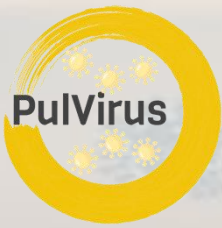


The effects of lockdown measures on air quality in Italy based on model simulations

Pulvirus – WP2

Ilaria D'Elia (ENEA) on behalf of WP2



Aim of WP2

Understanding the effect of the measures adopted during the lockdown on emissions and air pollutant concentrations through air quality model simulations, building:

- Base case emission scenario
- Scenario emissions «with measures»

Multi-model simulation of NO₂, PM₁₀, PM_{2.5} and O₃ concentrations.



To answer to the following questions:

- How air quality models reproduce significant emission variations in a very short period;
- Quantify emission variations from specific sectors affected by the COVID-19 restrictions;
- What is the effect on secondary pollutants.

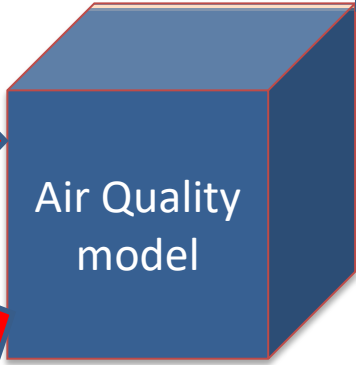


Methodology

Base case emission scenario - year 2017;
Period Feb-May 2020;
Top-down and Bottom-up approach.

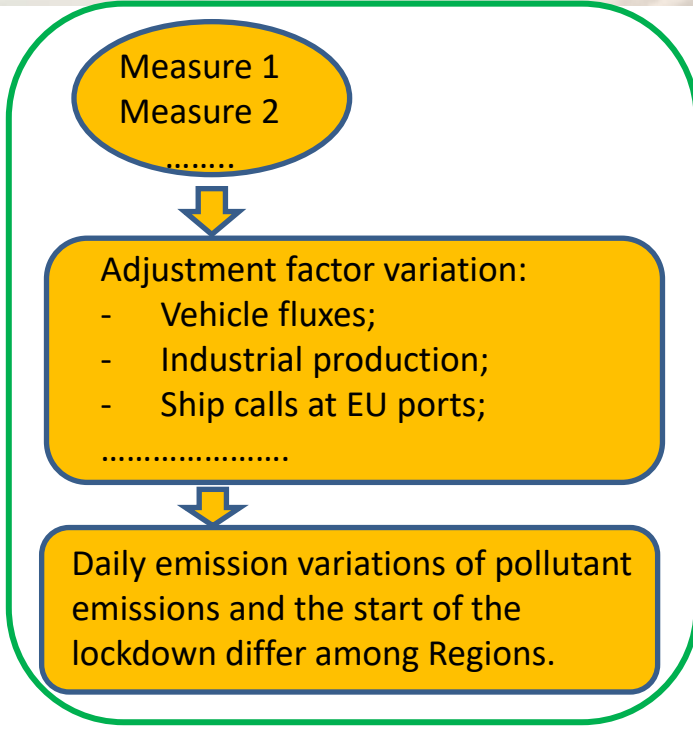
Meteo
2020

BCs



Baseline
emissions

Lockdown
Scenario
(«with
measures)



