AI4 café copernicus

7 September 2021

Monitoring and forecasting air quality in support of health applications

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European Centre for Medium-Range Weather Forecasts (ECMWF)

European Commission

opernicus Europe's eyes on Earth

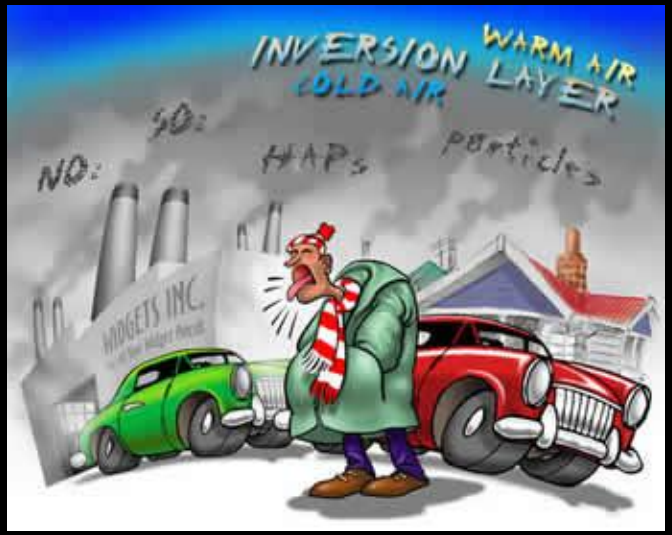
Impleme nted by ECMWF

Why does air quality matter so much for our health?

On average, each one of us

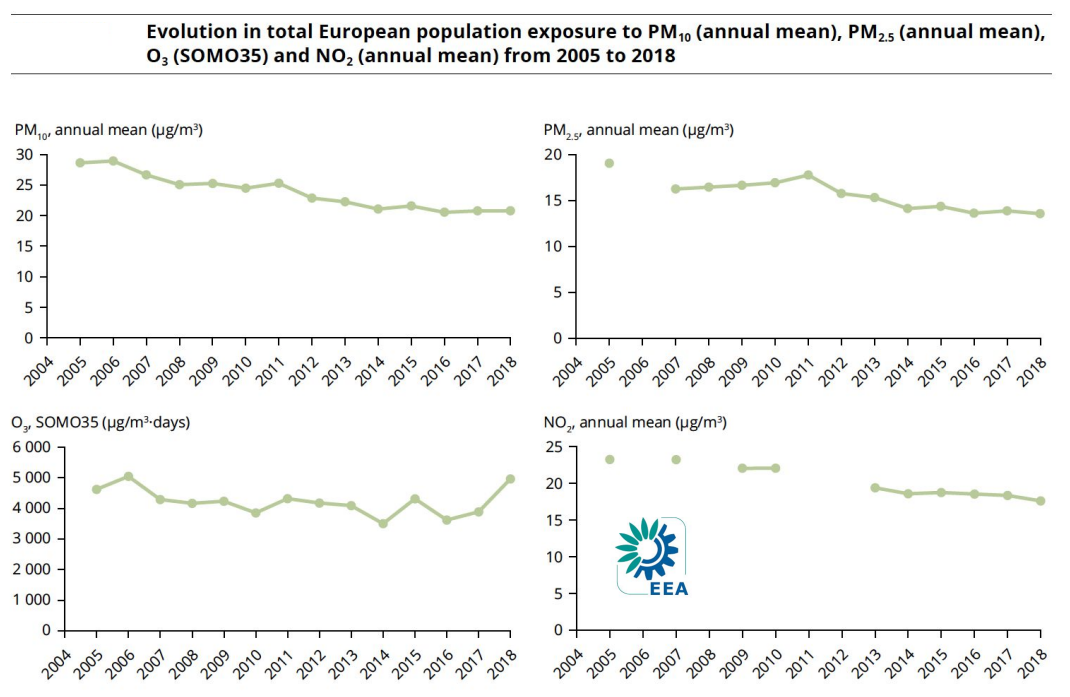
breathes… drinks… eats… daily.

Air pollution is all year round and involves different pollutants



Primary pollution
(PM10, PM2.5, NO_2, SO_2…)

Secondary pollution
(O_3, PM…)



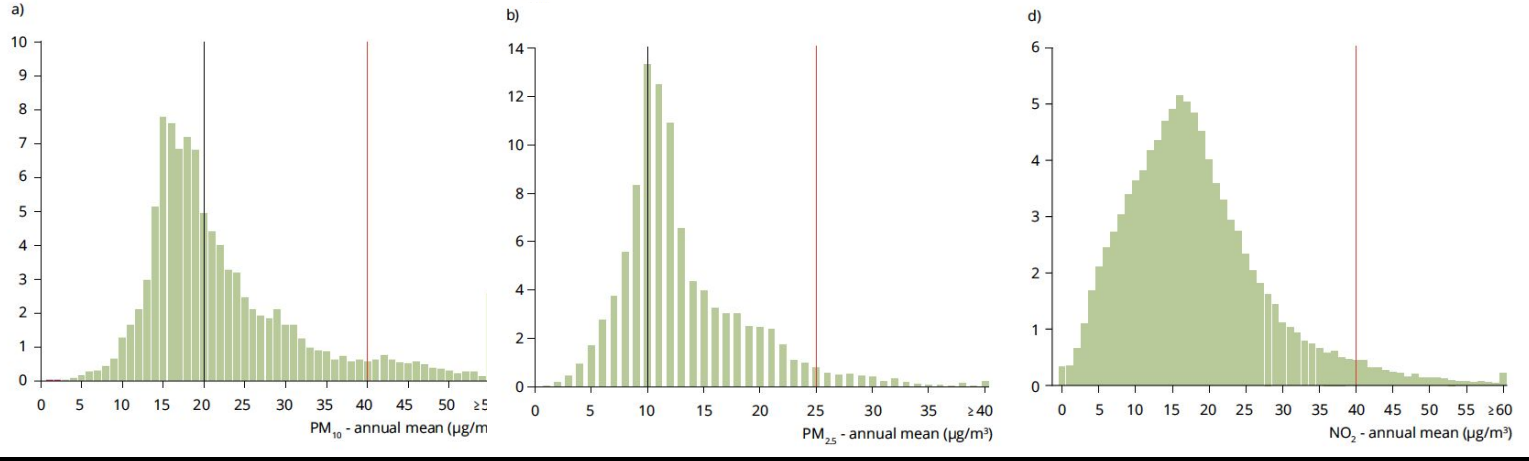
How has air pollution changed in Europe in the last 15 years?

