

COVID AND AIR QUALITY: HOW CAN CAMS HELP?



Atmosphere Monitoring

3 June 2021

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- **Highlights of the past year**
- CAMS in action: helping with COVID-19 research
- CAMS 2.0: Towards observations-based emissions



Q1 2021: >20000 registered users, 2500 routinely active; 100M+ reached with TV bulletins and smartphone apps.

- **Jun 2020:** formal opening of the Atmosphere Data Store
- **Aug-Sept 2020:** large wildfires in north-western USA with impact on weather
- **Aug-Dec 2020:** the Antarctic ozone hole lasted until Christmas
- **Dec 2020:** since June 2019, 3.8M users have explored CAMS data layers on Windy.com (15B page views)
- **Feb 2021:** large Saharan dust plumes affecting Europe
- **Mar 2021:** access to real-time pollen observations

See M. Parrington's presentation about the CAMS "weather room" & **check** <https://atmosphere.copernicus.eu/news>

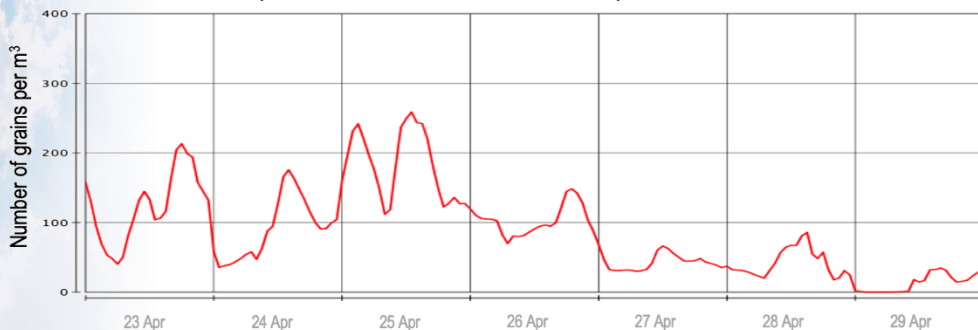


NEW: POLLEN FORECASTS EVALUATION

MeteoSwiss / Eumetnet / Autopollen Birch pollen **OBSERVATIONS**




Copernicus / ECMWF / CAMS Birch pollen **FORECASTS**



By partnering with the EAN and EUMETNET, CAMS can now **evaluate pollen forecasts in real-time** (Bavaria/Germany, Switzerland and a few stations in Finland, Lithuania...).



 Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal Office of Meteorology and
Climatology MeteoSwiss



REGISTER NOW!

Copernicus Atmosphere Monitoring Service (CAMS)
5th General Assembly

Dates: 8-10 June 2021

Join us to hear about the latest developments in our products and systems to help us shape the future of our service.

CAMS 5th General Assembly (virtual)

The CAMS General Assembly will highlight the past year's developments, offer opportunities for discussions about some of the challenges involved, and provide an outlook for the next phase of the Copernicus programme.

It is online: the best seats are still available!

