Using EMEP model in CAMS analysis of pollution episodes in European cities

Atmosphere Monitoring

Cooperation between EMEP and CAMS

Presented by Svetlana Tsyro

PROGRAMME OF THE EUROPEAN UNION
Copernicus Europe's eyes on Earth
IMPLEMENTED BY ECMWF
Norwegian Meteorological Institute

TFMM 24-th meeting
Warsaw, May 10-12, 2023

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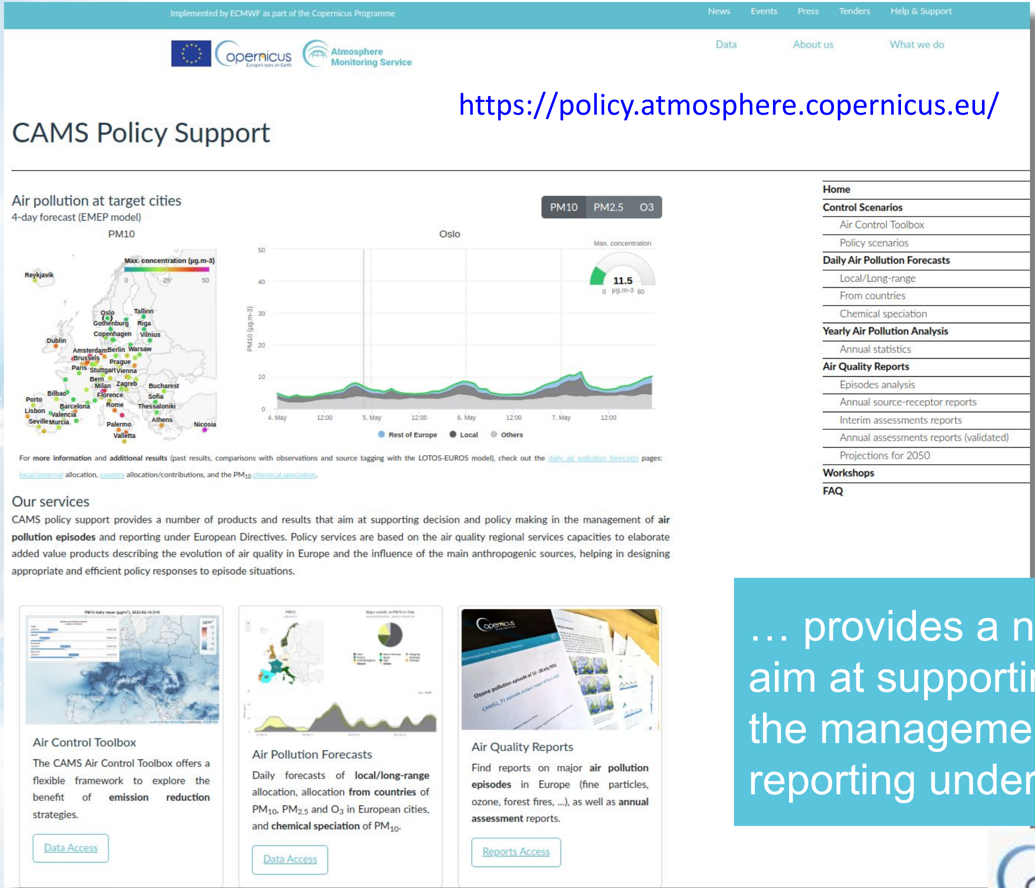
CAMS Policy Support:



The EMEP model is one of the members of the CAMS multi-model ensemble used for CAMS regional services, e.g. operational daily analyses and 4-day forecasts of air quality, and reanalysis.

Also, it contributes within CAMS Policy Support Service.

… provides a number of products and results that aim at supporting decision and policy making in the management of **air pollution episodes** and reporting under European Directives

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CAMS Policy Products: source allocation for PM and ozone

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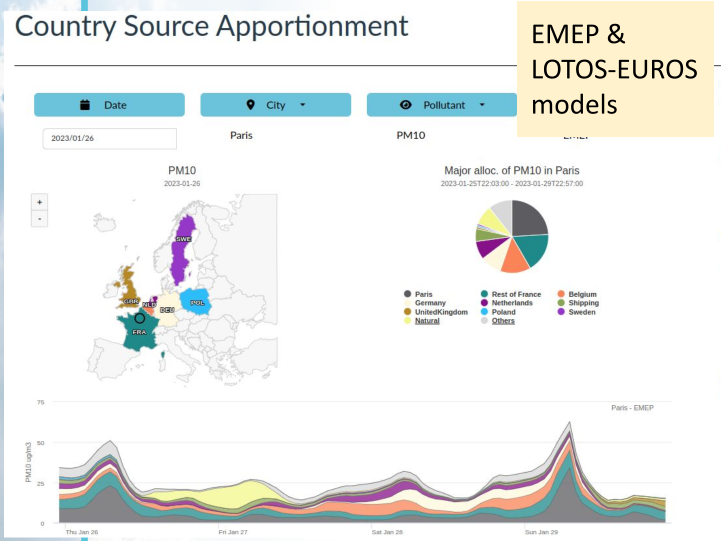
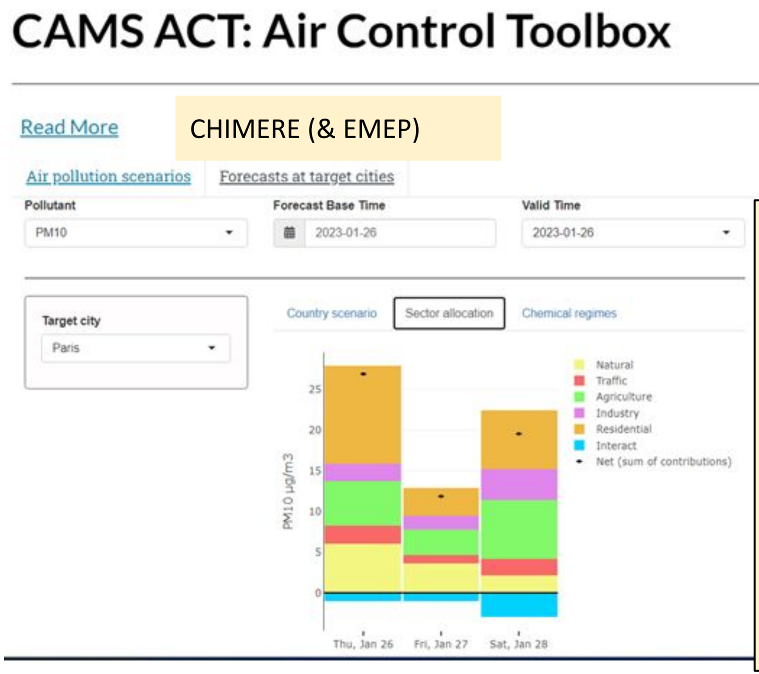
https://policy.atmosphere.copernicus.eu/