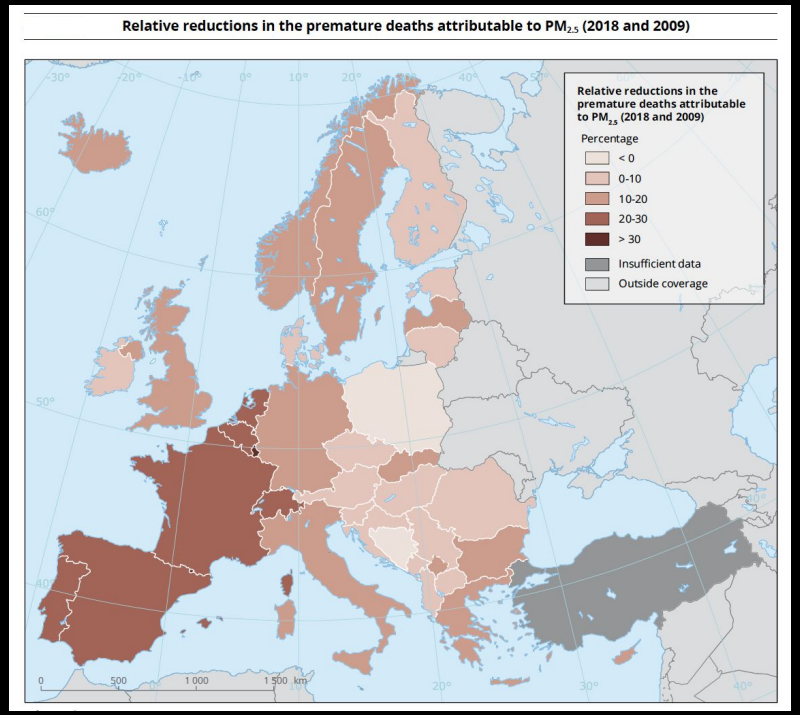
Population-averaged concentrations (EEA, Air Quality in Europe 2020)

What is the faction of the population exposed to unhealthy AQ?

Frequency distribution of the total population exposure to PM_{10} (annual mean), $PM_{2.5}$ (annual mean), O_3 (SOMO35) and NO_2 (annual mean) in 2018

WHO air quality guideline EU limit value





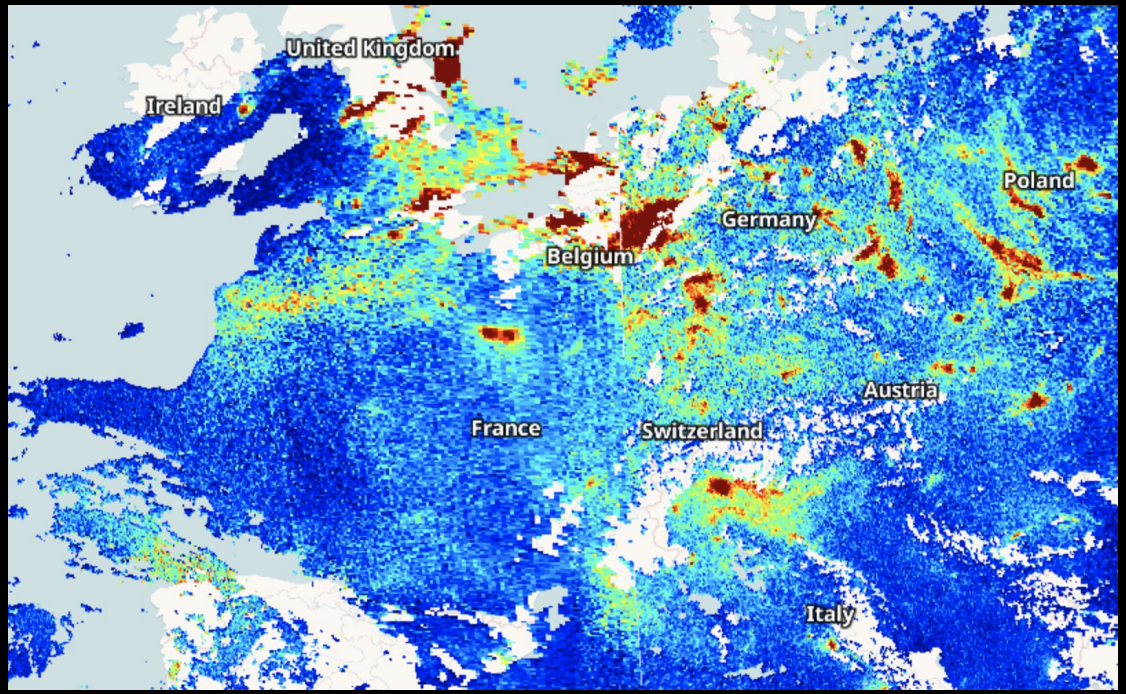
According to the EEA, in 2018, there were 452.000 premature deaths in EU-28 due to PM2.5 (83%), NO_2 (12%) and ozone (5%).

Worldwide, air pollution kills more people than smoking.

So… what can we do about it?

- Decide and enforce more deliberate policies to reduce pollutants emissions (good for carbon emissions and carbon too if implemented properly).
- Inform decision makers for launching warnings and taking appropriate measures when it is most relevant.
- Inform the general public for reducing exposure and changing own habits and consumption patterns.