Register now at: <https://atmosphere.copernicus.eu/cams-5th-general-assembly>

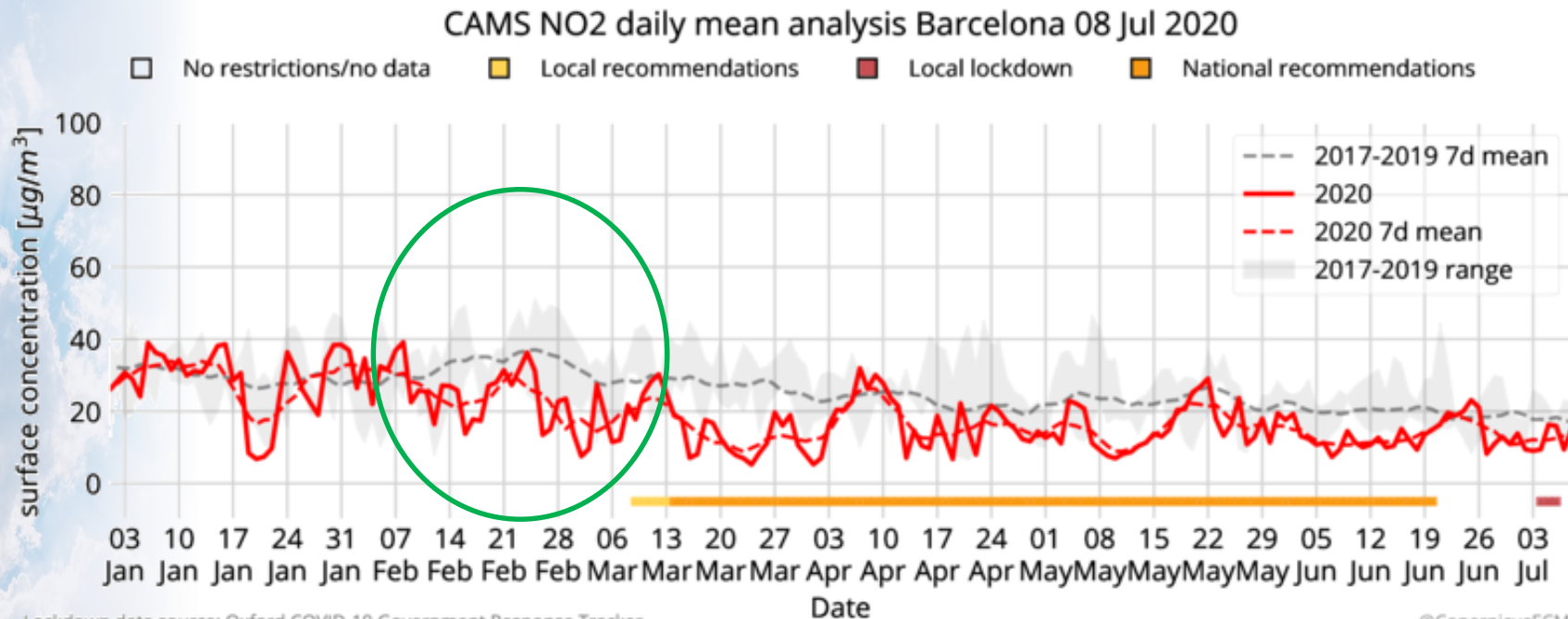


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INTEPRETATION OF COVID-19 "SIGNALS" IN AIR QUALITY

Let's re-start where we left last year... Weather matters!





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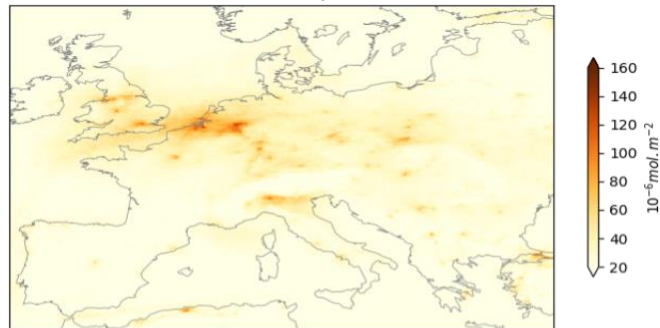
WHAT DID SENTINEL-5P SEE? (NO₂)