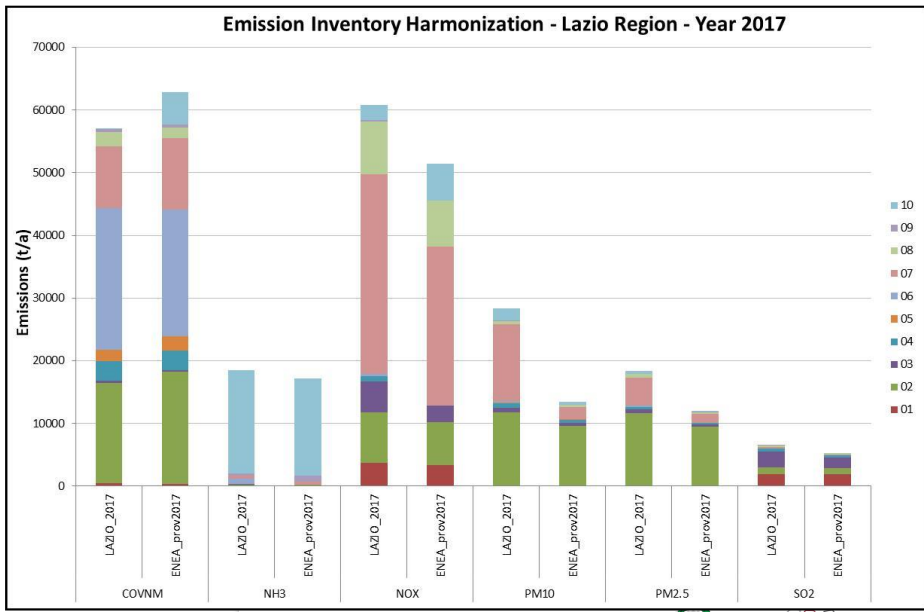
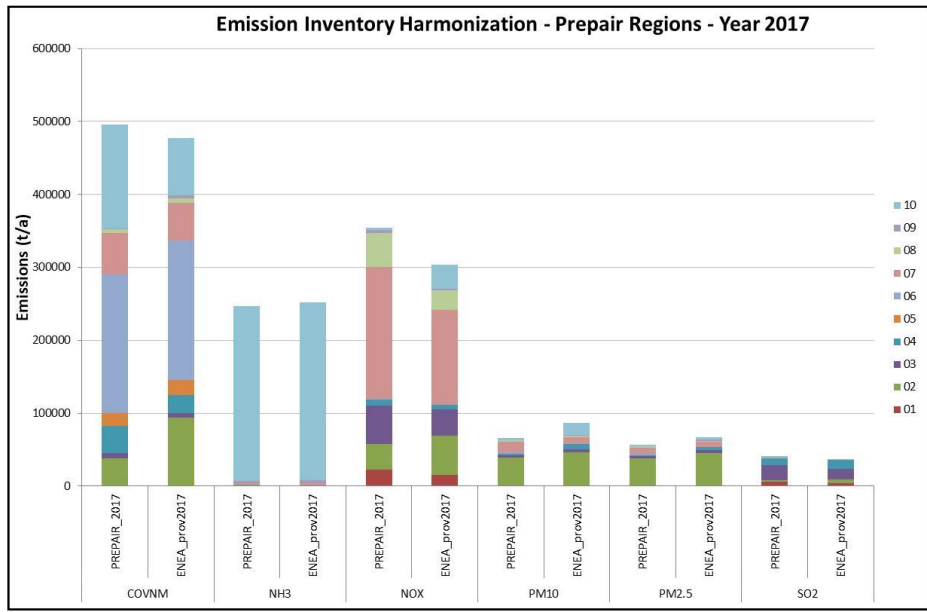
MINNI model (ENEA): 4km resolution (national simulation)
SNPA-ASI (ArpaE): 7 km resolution (national simulation)





