

Evolution temporelle de la mortalité liée à la Covid-19 en fonction des niveaux de PM2.5 pour l'Europe de l'Ouest entre 2020 et 2022

Temporal evolution of the mortality due to Covid-19 related to PM2.5 levels in West Europe for the 2020-2022 period

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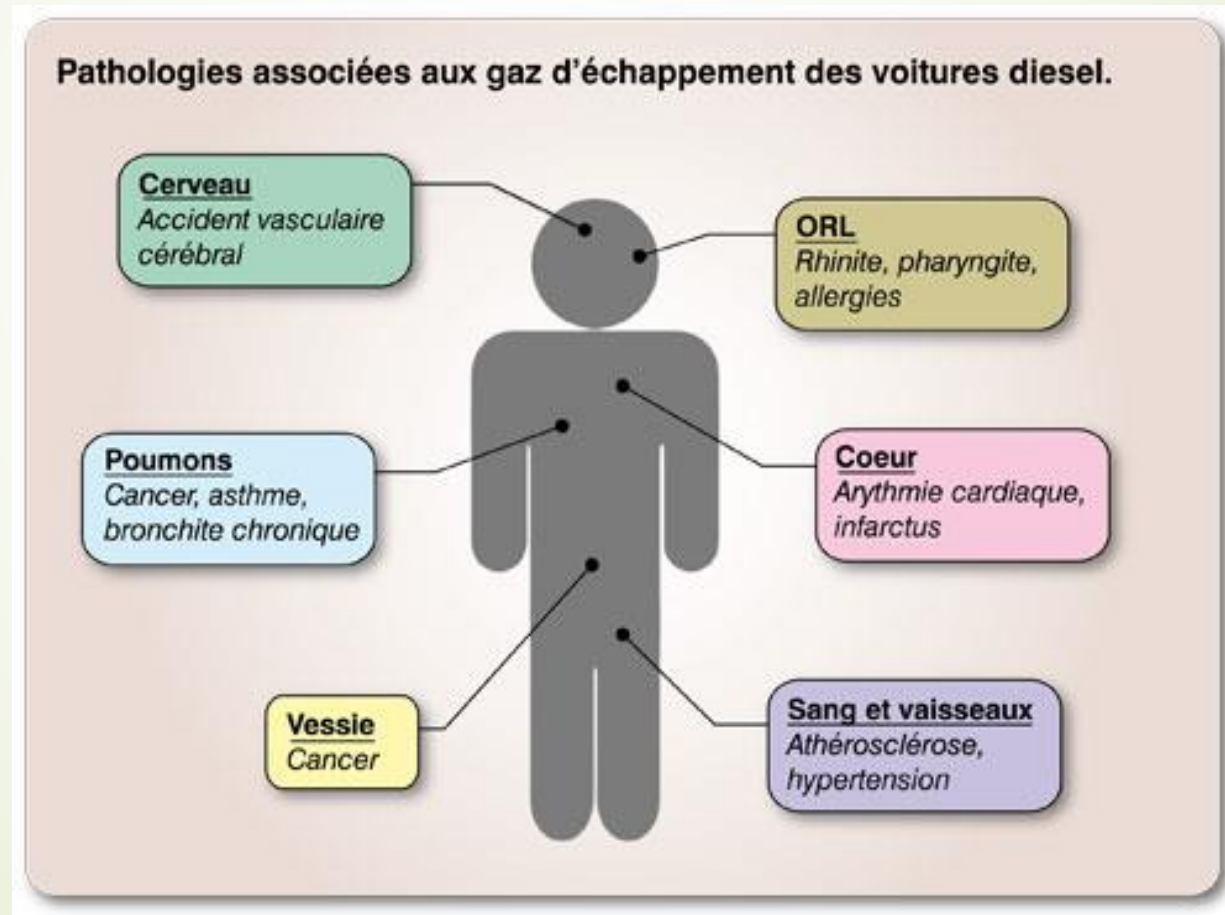