Source Contribution to EU Cities



EMEP & LOTOS-EUROS models

In addition, modelled PM10 country allocation and chemical composition and comparison PM10 with observations from 2019 onwards



CHIMERE (& EMEP)

In addition: country scenarios, chemical regimes

Use of the Policy Products:

- understand origin of episodes
- understand impact of mitigation measures (policy planning)
- identify sources
- compliance checking
- support communication towards the public

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EMEP model setup for the operational runs of SR forecasts

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Simulation domain: 0.25°x0.125° lon-lat

Emissions: CAMS-REG-AP_v5.1 (including condensables from Residential combustion)

Meteorology and Boundary conditions: IFS forecast (ECMWF)

Cities: **80** (popul > 500 000), defined as 3x3 grids (appr. 42x42 km)

Daily 4-day forecasts, starting at 3:30 UTC: **75 runs** in total

- 1 Base run
- 40 city reductions (2 cities in each run)
- 31 country reductions
- 1 Shipping reduction, 1 BCs reduction, 1 all domain reduction

15 % reduction of all emissions for the source region:

For each city, **hourly timeseries** are produced for **PM_{10}, $PM_{2.5}$, ozone,** Including source allocation

The results are visualized on the **web interface CAMS Policy Support**:
https://policy.atmosphere.copernicus.eu/

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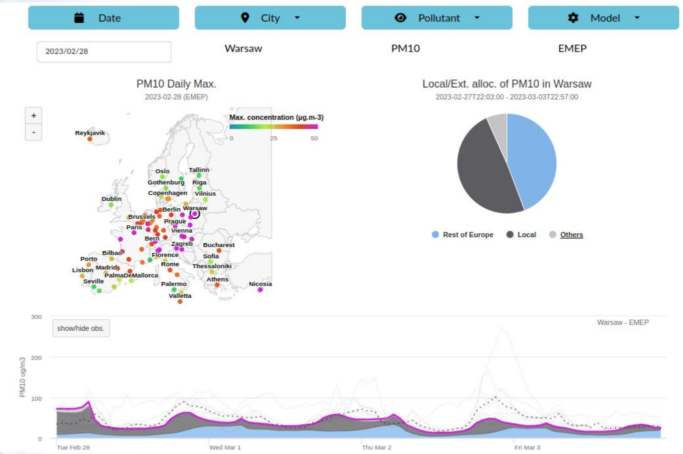
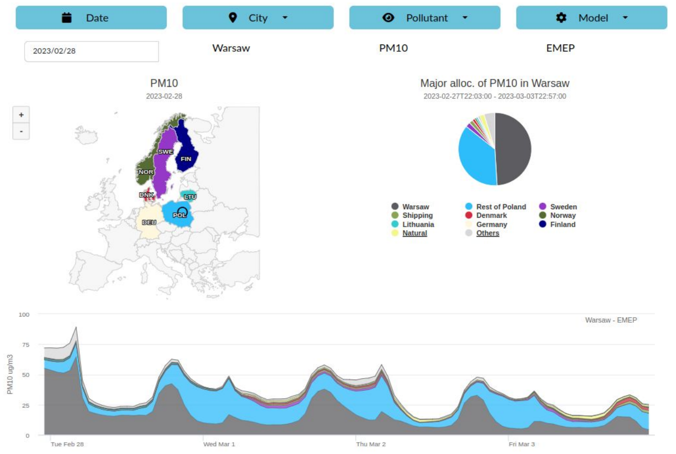
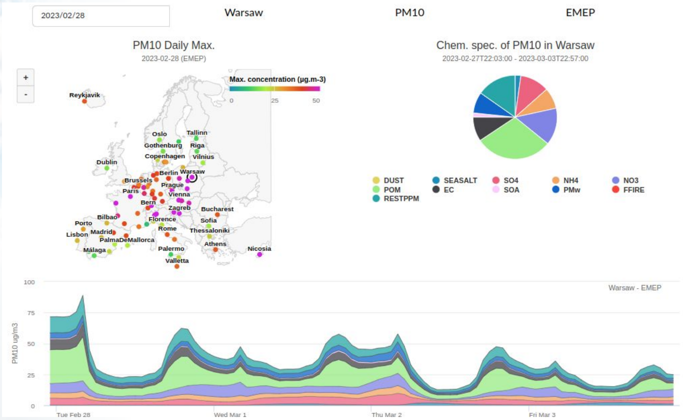
EMEP forecast for Warsaw (28 Febr - 3 March 2023)







Hourly timeseries for **PM_{10}, $PM_{2.5}$, ozone:**

- Local (city) and long-range contributions
- Top 10 sources-contributors
- Chemical speciation for PM
- EEA observations (for PM_{10} currently)

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Yearly Air Pollution Analysis: daily timeseries PM10 (Warsaw, 2022)

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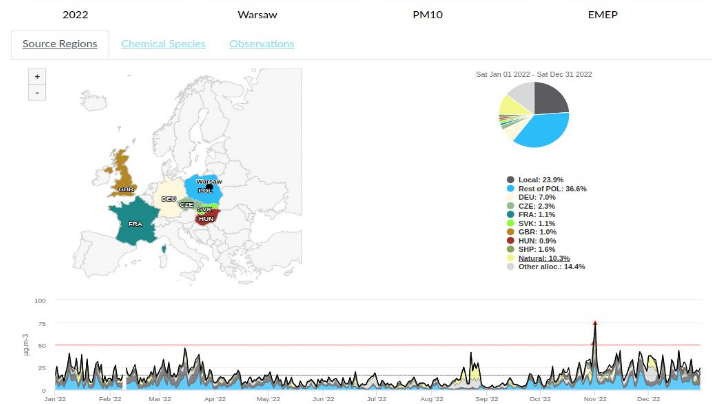