…And this should be made based on facts and observational evidence



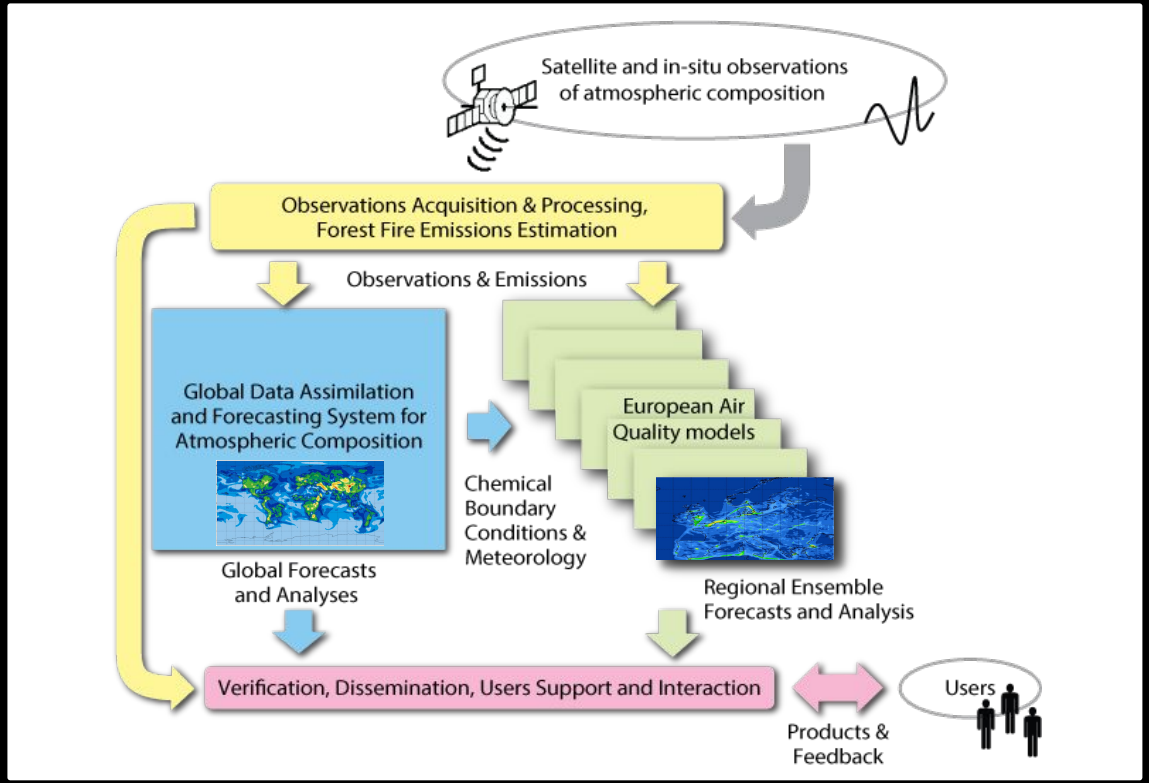
Copernicus Sentinel-5P
6 September 2021

But don't we have satellites for this?

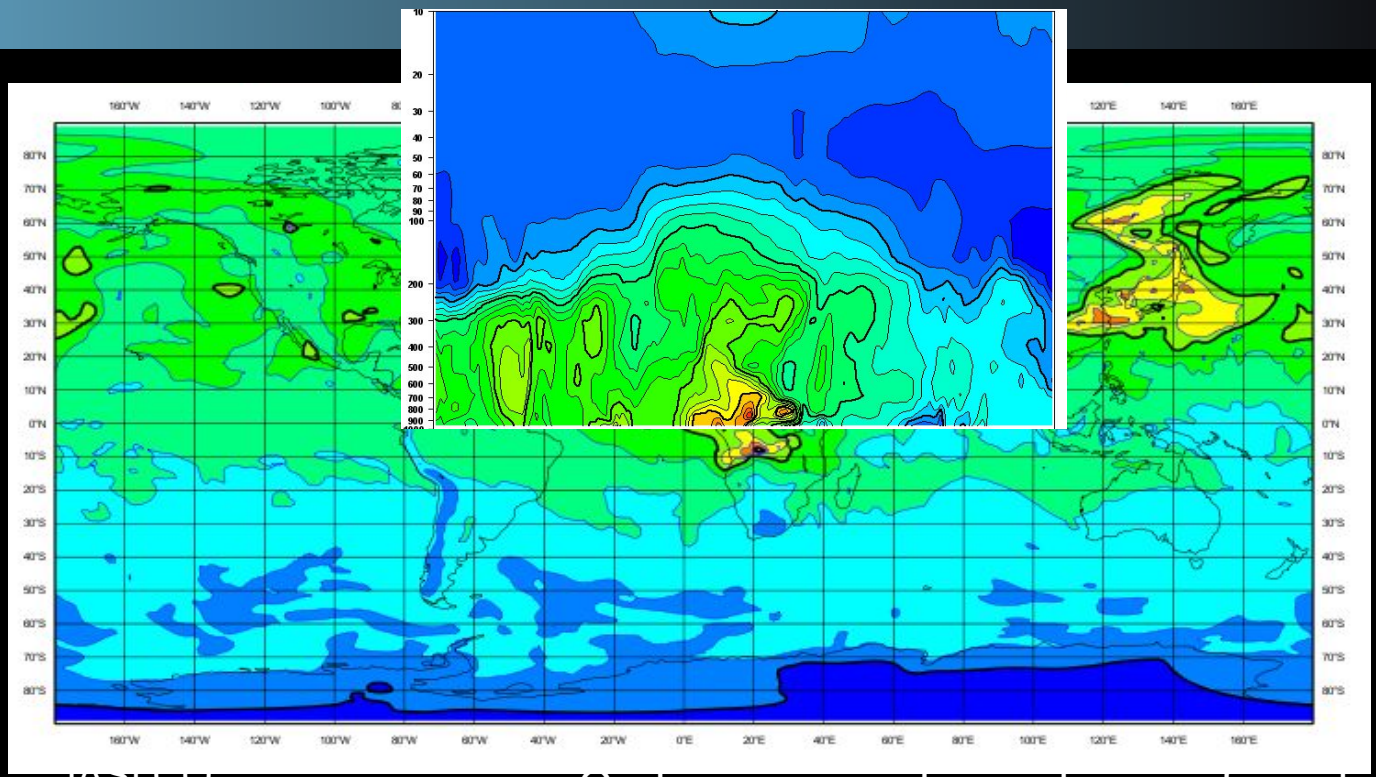
- Yes! Although it is recent
- Just like for weather, not most useful if used in isolation (clouds, 1 overpass per day…)
- It is not a mapping exercise: 3D with lots of physico-chemical processes involved!
- Need to combine satellite, surface & in situ and advanced numerical models