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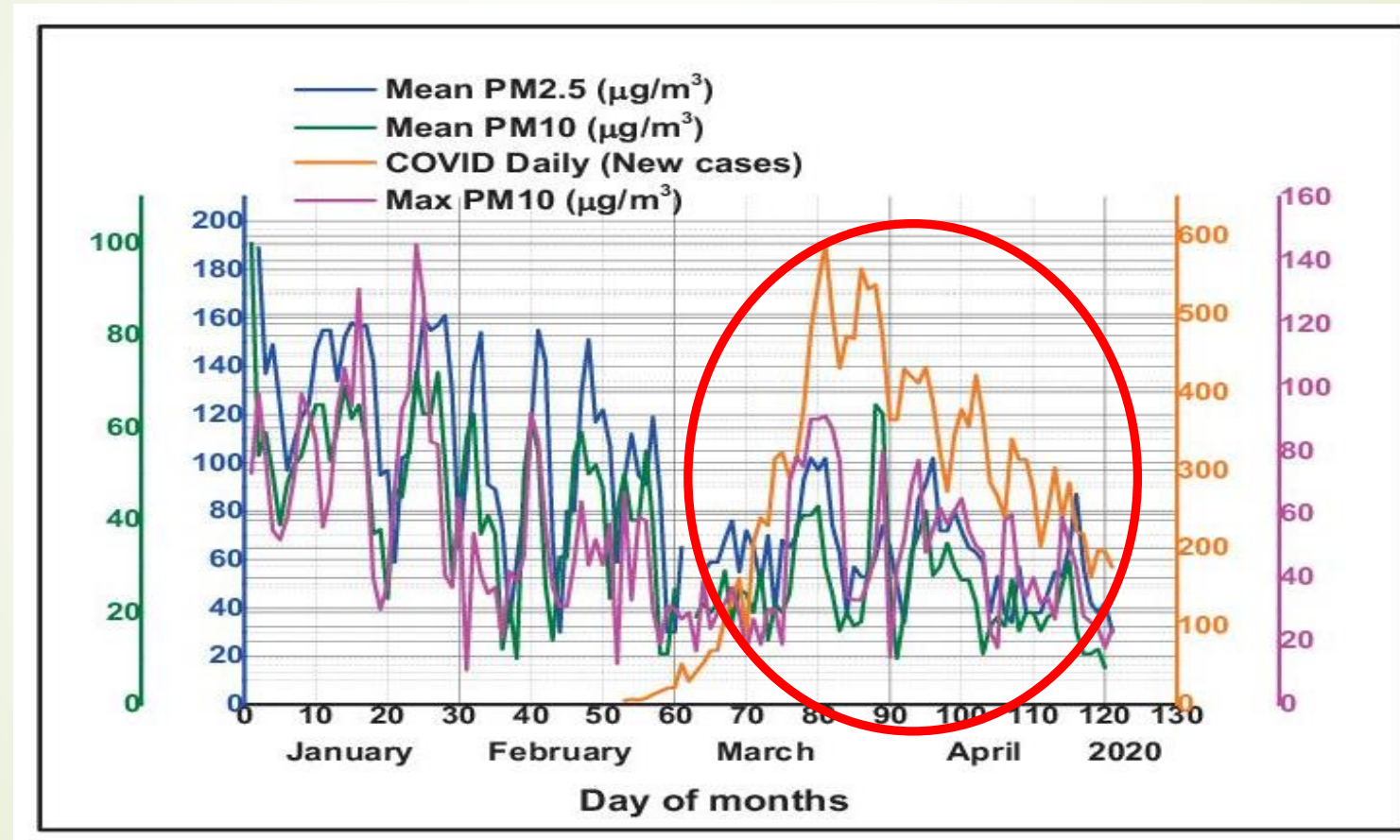
Based on the paper: J.-B. Renard, J. Surcin, I. Annesi-Maesano, G. Delaunay, E. Poincelet, G. Dixsaut, Relation between PM2.5 pollution and Covid-19 mortality in Western Europe for the 2020-2022 period, Science of the Total Environment, 848, 157579