2020

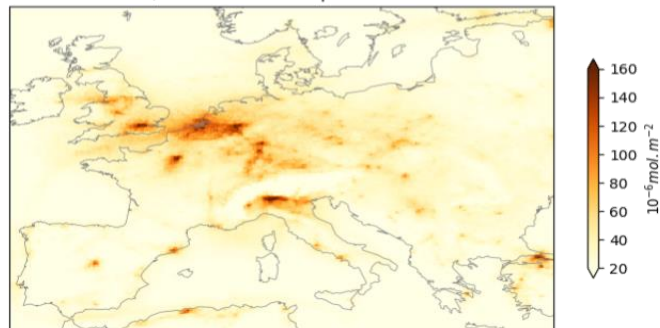
2019

15 Mar ←→ 30 Apr

b) From Mar. 15 to Apr. 30 2020



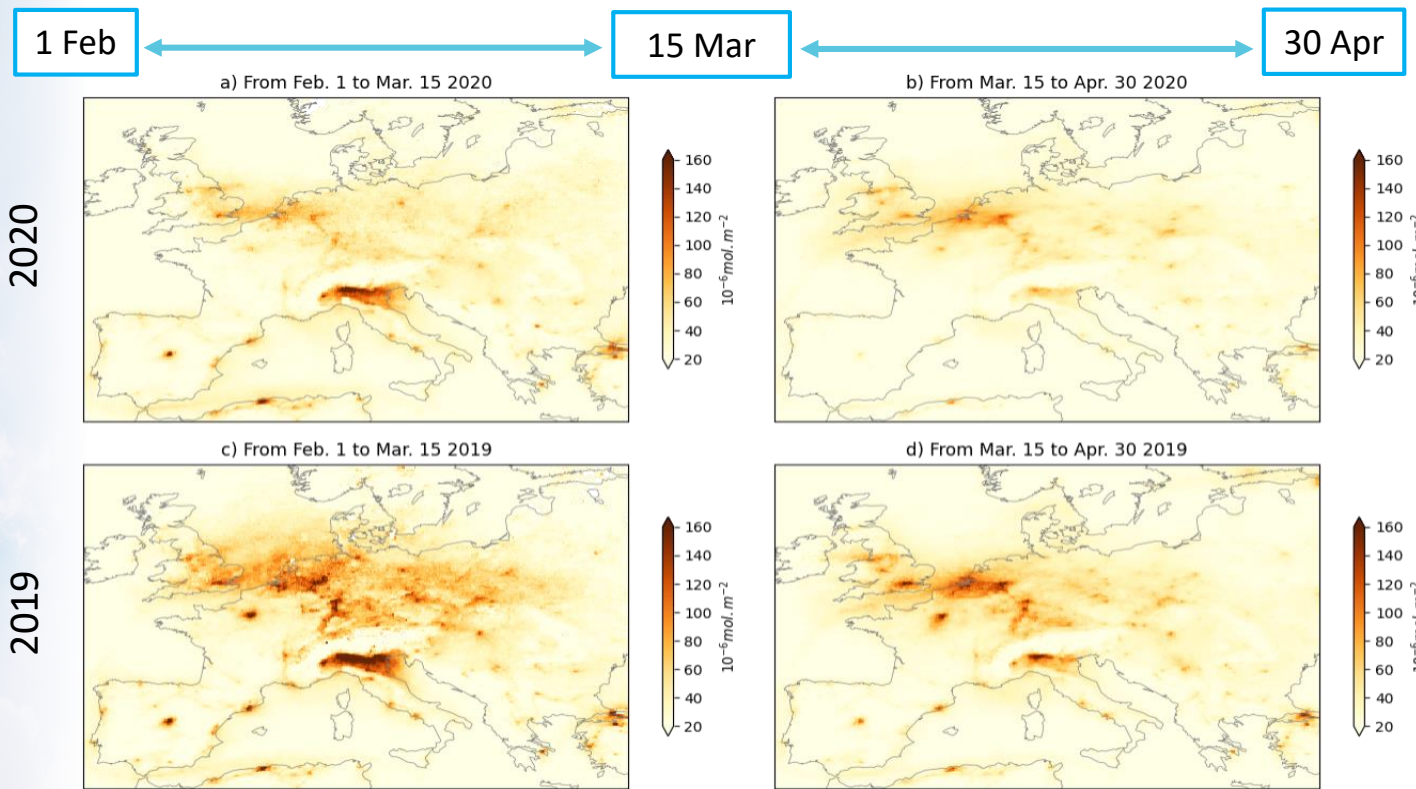
d) From Mar. 15 to Apr. 30 2019



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LIMITS TO NAÏVE INTERPRETATION...





WHY WAS THIS THE CASE?

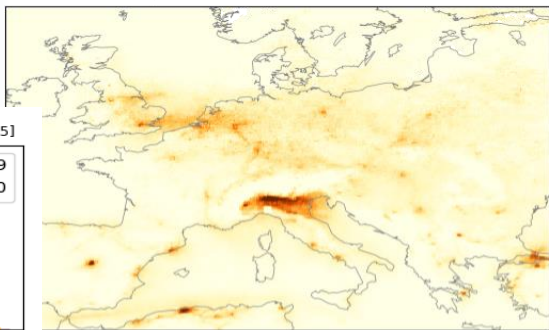
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1 Feb

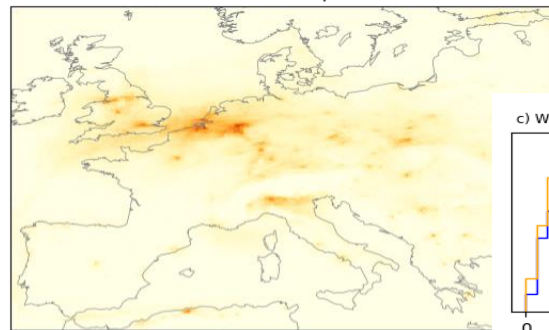
15 Mar

30 Apr

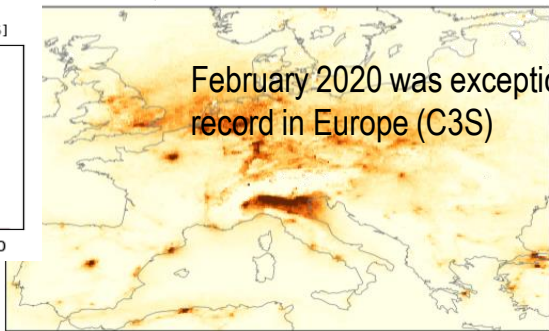
a) From Feb. 1 to Mar. 15 2020



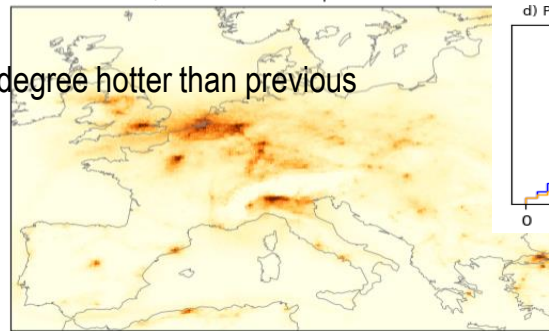
b) From Mar. 15 to Apr. 30 2020



c) From Feb. 1 to Mar. 15 2019

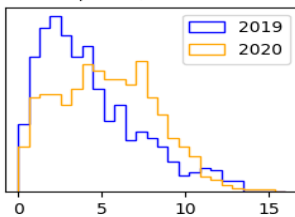


d) From Mar. 15 to Apr. 30 2019

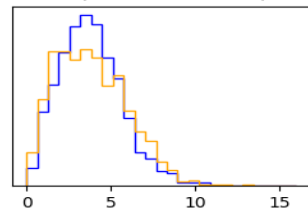


February 2020 was exceptional: +1.4 degree hotter than previous record in Europe (C3S)