How can we do this? Example: the Copernicus Atmosphere Monitoring Service (CAMS) system

- Actually, it is an augmented version of ECMWF's world leading numerical weather prediction system



Data assimilation



IASI CO
(LATMOS/ULB)

Carbon monoxide is a tracer of combustion sources, which is well monitored from space

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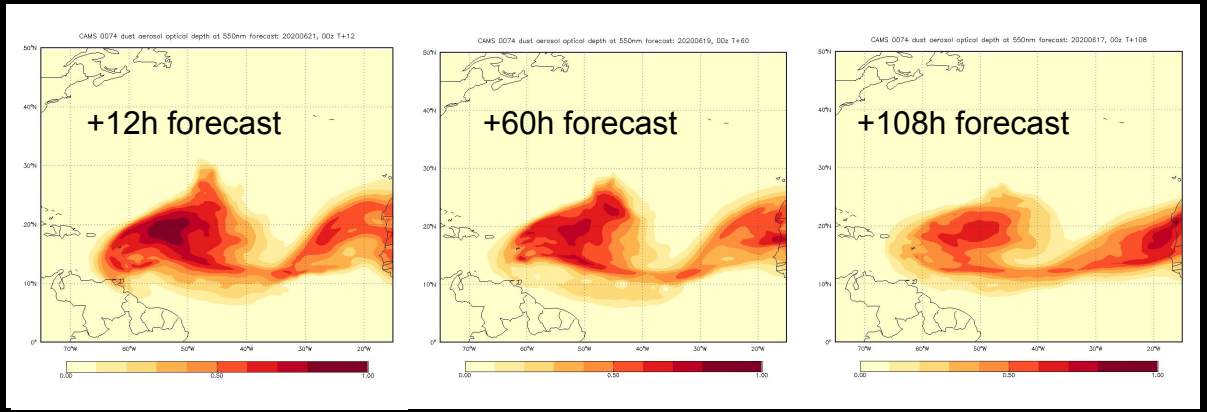
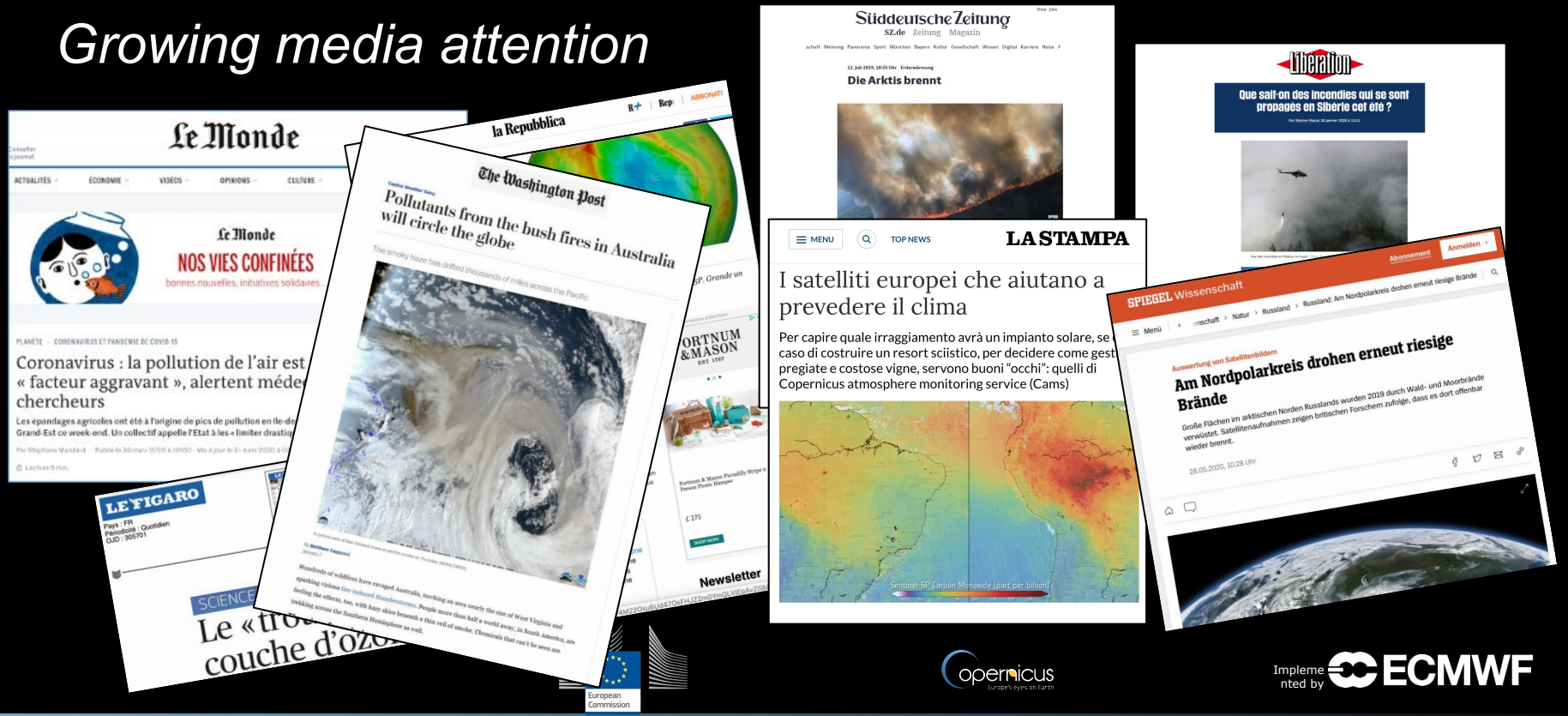
NASA/NOAA Suomi-NPP VIIRS imagery for 21 June 2020