The effect of particulate matter (PM) pollution on human health:

- More than 300 000 deaths in Europe have been attributed to exposure of PM_{2.5} pollution (particles < 2.5 µm), causing heart attacks, strokes and long term illnesses
- PM₁ (particles < 1 µm) and PM_{2.5} are the most dangerous due to their microscopic size, and can be found in all organs of the body



- Links between air pollution and viral infection have already been established during the 1918 Spanish Influenza Pandemic and during the 2002 SARS epidemic
- First studies published in 2020 have shown a correlation between PM pollution levels and Covid-19 mortality during the first phase of the pandemic (for example in Italy)



Example for Milan, Italy, during the first phase of the pandemic, Zoran et al., 2020, Sci. Tot. Envir. 738

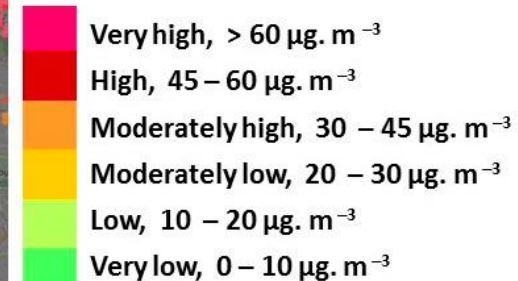
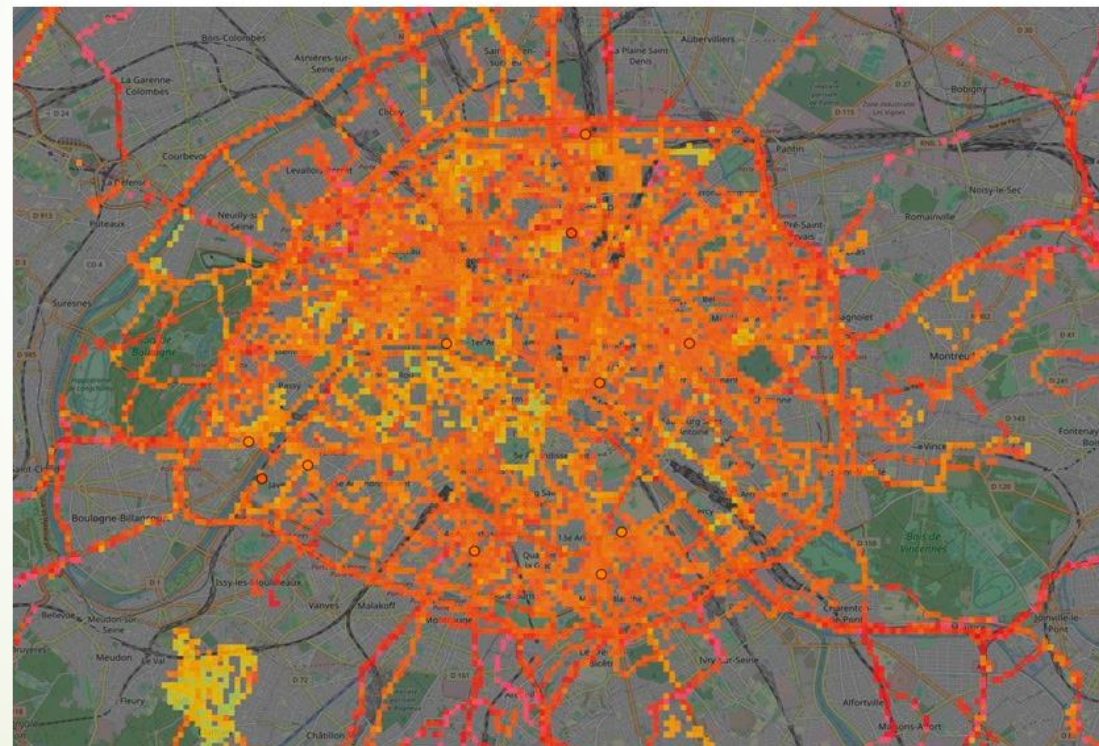
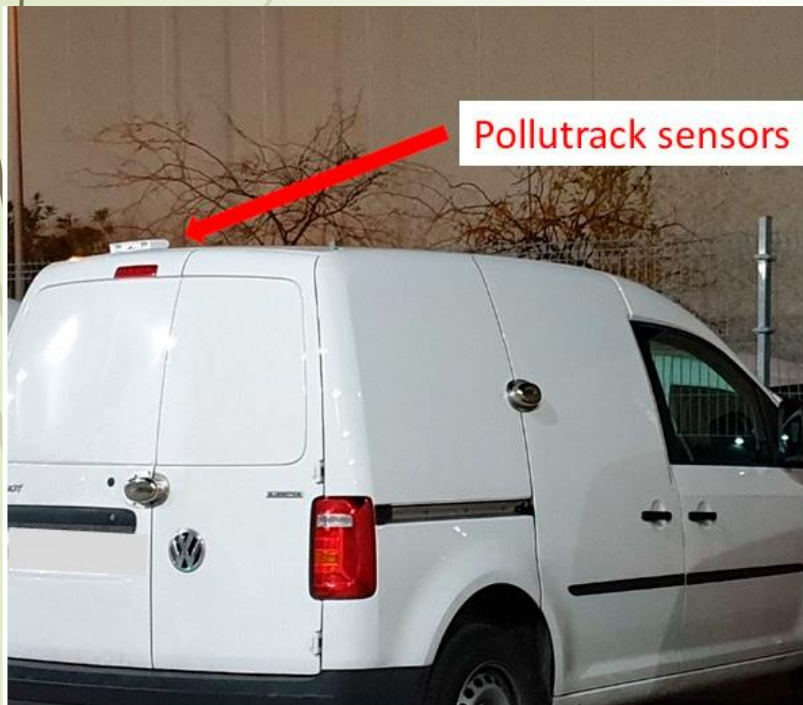
How to measure the PM ?