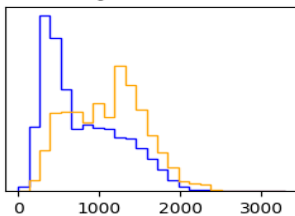
a) WindSpeed (m/s) [Feb 1 to Mar 15]



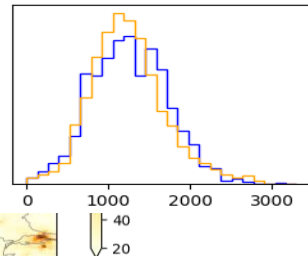
c) WindSpeed (m/s) [Mar 15 to Apr 30]



b) PBL Height (m) [Feb 1 to Mar 15]



d) PBL Height (m) [Mar 15 to Apr 30]



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WHAT AIR POLLUTION SHOULD HAVE BEEN IN MAR/APR 2020?

For this, we have used Machine Learning to estimate what S5P NO₂ should have measured in 2020 if there had been no lockdown. The work has been focusing on European cities >0.5M

- Predictors: NWP from ECMWF, CAMS regional forecast (no assimilation), time/date, population, location
- Model/Method: Machine Learning, Gradient Boosting Regressor
- Running the model. Caveat: the depth of raining set is small only Jan-Feb-Mar-Apr 2019/Jan-Feb2020 (availability of S5P data), noise expected.

Details in [Barré et al., ACP, 2021]



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REDUCTION ESTIMATIONS CITIES > 0.5 M

1 Feb

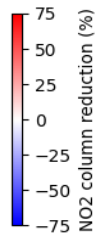
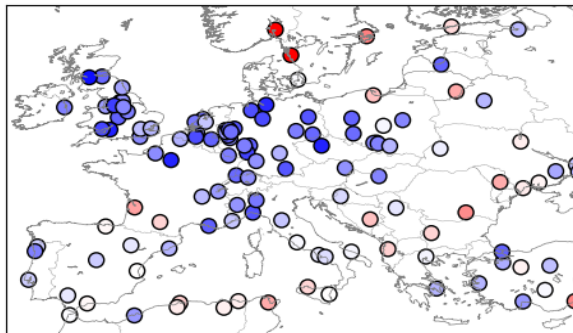
15 Mar

30 Apr

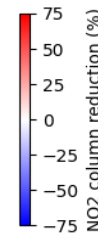
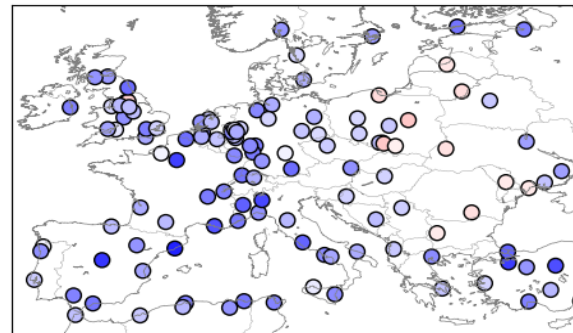
[OBS_2019] - [OBS_2020]

“naive”
interpretation

c) [2019 S5P] minus [2020 S5P] (Feb 1 to Mar 15)



d) [2019 S5P] minus [2020 S5P] (Mar 15 to Apr 30)





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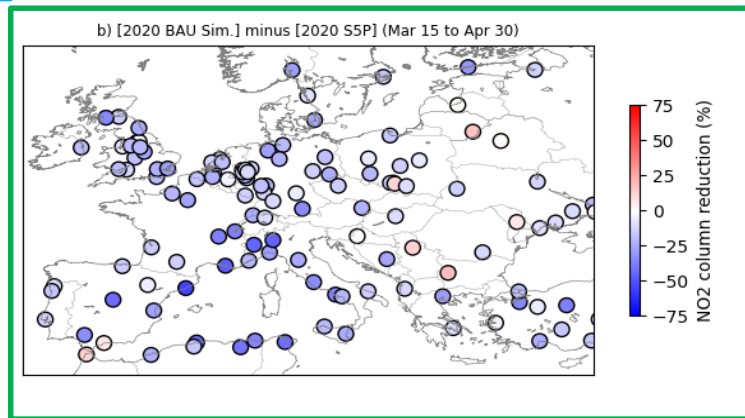
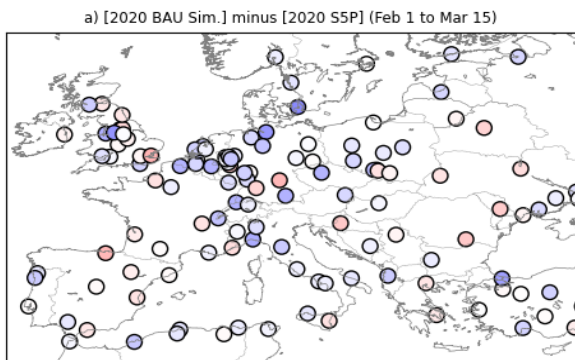
REDUCTION ESTIMATIONS CITIES > 0.5 M