"Godzilla" dust plume (June 2020)

ECMWF CAMS

Growing media attention



European Commission

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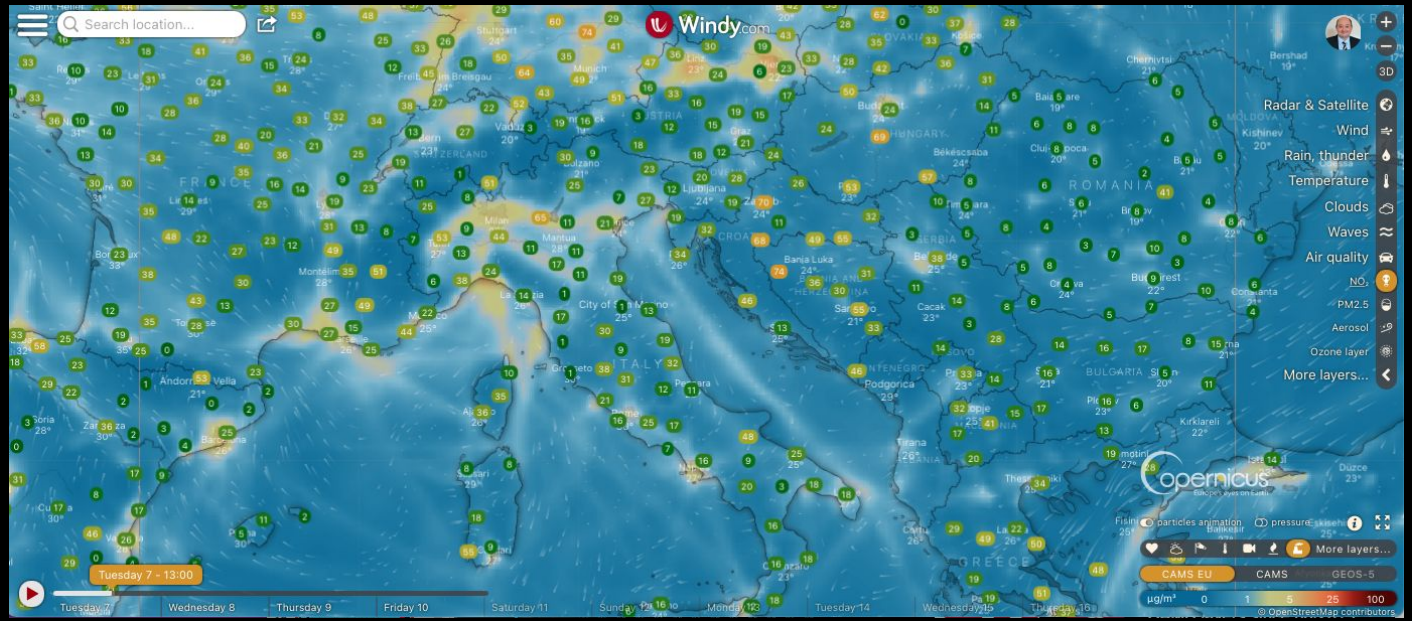
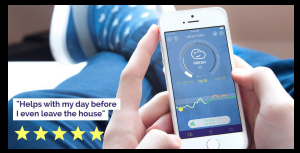
Impleme nted by ECMWF

AQ becoming mainstream information



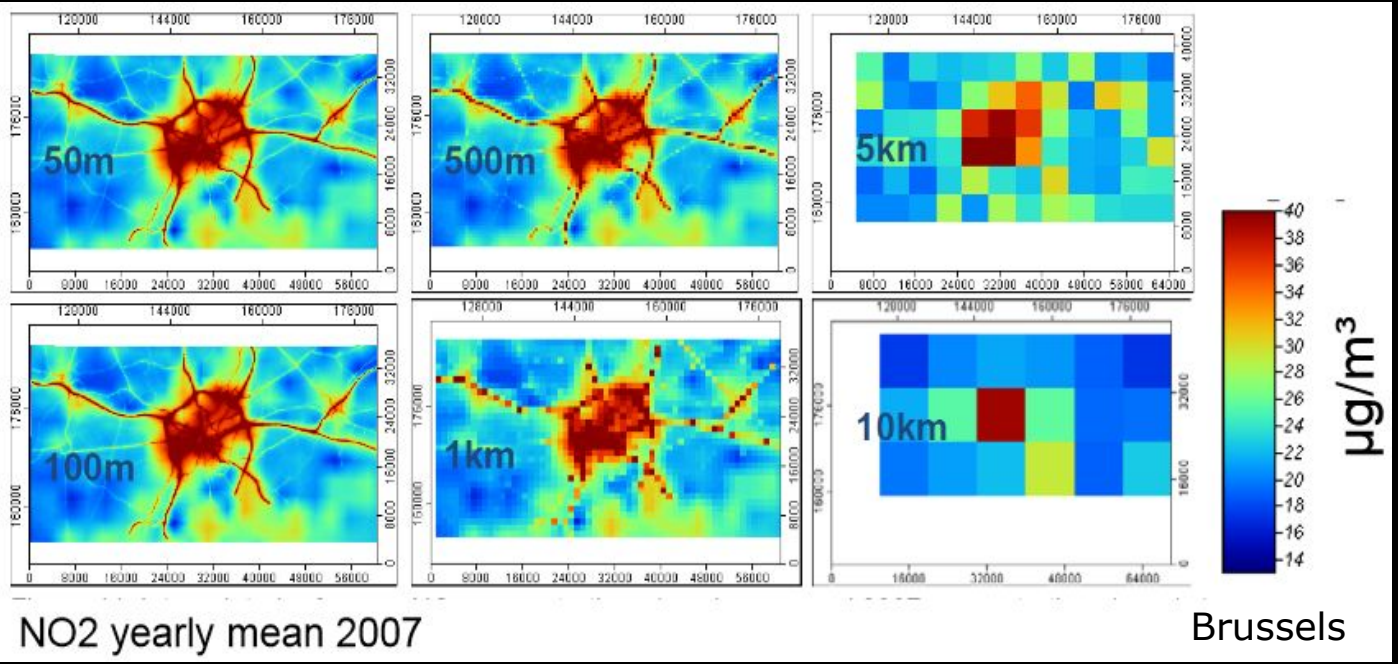
The Weather Channel



euronews.