- Normative mass concentrations for PM10 and PM2.5, obtained by few expensive instruments per region, managed by regional air quality monitoring networks
- PM10 limits : 50 $\mu\text{g}/\text{m}^3$ per day less than 35 days per year; annual mean value < 40 $\mu\text{g}/\text{m}^3$
- PM2.5 WHO recommendations : < 15 $\mu\text{g}/\text{m}^3$ per day and annual mean value < 5 $\mu\text{g}/\text{m}^3$



Another source of measurements :

- PM2.5 measurements by optical counters on the roof of hundreds of cars in 33 cities in Europe, performed by the Pollutrack French company
- Vastly superior to the 5 static devices in Paris



1 km

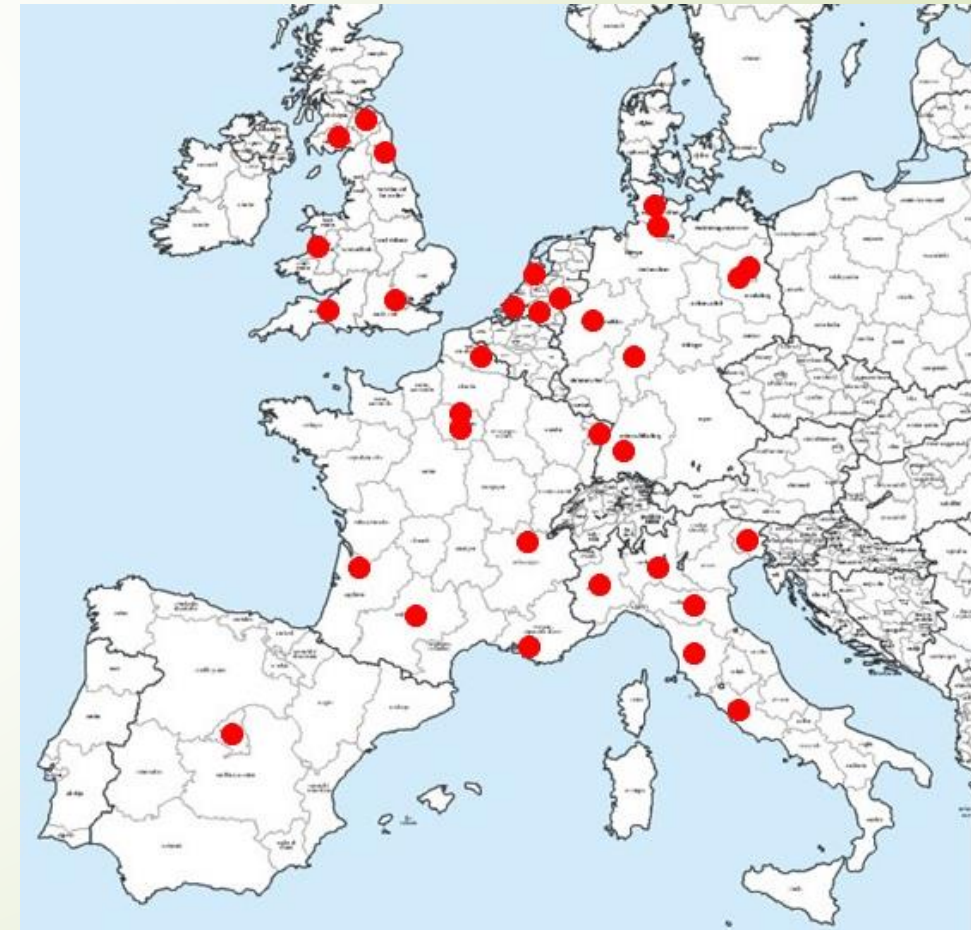
Motivation of the study

- Extensive analysis on the possible correlation between PM2.5 pollution level and daily number of deaths attributed to Covid-19 in Europe
- Why considering mortality ? The data are less statistically biased than those on the number of new cases
- High and low levels of mortality in the same country (ex. low levels for the cities in the West of France and high levels in most polluted cities as Paris)
- The spatial and temporal variabilities of the pollution is a good candidate to partly explain the Covid-19 mortality spatial variability