1 Feb

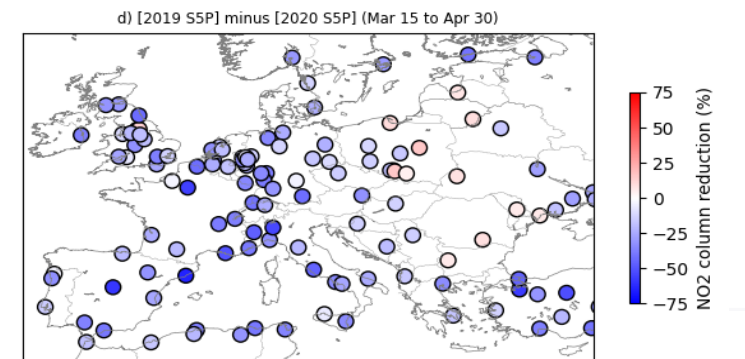
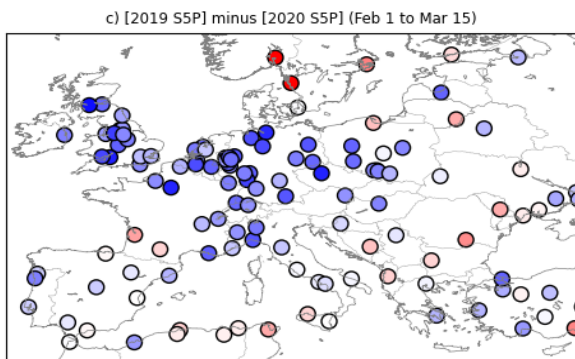
15 Mar

30 Apr

[BAU_2020] - [OBS_2020]














[OBS_2019] - [OBS_2020]



“weather
-
adjusted”
interpreta
tion

“naive”
interpre
tation



11 Contributing Models	
CHIMERE (INERIS)	
DEHM (Aarhus Univ.)	
EMEP/MSC-W (Met Norway)	
EURAD-IM (RIUUK)	
GEM-AQ (WUT/IEP)	
Lotos-Euros (KNMI+TNO)	
MATCH (SMHI)	
MOCAGE (Météo-France)	
SILAM (FMI)	
MINNI (ENEA)	
MONARCH (BSC)	

- See next presentation by M. Guevara on CAMS « COVID-19 » emissions change factors
- Leveraging on several CAMS elements:
 - Air Pollutant Emissions (CAMS_81 & BSC)
 - Regional production (CAMS_50)
 - Multi-model approach
 - 11 participating models
 - Policy Service (CAMS_71)
 - Coordination





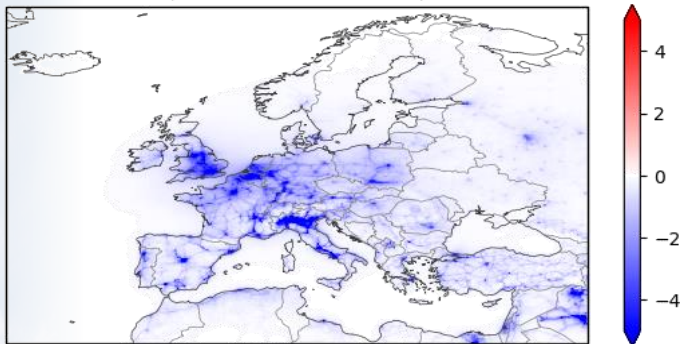
CAMS: MULTI-MODEL LOCKDOWN EMISSIONS HINDCAST

Up to 60% reduction in NO₂ surface concentrations

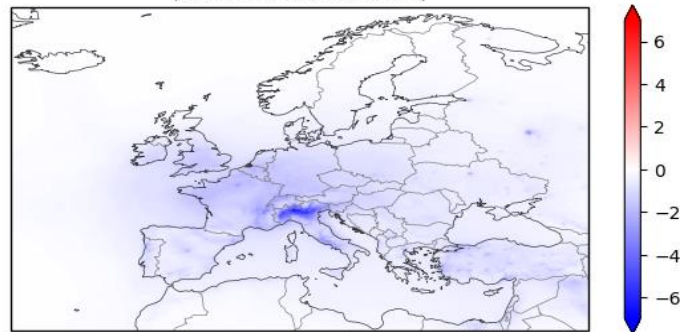
Up to 20% reduction in PM₁₀ surface concentrations