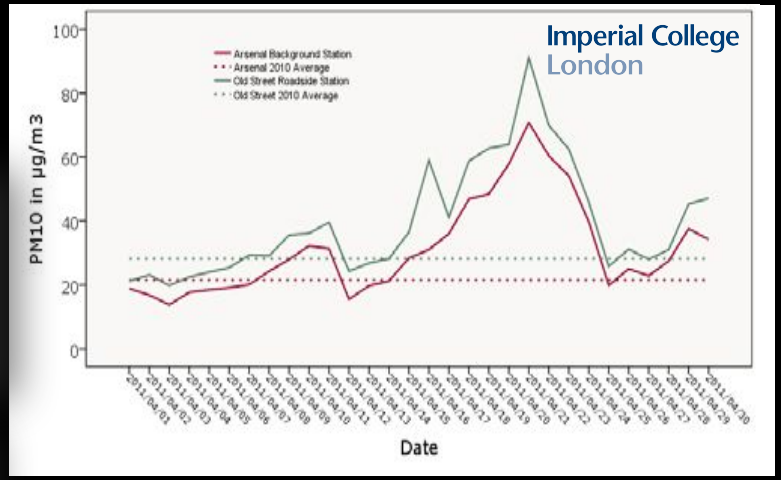
CNN

But are 10km resolution monitoring/forecast useful?



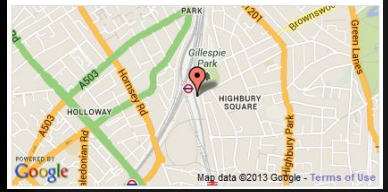
VITO

Clearly yes: information is both in space and time!



Address:	*Islington Ecology Centre, 191 Drayton Pk*
Grid Ref:	*531325, 186032*
Latitude & Longitude:	*51.557895000000, -0.106989000000*

Click on the map to see the nearest street view (if available).

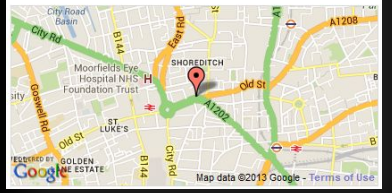


Islington Arsenal Urban Background station

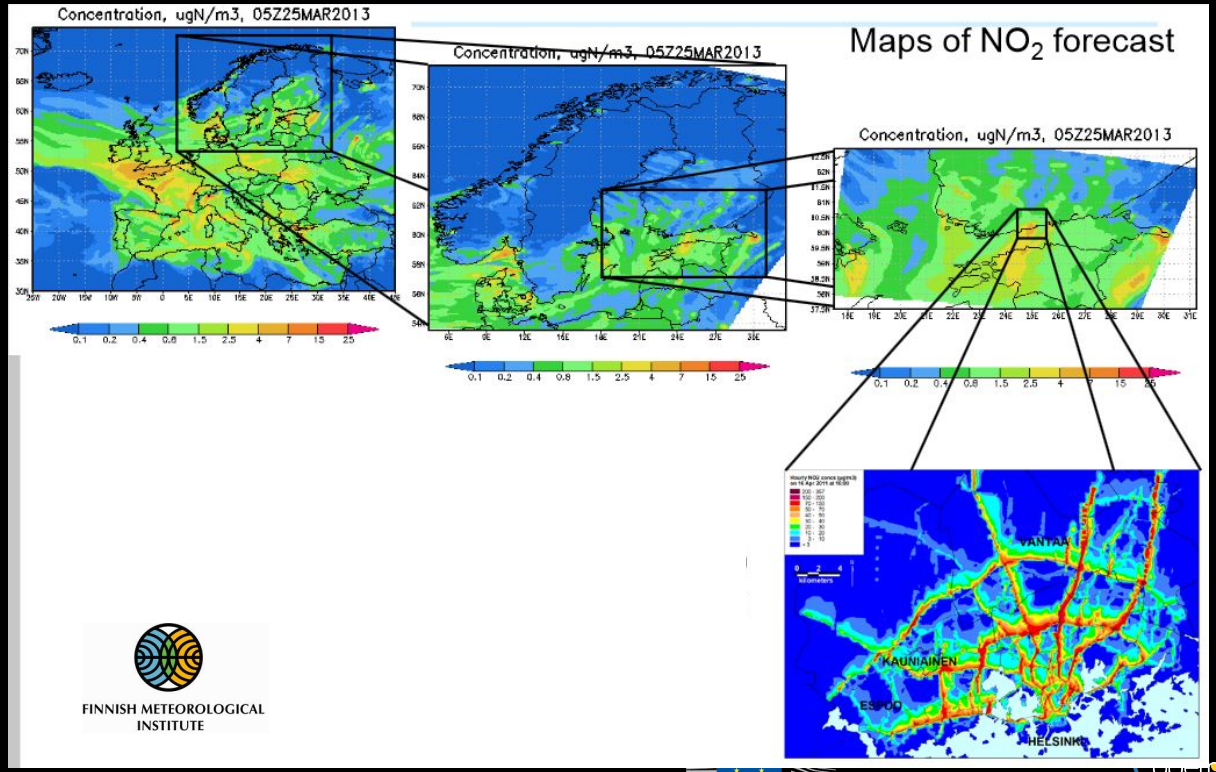
London Old Street Roadside station

Address:	*Old Street*
Grid Ref:	*532947, 182575*
Latitude & Longitude:	*51.526454000000, -0.084910000000*

Click on the map to see the nearest street view (if available).