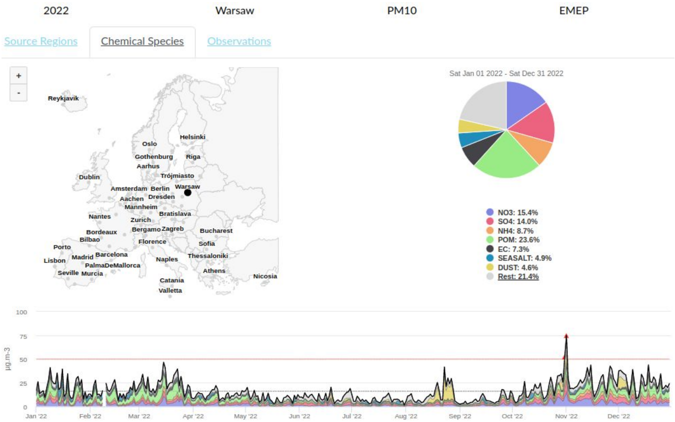

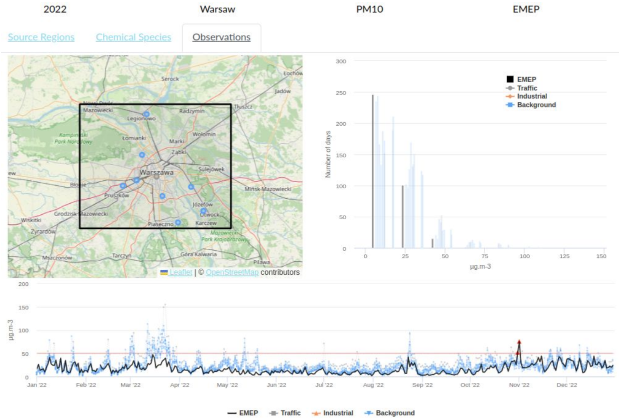

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Episode Reports

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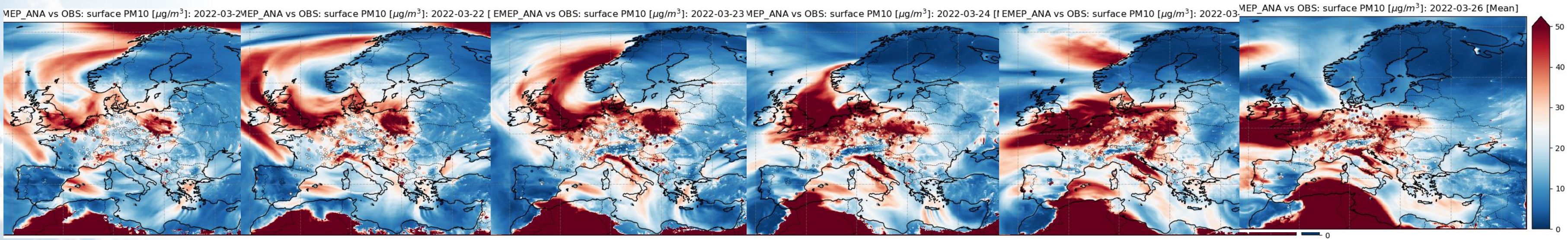
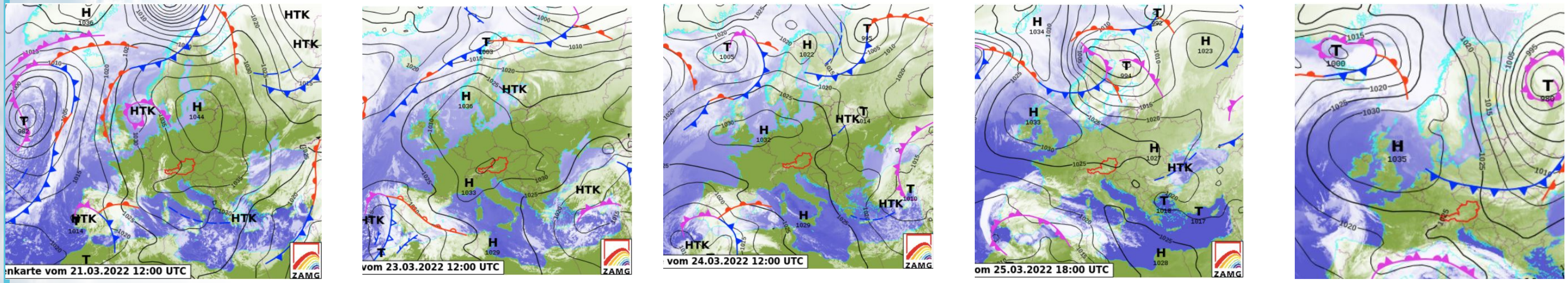
PM10 episode 20-27 March 2022

Practically all capitals in central/western Europe experienced several days with daily PM10 above 50 μg/m3