The base case emission scenario

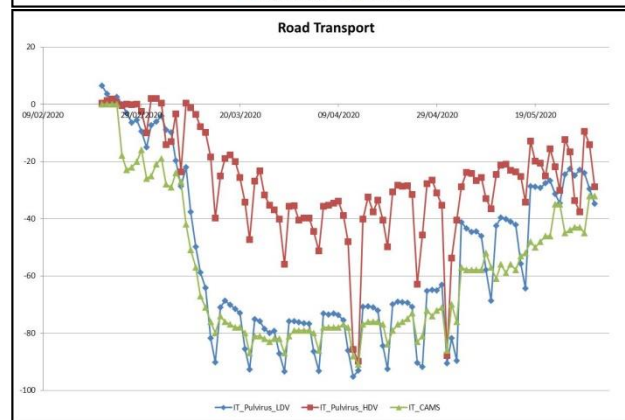
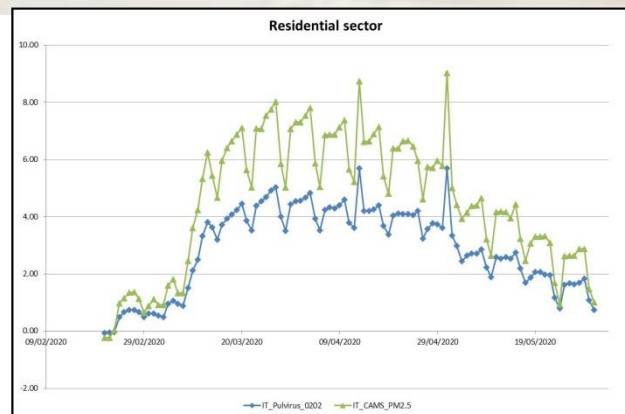
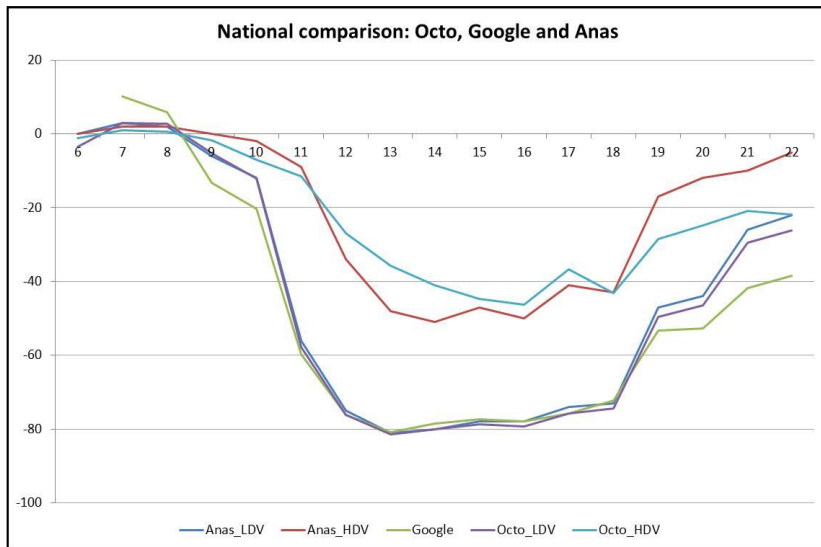
- Base case emission scenario - year 2017
- Harmonization with the available regional emission inventories





The lockdown emission scenario

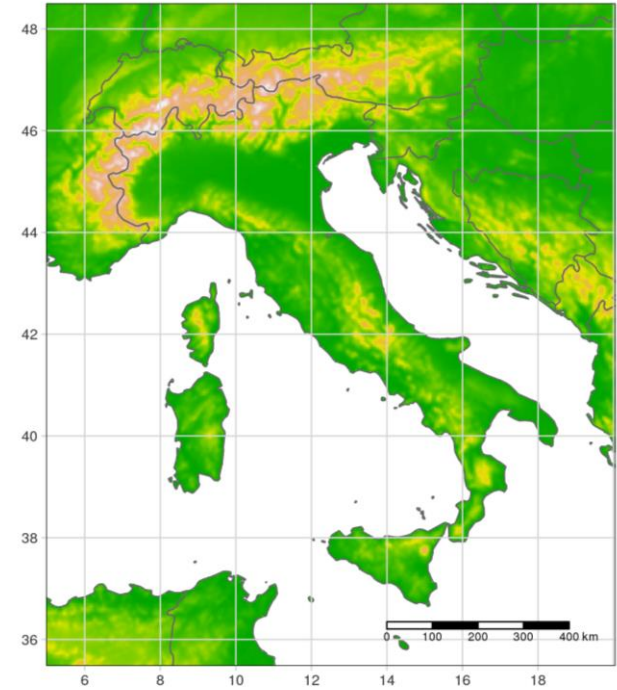
- Selected adjustment factor variations for each sector
- Comparison with regional and European variations
- Daily/weekly or monthly profiles