Ideas for AI4Copernicus Call

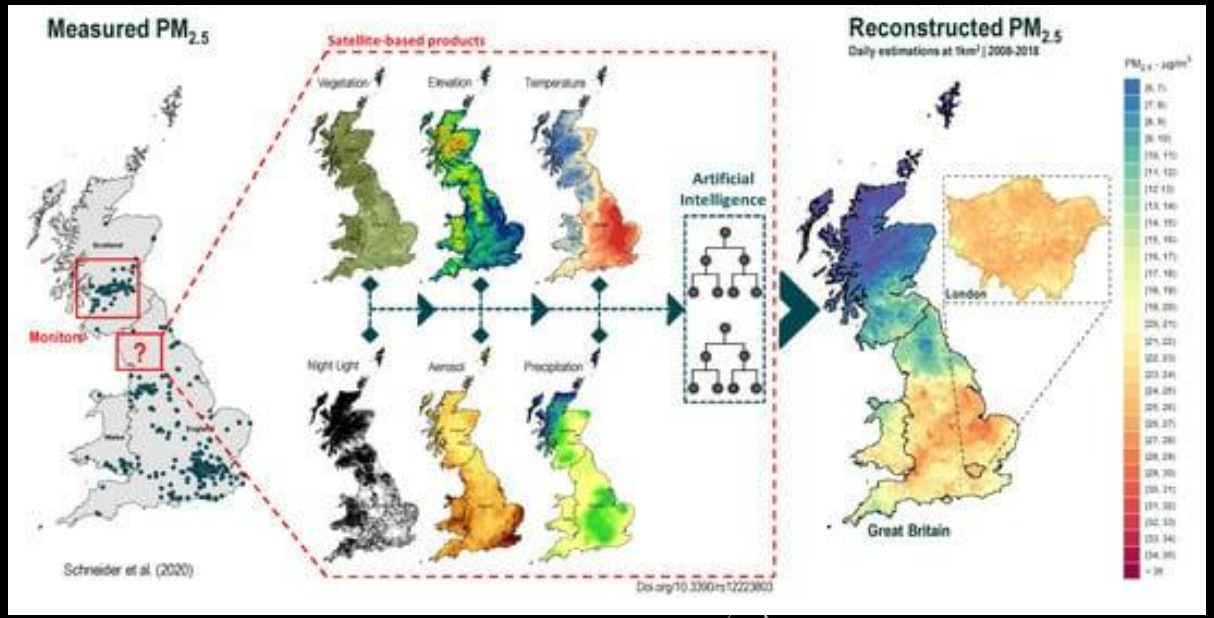


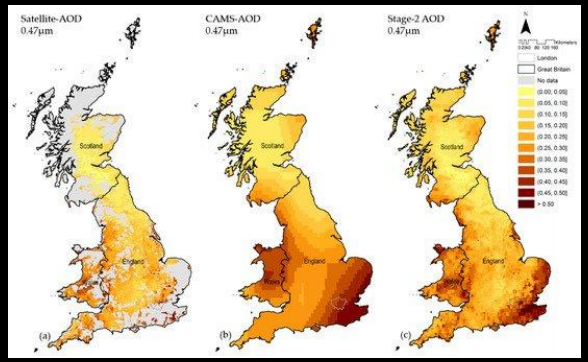
Downscaling: from globe to street-level forecasting

- High resolution is required for certain applications, including assessing health impacts
- Several approaches available, here cascade of numerical models
- No need to start from scratch: lots of processing has already been done at coarse scale

Ideas for AI4Copernicus Call

AI: very promising approaches

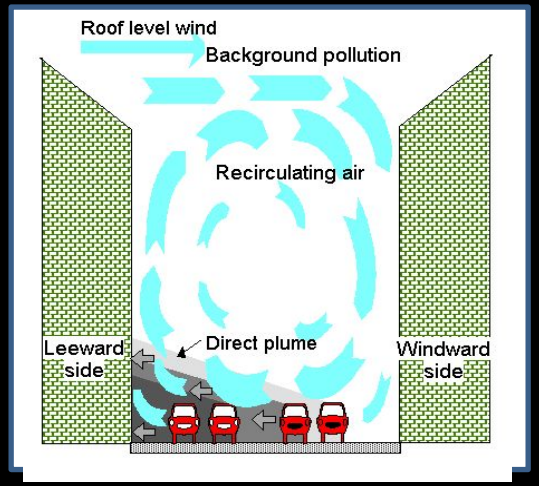


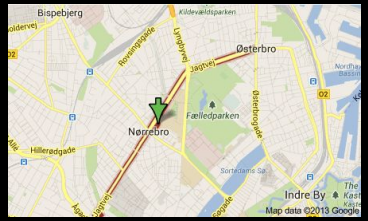


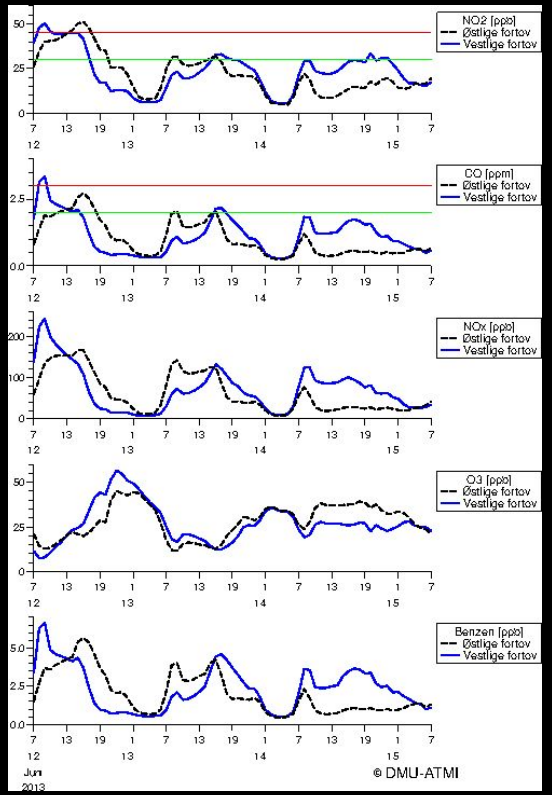
(R. Schneider et al., Remote Sens. 2020, 12(22), 3803; https://doi.org/10.3390/rs12223803)

Ideas for AI4Copernicus Call

On which side of the street should I walk?