March 21 | March 22 | March 23 | March 24 | March 25 | March 26





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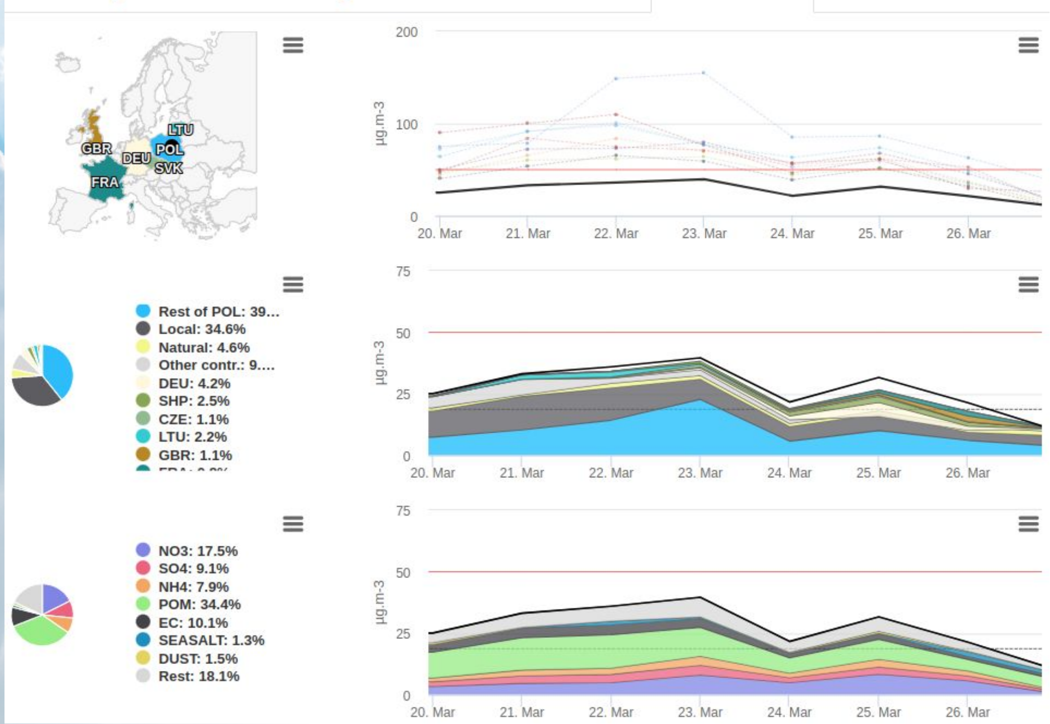
PM10 episode 20-27 March 2022: analysis for Warsaw

Daily time-series of PM_{10} concentrations, source allocation and chemical composition for Warsaw during the PM_{10} episode from EMEP model simulations. https://policy.atmosphere.copernicus.eu/YearlyStatistics.php.



- ➔ One of the most affected cities (4-7 exceedance days observed)
- ➔ The major sources of PM_{10} - domestic emissions from Poland (74%): with contributions from the city itself 35% and the rest of Poland 39%.
- ➔ The main PM components: primary organic matter (POM) and nitrate (NO_3^-), which contributed during the most polluted days with around 40% and 15% respectively.
- ➔ EMEP model reproduced the development of the PM episode, but observed PM_{10} are underestimated (coarse model resolution; uncertainties regarding condensables in primary PM emissions, not accounting for temperature dependence of residential PM and ammonia emissions)

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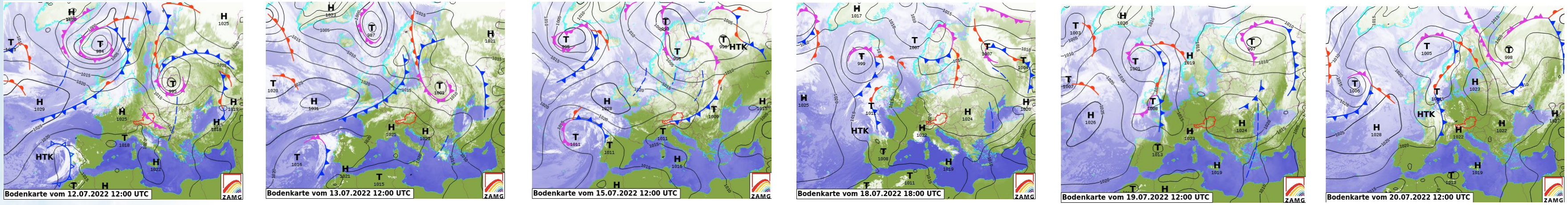
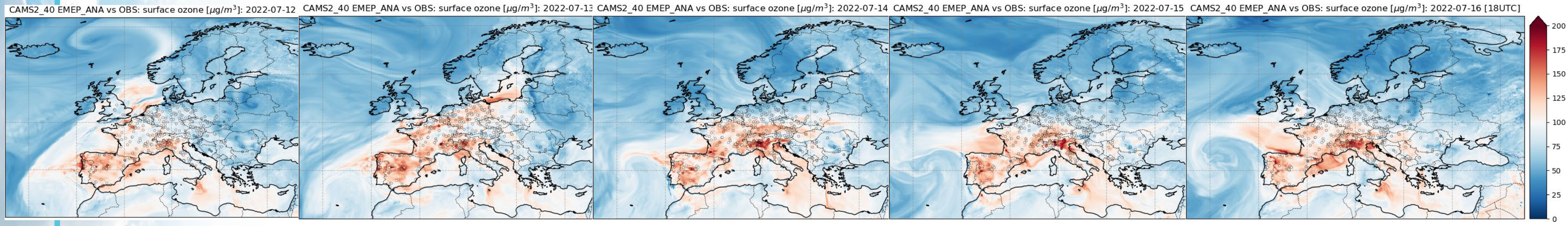
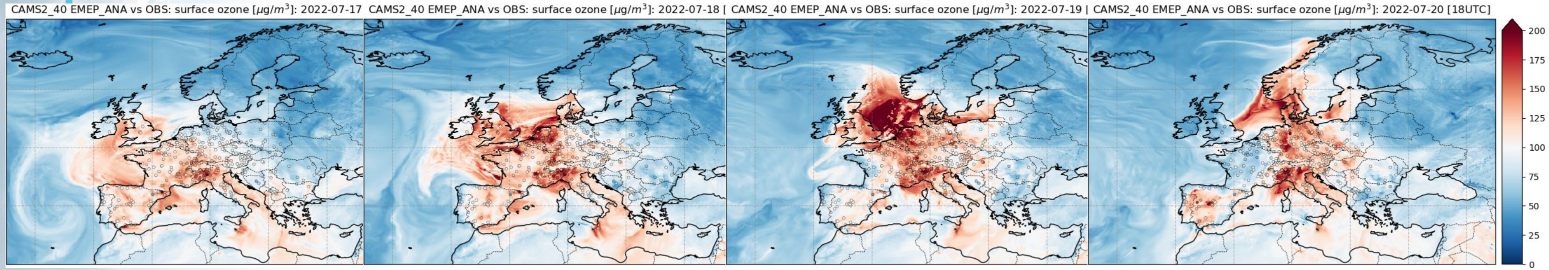
Ozone episode 12-20 July 2022:

CAMS forecast support to the activation of EMEP Ozone IMP



Analysis of the ozone episode: CAMS71 report 3 in 2022





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Ozone episode 12-20 July 2022:

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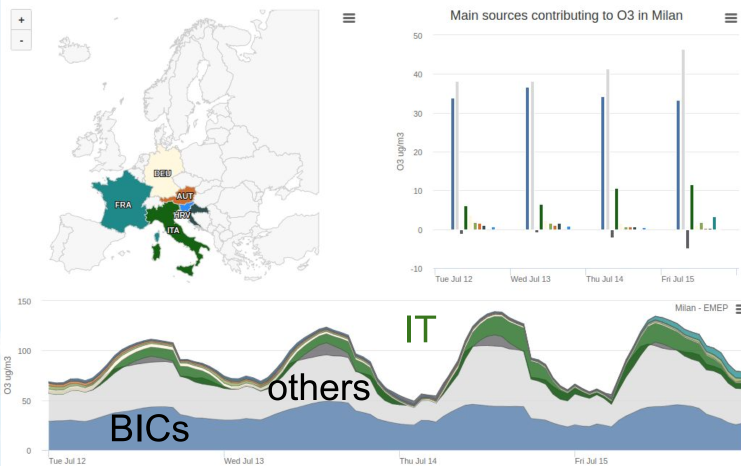
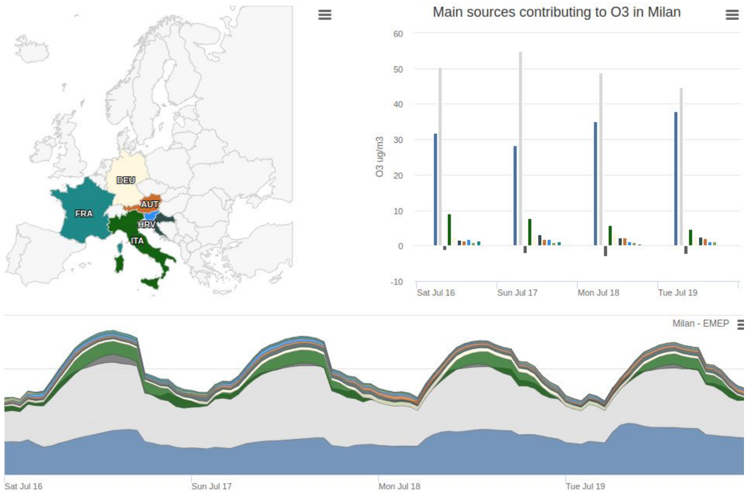
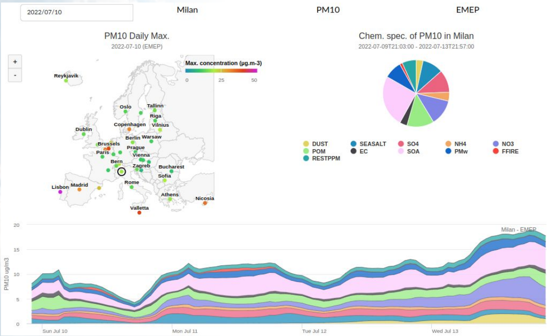
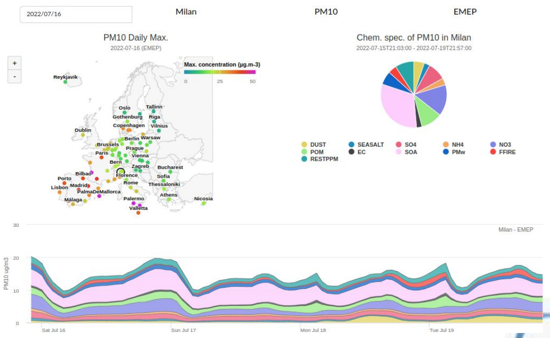
Milan









On the days with higher ozone concentrations, the contribution from BICs decreased wrt that from European sources within the CAMS domain, whereas the effect of domestic emissions increases (city emissions typically titrate ozone).

SOA portion in PM10 increases from 15% to >30% from the days before and during the episode, indicating increased VOC (biogenic, forest fires)

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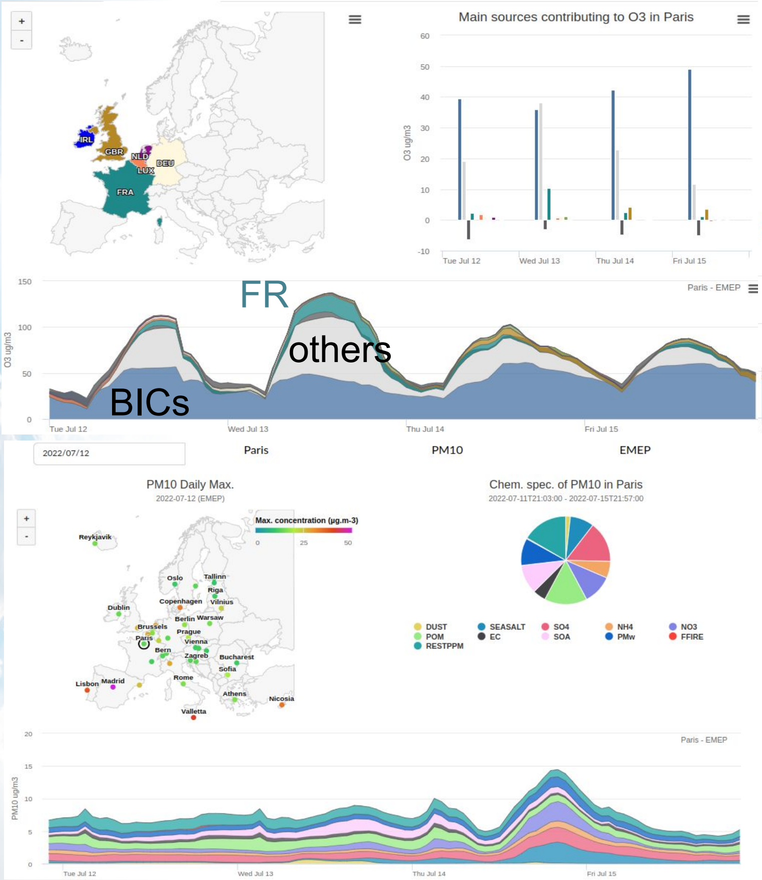
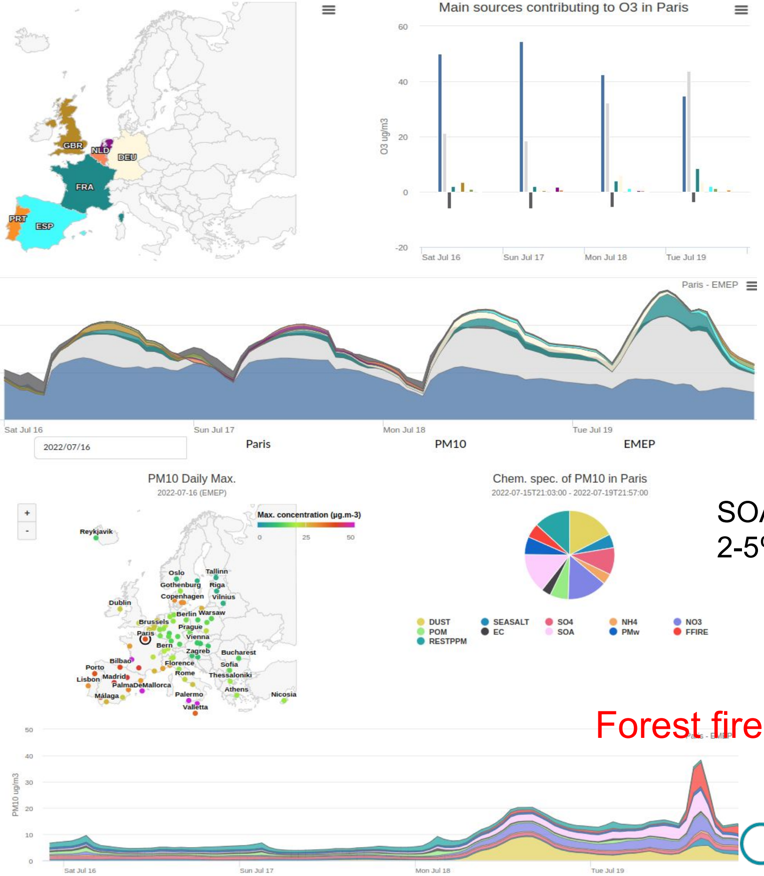
Ozone episode 12-20 July 2022:

Paris





SOA in PM10:
2-5% to 20-25%

Forest fires

Norwegian Meteorological Institute

PM10 episodes due to natural sources

Natural aerosol episodes happen on a regular basis and may impact local air quality and cause/contribute to exceedances of critical levels

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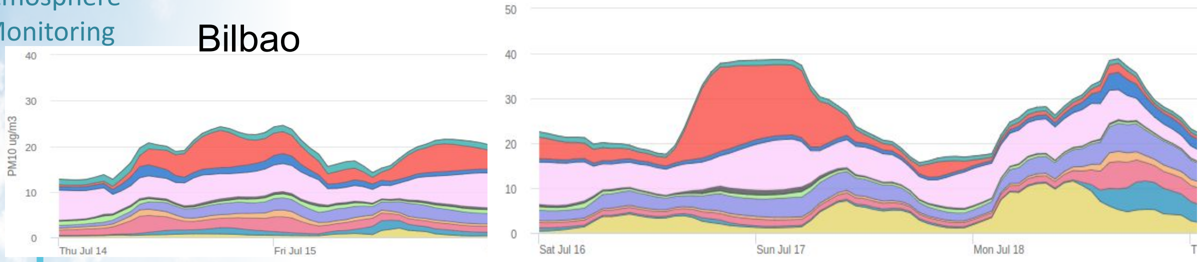
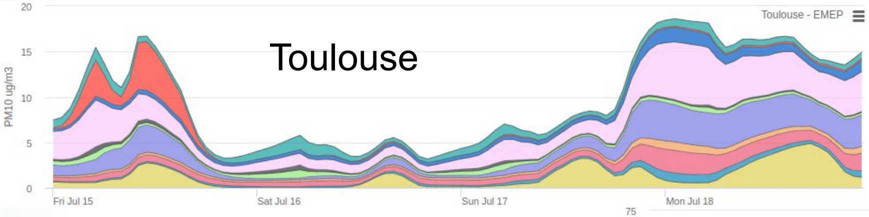
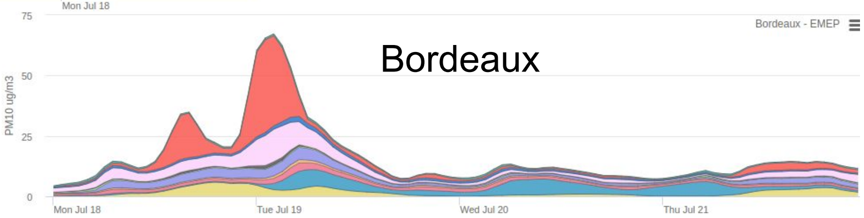
Forest fires episode 14-23 July 2022

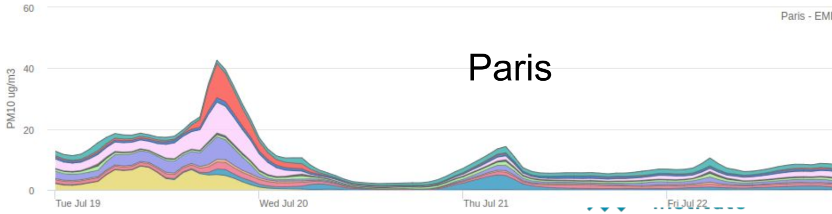
Hourly time-series of PM_{10} concentrations and chemical composition from the 4-day EMEP forecasts

- DUST
- SO4
- NO3
- EC
- PMw
- RESTPPM
- SEASALT
- NH4
- POM
- SOA
- FFIRE









https://policy.atmosphere.copernicus.eu/DailySourceAllocation

Dust & Forest fires episode: 27 Sept - 4 Oct 2020

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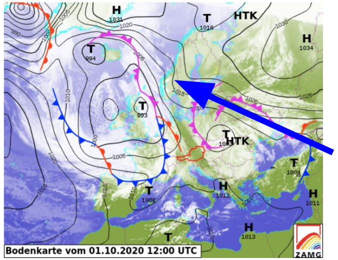
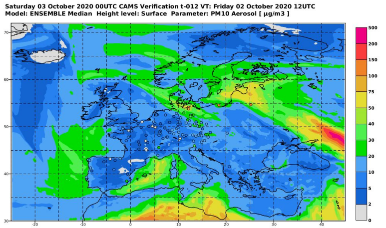
Pollution origin: southern Russia and eastern Ukraine