Absolute

NO₂ concentration mean difference, ENSEMBLE (absolute diff. in ug/m³)
Lockdown scenario minus Reference
(2020-03-01 to 2020-04-30)

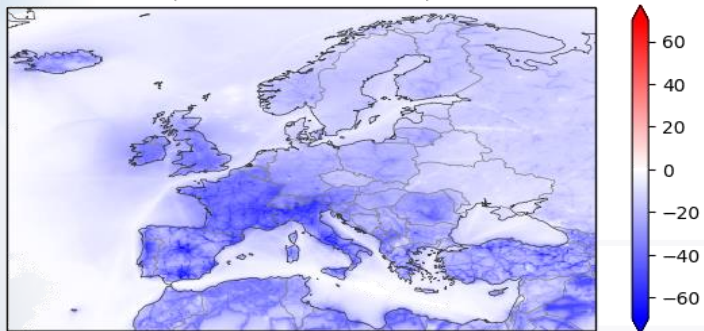


PM₁₀ concentration mean difference, ENSEMBLE (absolute diff. in ug/m³)
Lockdown scenario minus Reference
(2020-03-01 to 2020-04-30)

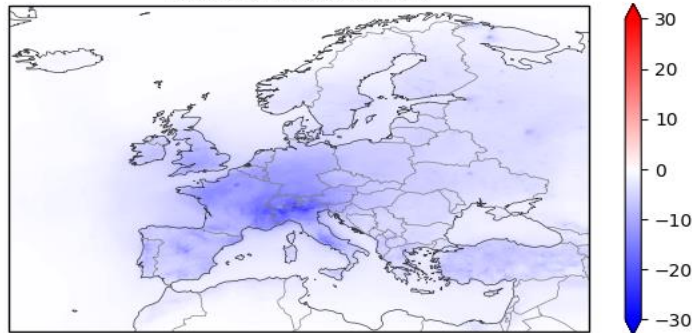


Relative

NO₂ concentration mean difference, ENSEMBLE (relative diff. in %)
Lockdown scenario minus Reference
(2020-03-01 to 2020-04-30)

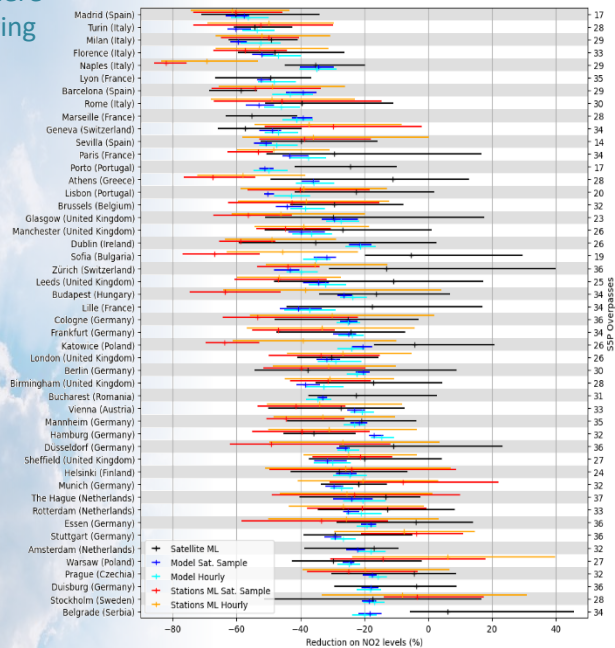


PM₁₀ concentration mean difference, ENSEMBLE (relative diff. in %)
Lockdown scenario minus Reference
(2020-03-01 to 2020-04-30)

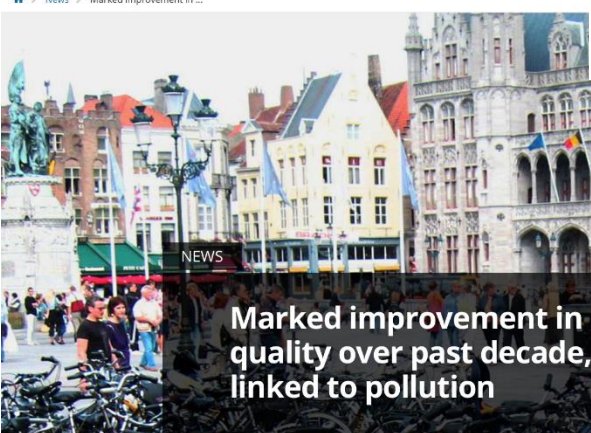




EFFECT OF LOCKDOWN ON NO₂



Different methods...
... consistent estimates.



