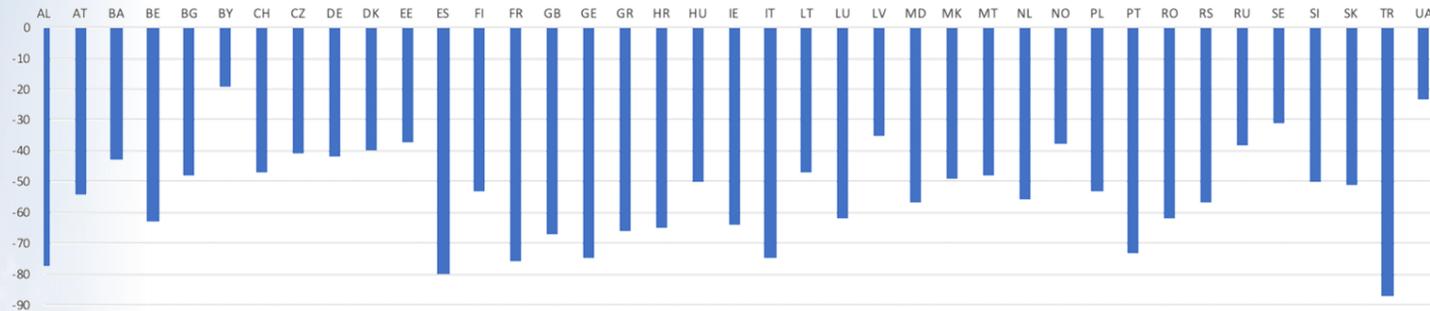
Country emissions reduction factors (industry)

Country emissions reduction factors (aviation)

Estimating emissions from diverse sources (mobility, activity reports…) will be an essential input for future assessment work. Target: daily/country emissions reduction factors for the lockdown period.

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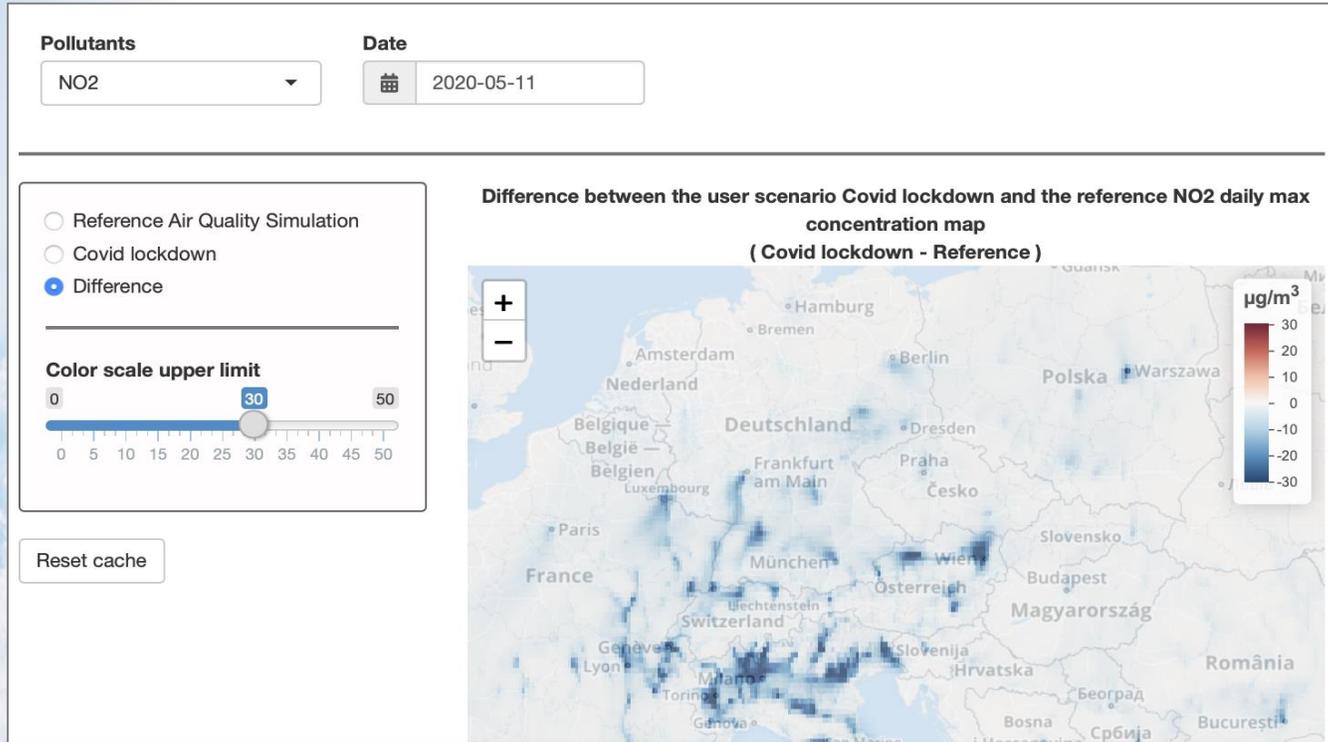
INE·RIS

Ineris (France)

Daily scenario runs (BAU
vs COVID-19) are
compared to provide a
daily estimate of
expected impacts on key
pollutants.

Finally, CAMS works with WMO to help structure and organise the
efforts of 100+ teams from across the world within the Global
Atmospheric Watch programme

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@VHPeuch
@RichardJEngelen
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@AntjeInness
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