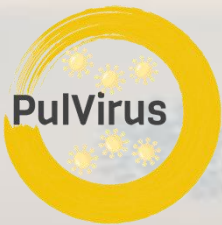




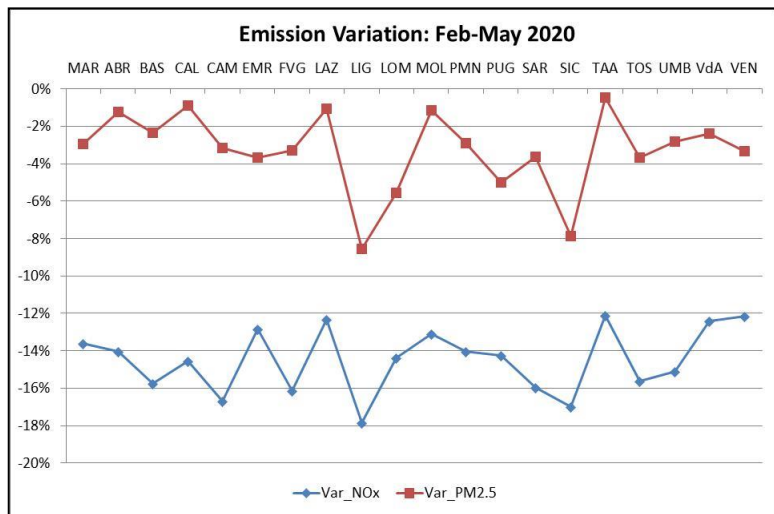
The MINNI model setup

- Two air quality simulations: BASE and LOCK;
- Period: 1 February – 31 May 2020;
- MINNI model: 4km resolution;
- MINNI model:
 - BC from CAMS Covid Simulation base and lockdown (MINNI_CAMS details:
 - o Emissions -> CAMS_REG_APv4.2 – year 2017;
 - o meteo IFS;
 - o base and lockdown scenario with lockdown starting the 21st of February 2020).
 - Meteo: WRF (year 2020), two-way nesting (12km -> 4km) and ERA5 as BC;
 - BVOC: MEGAN model.



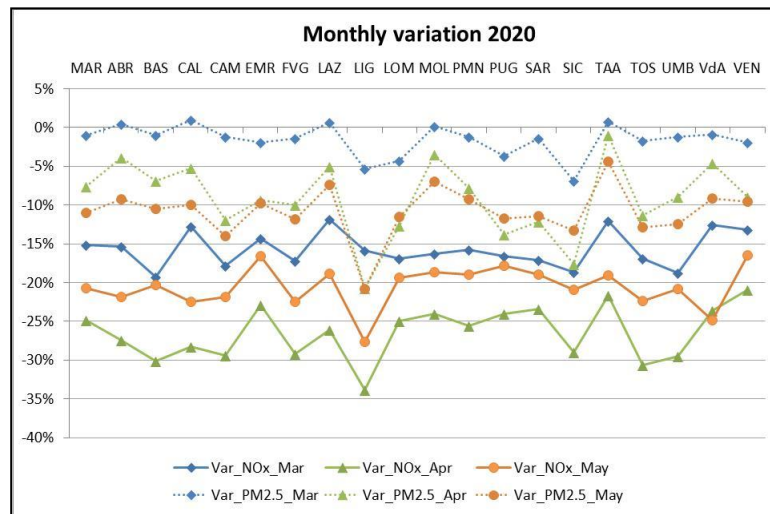


Emission Variations: LOCK vs BASE



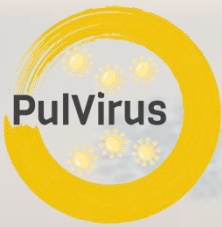
In the entire period:

- NOx Emission Reductions vary from 12% to 18%;
- PM2.5 Emission Reductions vary from 0.5% to 8%