- ➢ very hot and dry summer resulted in dry bare soils and dried vegetation
- ➢ severe wind storm end of September gave rise to large dust storms and grassland and forest fires

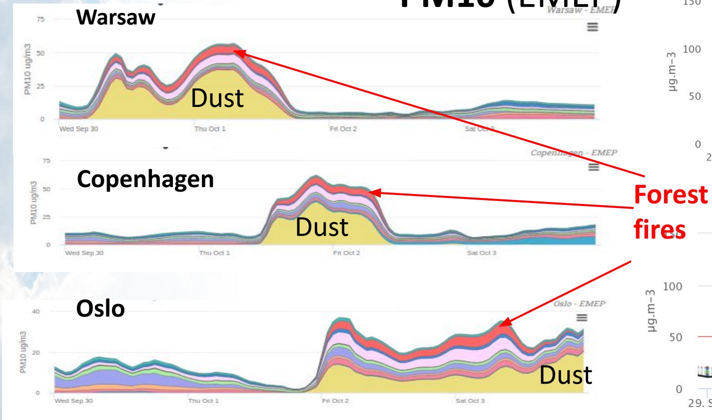
The combination of high pressure over Russia and the lows over E/SE and Western Europe created a kind of channel, where the air could stream from the south of Russia across eastern Europe towards Scandinavia

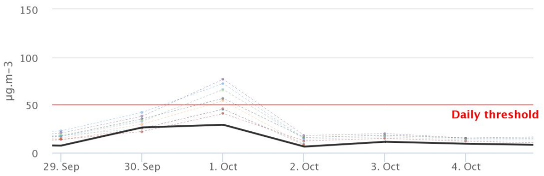


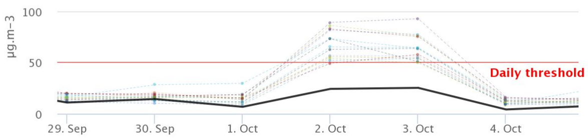
PM10 (CAMS Ensemble forecast)



PM10 (EMEP)







Large amounts of smoke and soil dust were transported by strong winds over Poland, northern Germany, Denmark, Sweden, southern Finland and then onwards through most of Norway.

Hazy air in Western Norway.
Foto: Michael Schulz.

Norwegian Meteorological Institute

Saharan dust episode: 13-18 March 2022

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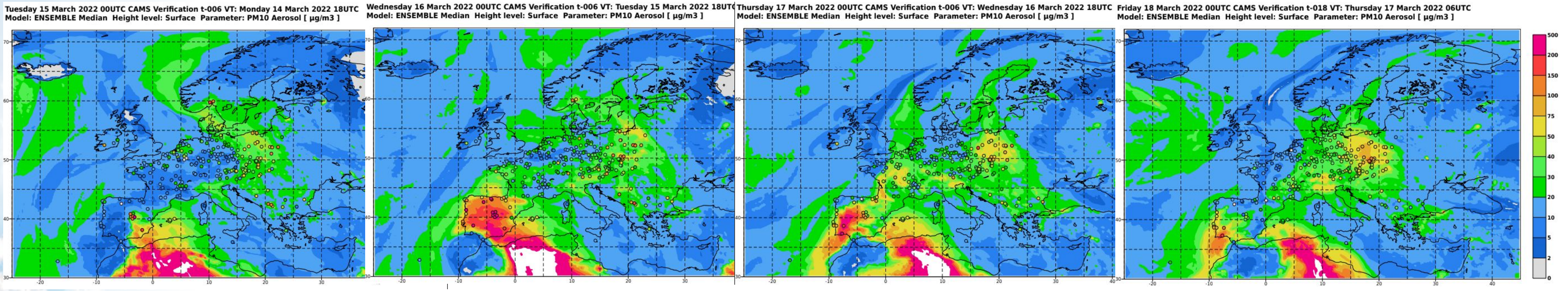
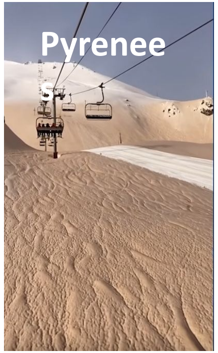
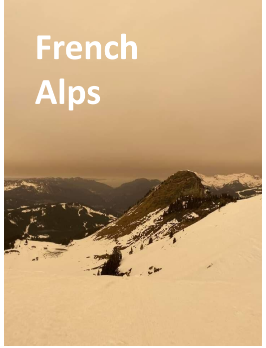
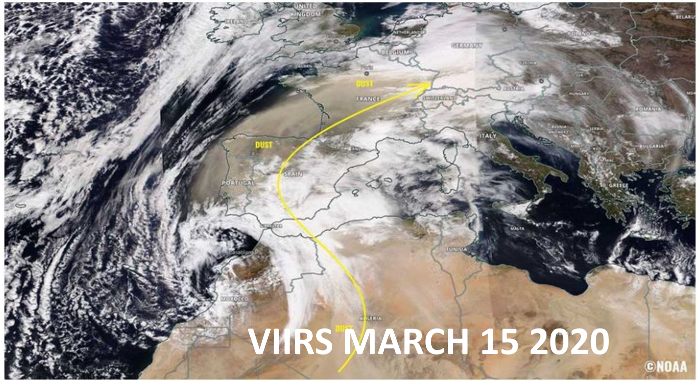
https://regional.atmosphere.copernicus.eu/

MARCH 14 | MARCH 15 | MARCH 16 | MARCH 17









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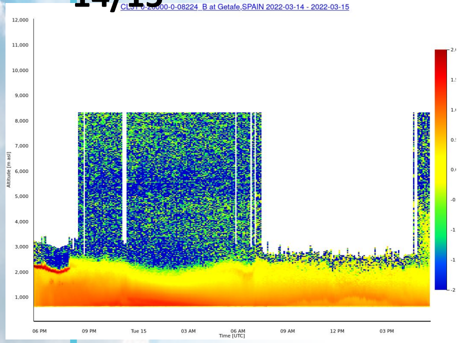
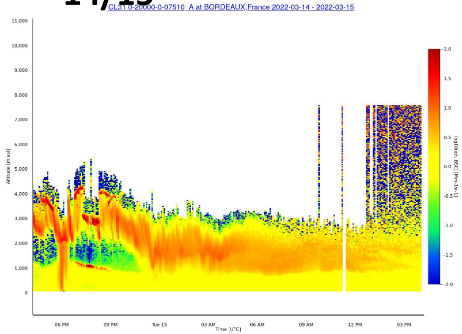
Aerosol backscatter profiles from ceilometer network give indication of the height of dust layer