Marked improvement in Europe's air quality over past decade, fewer deaths linked to pollution

Better air quality has led to a significant reduction of premature deaths over the past decade in Europe. However, the European Environment Agency's (EEA) latest official data show that almost all Europeans still suffer from air pollution, leading to about 400,000 premature deaths across the continent.

Air quality and COVID-19

The EEA report also contains an overview of the links between the COVID-19 pandemic and air quality. A more detailed assessment of provisional EEA data for 2020 and supporting modelling by the Copernicus Atmosphere Monitoring Service (CAMS), confirms earlier assessments showing up to 60 % reductions of certain air pollutants in many European countries where lockdown measures were implemented in the spring of 2020. The EEA does not yet have estimates on the potential positive health impacts of the cleaner air during 2020.

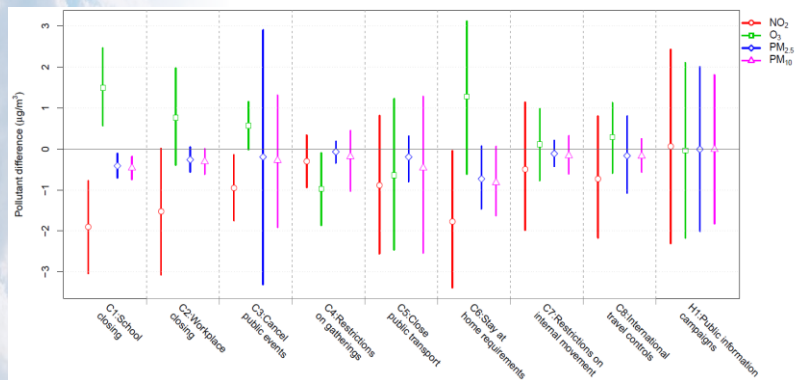
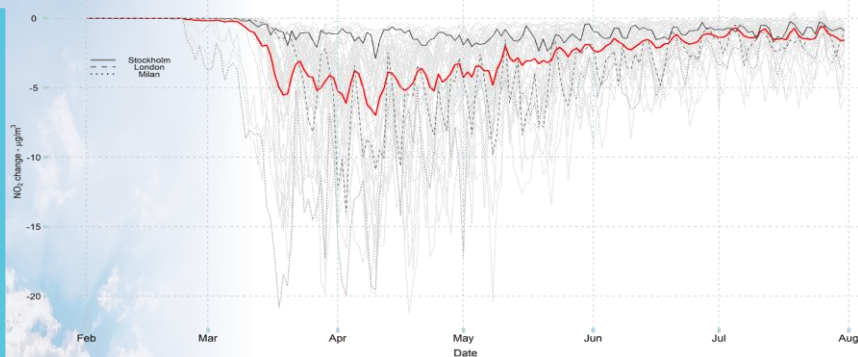
The report also notes that long-term exposure to air pollutants causes cardiovascular and respiratory diseases, which both have been identified as risk factors for death in COVID-19 patients. However, the causality between air pollution and severity of the COVID-19 infections is not clear and further epidemiological research is needed.

CAMS contributed to a specific chapter in EEA's 2020 Annual Air Quality report.



EFFECTIVENESS OF MEASURES AND HEALTH IMPACTS

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CAMS id	Country	Name	Excess Deaths NO2	Excess Deaths O3	Excess Deaths PM25	Excess Deaths PM10
AQ031	France	Paris	-69.2	10.9	-23.2	-17.4
AQ003	Greece	Athens	-40.1	4.6	-10.0	-7.8
AQ004	Spain	Barcelona	-39.2	4.5	-12.2	-9.3
AQ023	Spain	Madrid	-38.8	4.4	-7.7	-6.1
AQ020	United Kingdom	London	-37.9	8.5	-13.9	-10.5
AQ025	Italy	Milan	-36.7	2.3	-18.1	-12.6
AQ028	Italy	Naples	-29.9	2.8	-8.2	-5.9
AQ018	Portugal	Lisbon	-18.9	3.1	-11.4	-10.6
AQ037	Italy	Rome	-18.4	-0.2	-6.8	-4.8
AQ044	Italy	Turin	-13.3	-0.2	-6.8	-4.9
AQ010	Belgium	Brussels	-10.4	2.4	-3.2	-2.4
AQ013	Germany	Cologne	-10.1	1.7	-4.4	-3.2
AQ006	Germany	Berlin	-9.6	0.4	-4.7	-3.5
AQ011	Romania	Bucharest	-9.5	-0.3	-2.8	-2.2
AQ008	United Kingdom	Birmingham	-8.9	1.9	-4.2	-3.1

Top 15 cities
 *ranking order is determined by NO2 deaths
 * **Negative** values indicate avoided deaths

Included on Stringency Index	
C1	School closing
C2	Workplace closing
C3	Cancel public events
C4	Restrictions on gathering
C5	Close public transport
C6	Stay at home requirements
C7	Restriction on internal movement
C8	International travel controls
H1	Public information campaigns