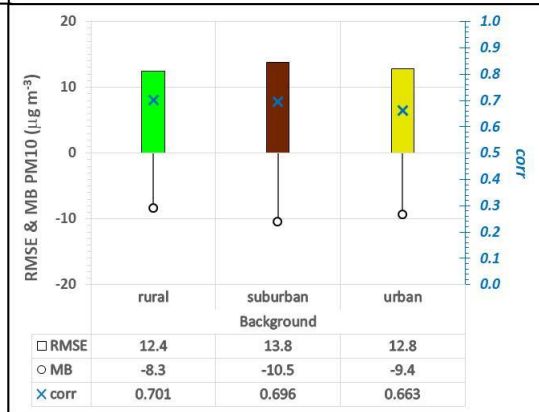
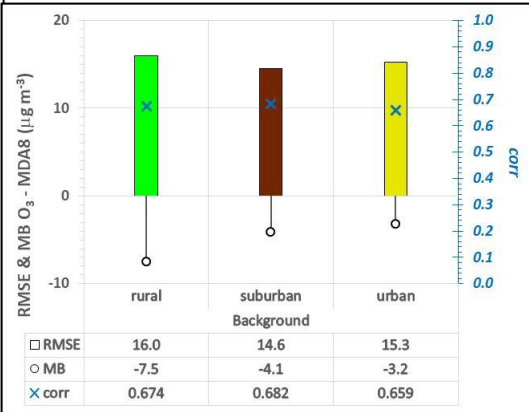
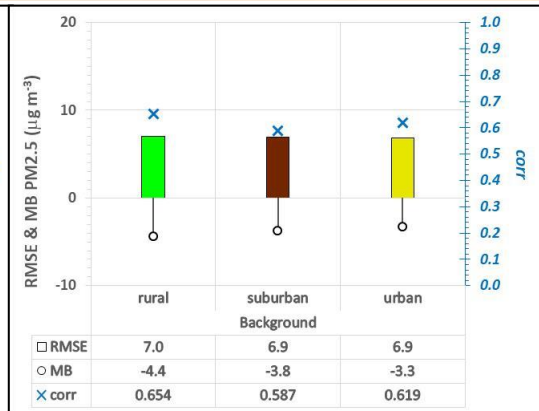
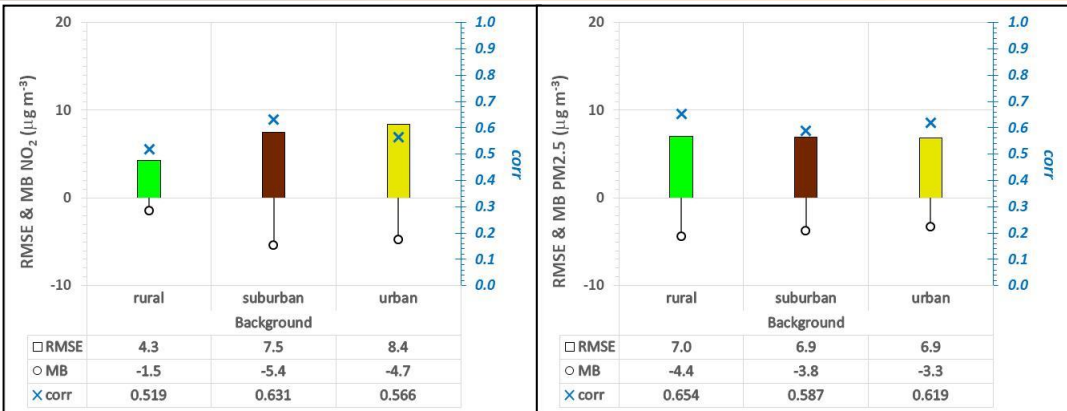


Monthly variations:

- NOx highest reductions in April;
- In some Regions PM2.5 increases in March



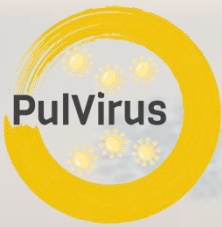
MINNI lockdown and observations



Score calculated in the period Feb – May 2020 for LOCK simulation:

- daily values for NO₂ and PM
- MDA8 (maximum daily 8-hour average concentration) for O₃