West / East side of Jagtvej (Copenhagen)

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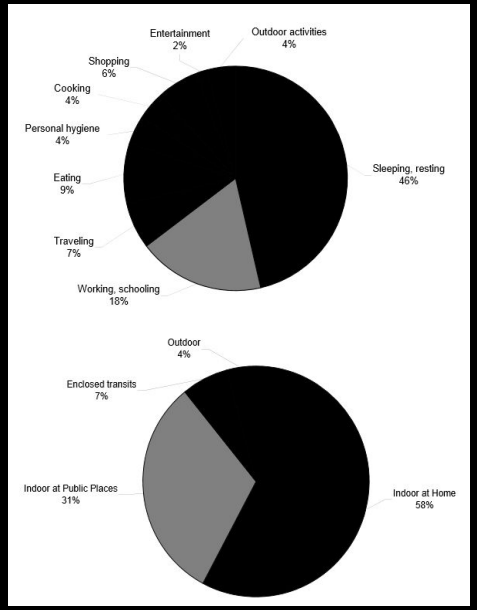
Towards personalised medicine



How do we spend our time?

In what type of environments

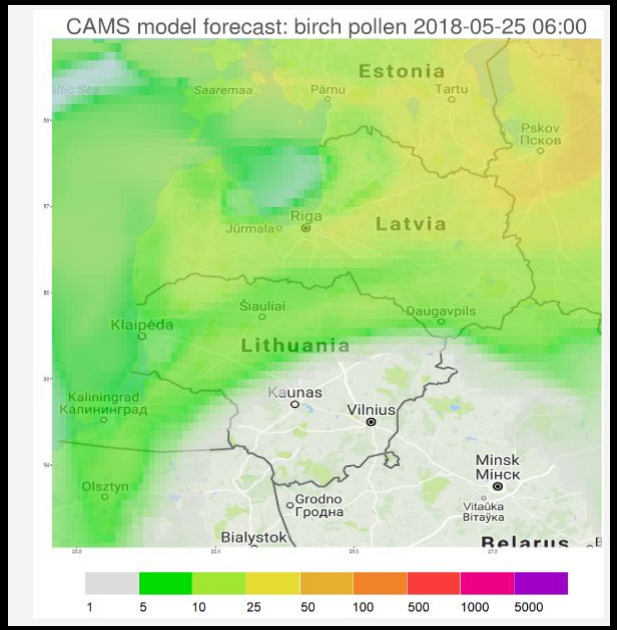
E. Tu You, “Time Budget study and total exposure assessment to air pollutants of Hong-Kong population”, PhD, 2005.

And what is air quality in these environments?

Microenvironments	Air Pollutants			
	CO (µg/m³)	CO_2 (mg/m³)	PM_{10} (µg/m³)	NO_2 (µg/m³)
Indoor at home				
Residential building/home	943	1561.6	46.2 (119.2[3])	118
Indoor away from home				
Office building	854.3[1]	1883[1]	29.7[1]	18.9[1]
School	187	2416.1	117	0
Industrial plant	N/A	N/A	N/A	N/A
Restaurant	3750 (3344.9[1])	2370 (2497.8[1])	385 (323[1])	718 (133[1])
Pub/Bar/Night club	9375	2797.2	810	108
Hospital	N/A	747.8	N/A	N/A
Hotel	3500	1620.5	85.6	21.4
Indoor gym.	750	1532.1	80[4]	44[4]
Shopping center	1660[1]	1870.2[1]	78[1]	63.64[1]
Car park/Garage	13750	1021.5	150[4]	356[4]

Ideas for AI4Copernicus Call

Can we forecast patient-specific allergy symptoms?



PASYFO

ŠIAULIŲ UNIVERSITETAS

The aim of PASYFO is to provide a high-resolution regional system for predicting the personal allergy symptoms o pollen-sensitive people using personalised sensitivity information.

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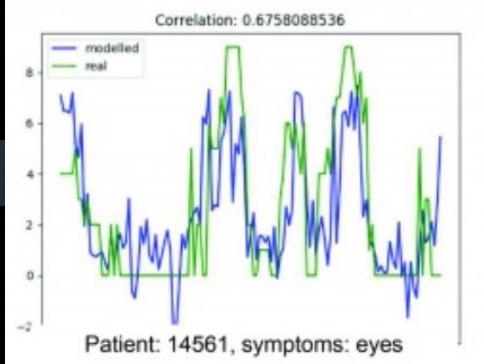

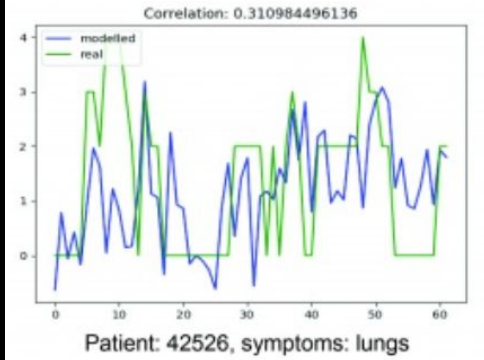

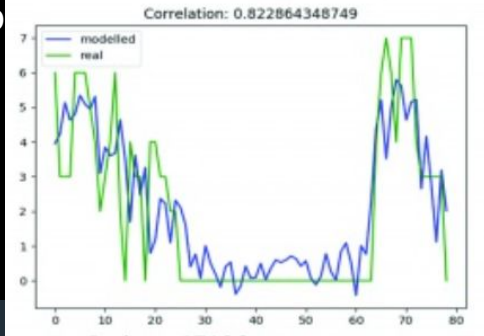

Up to you now!

atmosphere.copernicus.eu