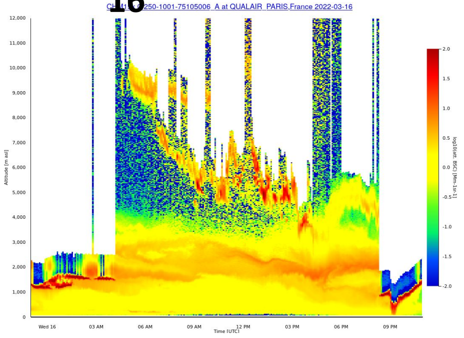
Madrid MARCH 14/15



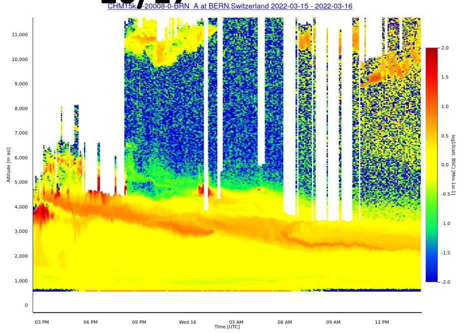
Bordeaux MARCH 14/15



Paris MARCH 16



Bern MARCH 16/17



Source: EUMETNET (e-profile.eu)

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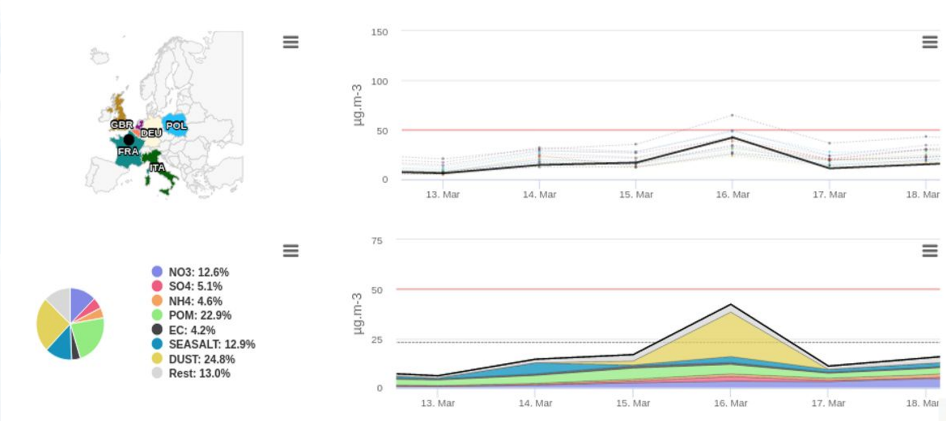
Saharan dust episode: 13-18 March 2022

PM10 Madrid

PM10 Paris



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Dust episode 26-29 March 2020

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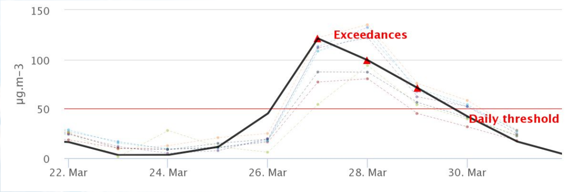
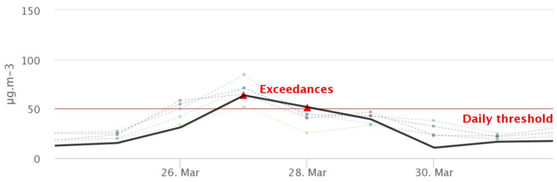
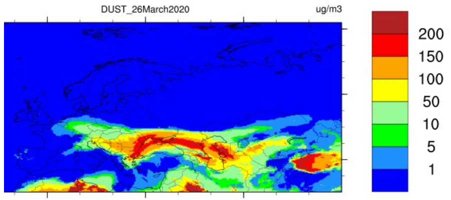
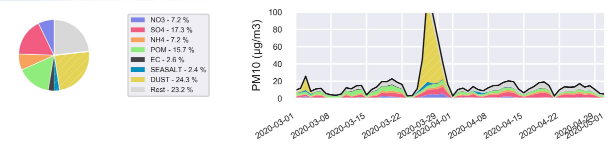
The severe pollution episode on 26-29 March in parts of SE and Central Europe was caused by dust originating in the Aralkum Desert.

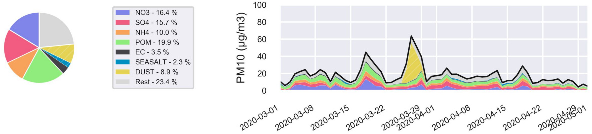
PM10: Sofia | Budapest

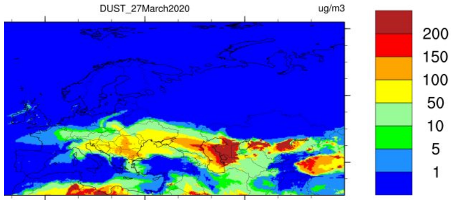












Source: EMEP model, CAMS71 source-receptor forecast

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Summary and concluding remarks

- The EMEP model contributes to CAMS forecasting of air quality and pollution source allocation
- Operational 4-day source-receptor forecasts are performed daily
- Hourly time series of source allocation (SA) are provided for PM_{10}, $PM_{2.5}$ and ozone (and chemical speciation for PM_{10} and $PM_{2.5}$) for 80 EU cities
- The results are used in the analysis of pollution episodes, documented in CAMS Episode reports - one of the CAMS policy support products: examples of ozone, PM (from anthropogenic and natural sources) episodes
- LOTOS-EUROS is the other model contributing to CAMS SA for cities.

  The results from EMEP and L-E differ due to differences in model formulations and setup (resolution, city definition) and SA methodology - to be thoroughly investigated within CAMEO project

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Thanks to my colleagues at MSC-W and CAMS team

Thank you for your attention

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PM10 Surface concentrations two models