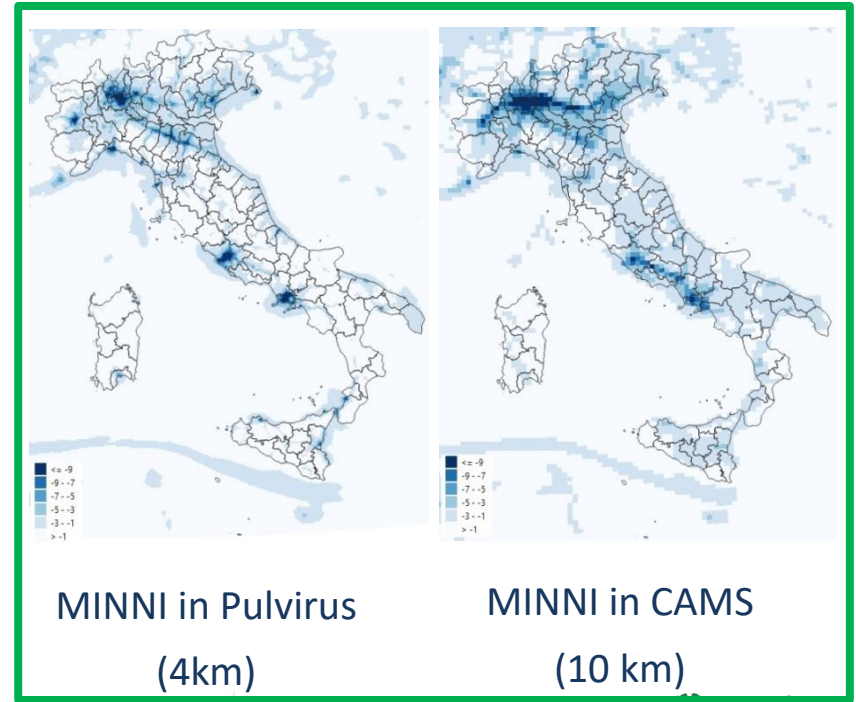
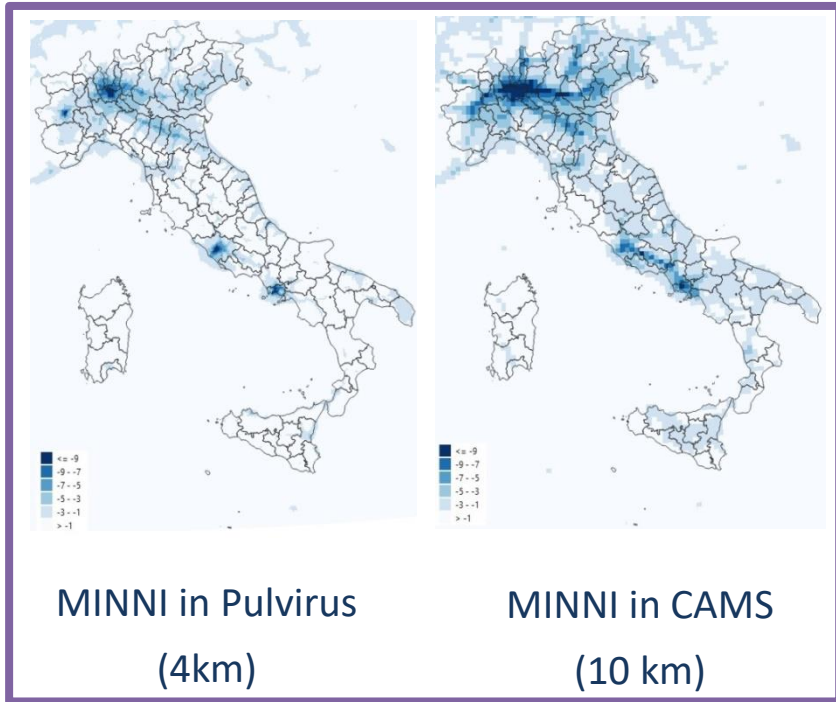