LONDON SCHOOL of HYGIENE & TROPICAL MEDICINE



A. Gasparrini, R. Schneider, P. Masselot et al., Nature SR, submitted

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Highlights COVID-19 studies Emissions



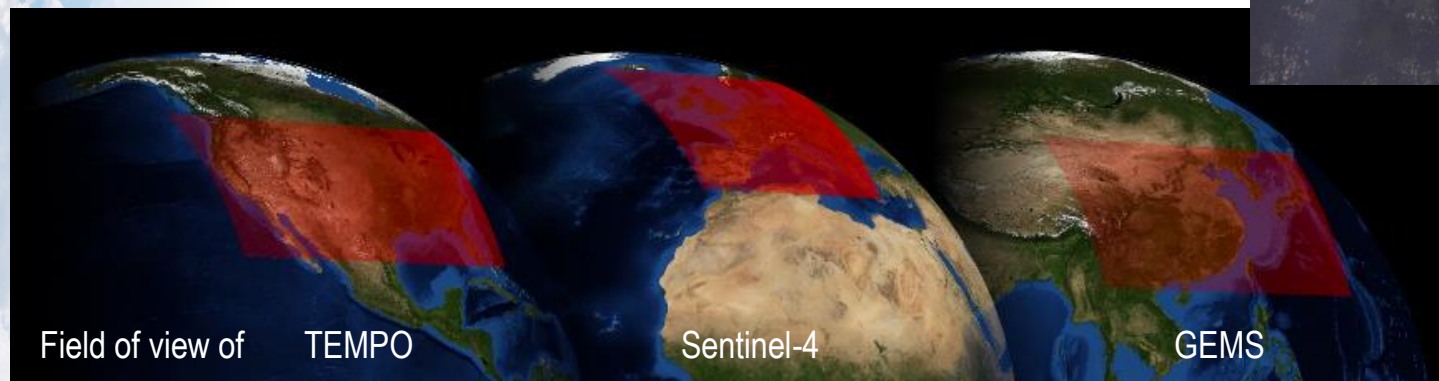
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THE UPCOMING GLOBAL OBSERVING SYSTEM

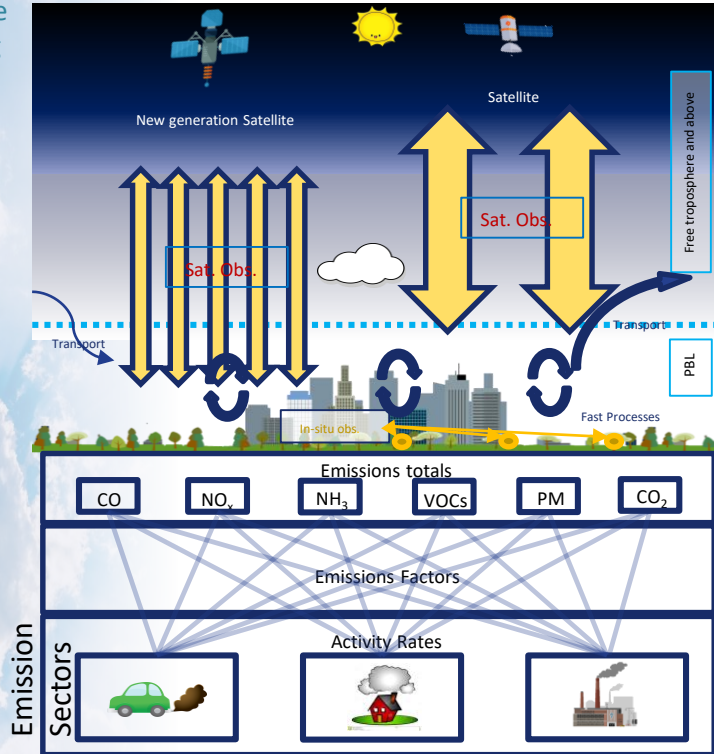
- Low Earth Orbiting instruments: Sentinel-5p, Sentinel-5, IASI-NG, 3MI...
- The global geostationary constellation providing **hourly** revisit: Sentinel 4 + MTG/IRS, TEMPO (USA), GEMS (Korea)

This calls for a global integrated approach to benefit from all the possible synergies between instruments and species observed.





“ INVERSE MODELLING ” OF EMISSIONS



- Target species (direct): NO₂, CO, NH₃, CH₄, SO₂ (large sources only)
- Target species (indirect): PM_{2.5}/PM₁₀ (AOD and aerosol size information) and NMVOCs (HCHO, glyoxal, vegetation parameters...).
- global, ~10km, hourly.
- Sectorial inversion.
- Requirements on emissions prior information (link to activities on uncertainty).
- Same building blocks as for the CO₂ service IFS system: co-emission with NO₂.
- Links and support to policies on AQ and GHG emissions, working with the Member States and national efforts.



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@AntjelInness



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