MINNI lockdown and CAMS lockdown: variation in NO₂ concentrations

March 2020

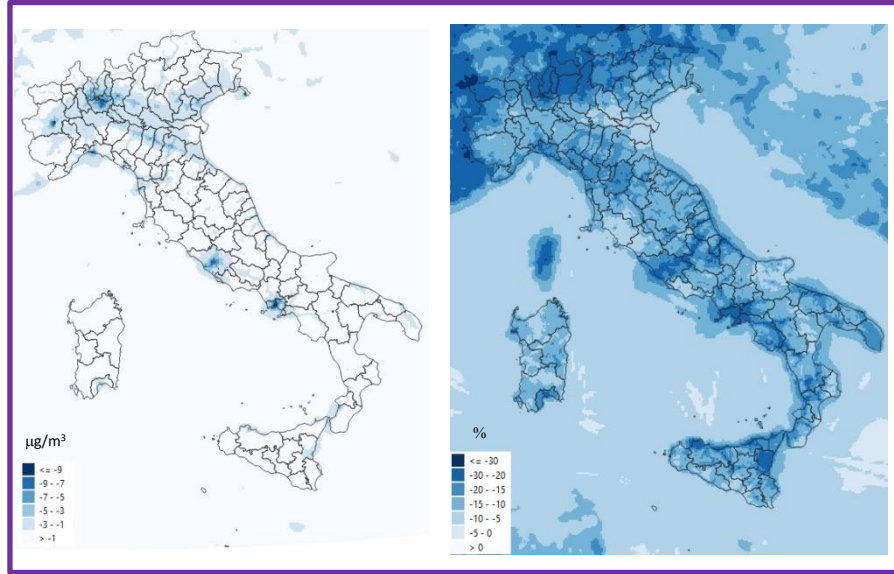
April 2020



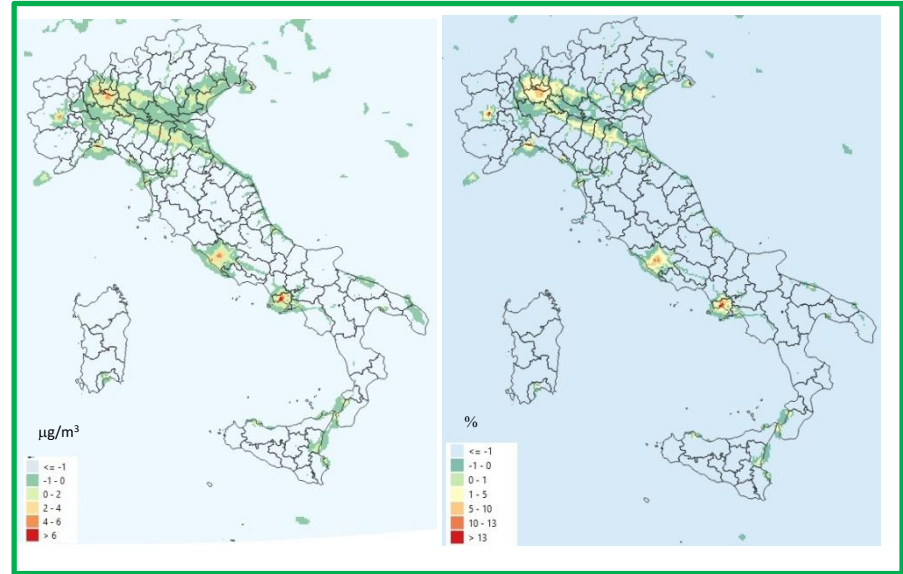


MINNI lockdown: concentration variations – period Feb – May 2020

NO₂



O₃



In the entire period:

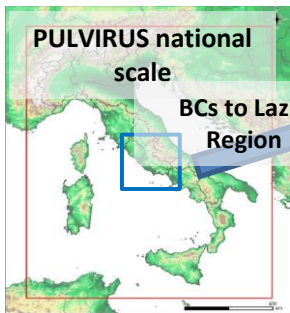
- NO₂ concentration reductions vary from 1 to 9 µg/m³ (3% to 30%);
- O₃ concentration increases in urban areas till 13% (5-6 µg/m³);
- PM does not show significant variations.

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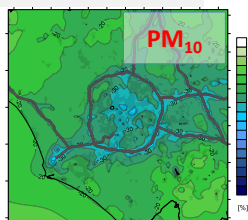
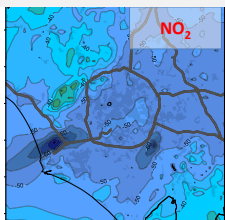
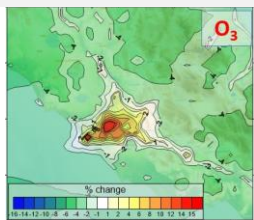


MINNI simulations as BC to other models



LAZIO REGION

April 2020 monthly mean concentrations:
% reduction due to 2020 vs BASE emissions



O₃
Increases inside the conurbation and near the major roads
Decreases at rural background

ARPA estimation from
2020 vs 2016-2019
obs.:

NO₂
-58% outside GRA
-45% inside GRA
PM₁₀
-14% outside GRA
-25% inside GRA

Credits by ARIANET e Arpa Lazio

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In preparation Data for
PUGLIA REGION to be used as
BC for Regional simulations



Data available as BC for all the
Regions for higher resolution
regional simulations





Conclusions

In the entire period (Feb - May 2020) from MINNI model simulations:

- Total NO_x emission reductions vary from 12% to 18%;
- Total PM_{2.5} emission reductions vary from 0.5% to 8%;
- Large reductions in NO₂ concentration especially in urban areas and corresponding O₃ increases in urban areas;
- PM does not show a huge variation.

In comparison to CAMS simulations, less variations are observed especially in NO₂ concentrations probably due to the use of different adjustment factors for the road transport sector: Google in CAMS with no distinction between Light and Heavy Duty vehicles and Octo_Telematics in Pulvirus distinguishing LDV and HDV, so CAMS factor for the traffic sector may overestimate the overall reduction of emissions, especially in areas with a higher share of HDV (Guevara et al., ACP, 2021).

A comparison between the concentration variations estimated with the MINNI model and the Random Forest approach is ongoing.