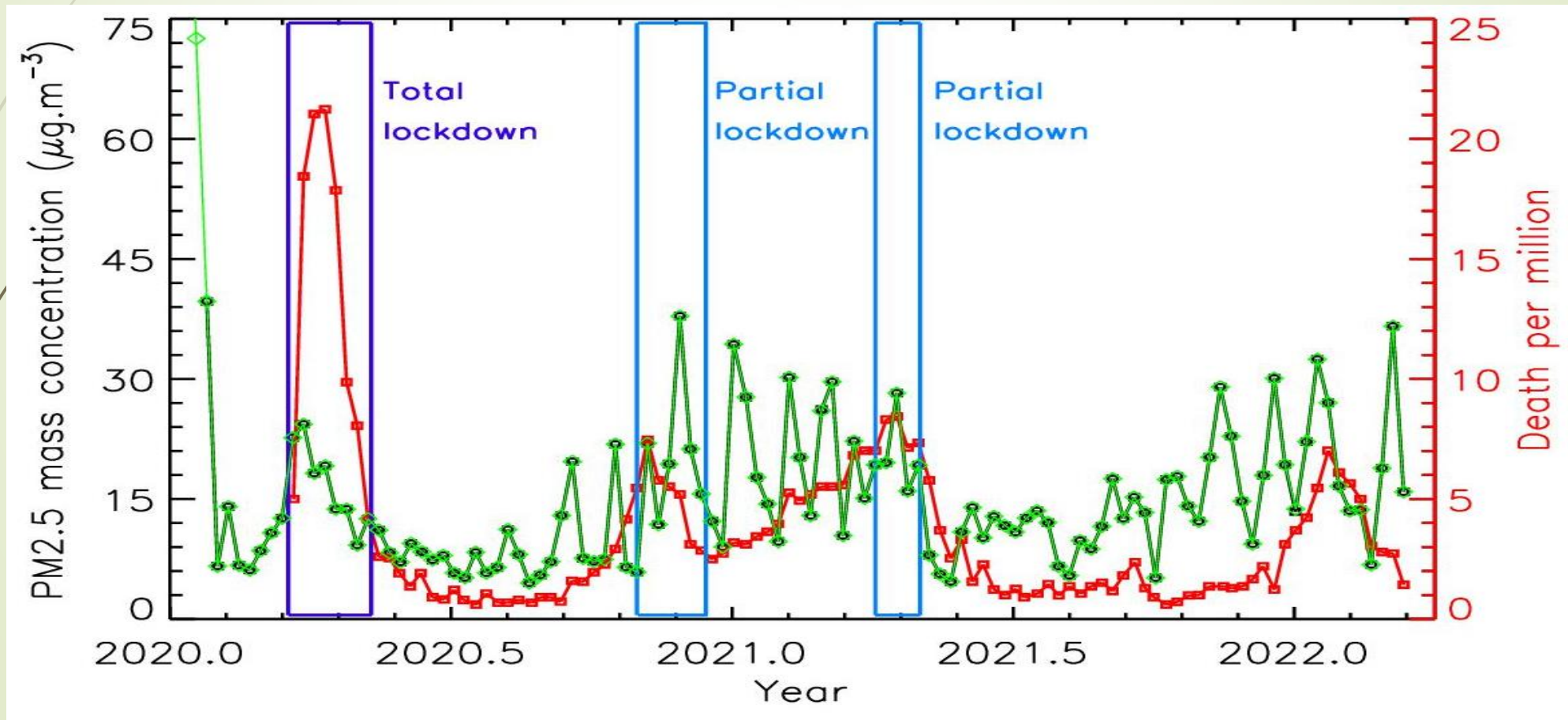
- 32 large cities in Southern and Western Europe are considered (France, Germany, Italy, Netherlands, Spain, United Kingdom) in order to offer comprehensive representation of the different levels of PM_{2.5} that can be encountered

- Reliable daily data required for Covid mortality (per million inhabitants)
- Weekly data averaging conducted
 - Covid-19 source : John Hopkins University
 - PM 2.5 sources : air quality networks, and Pollutrack data when available

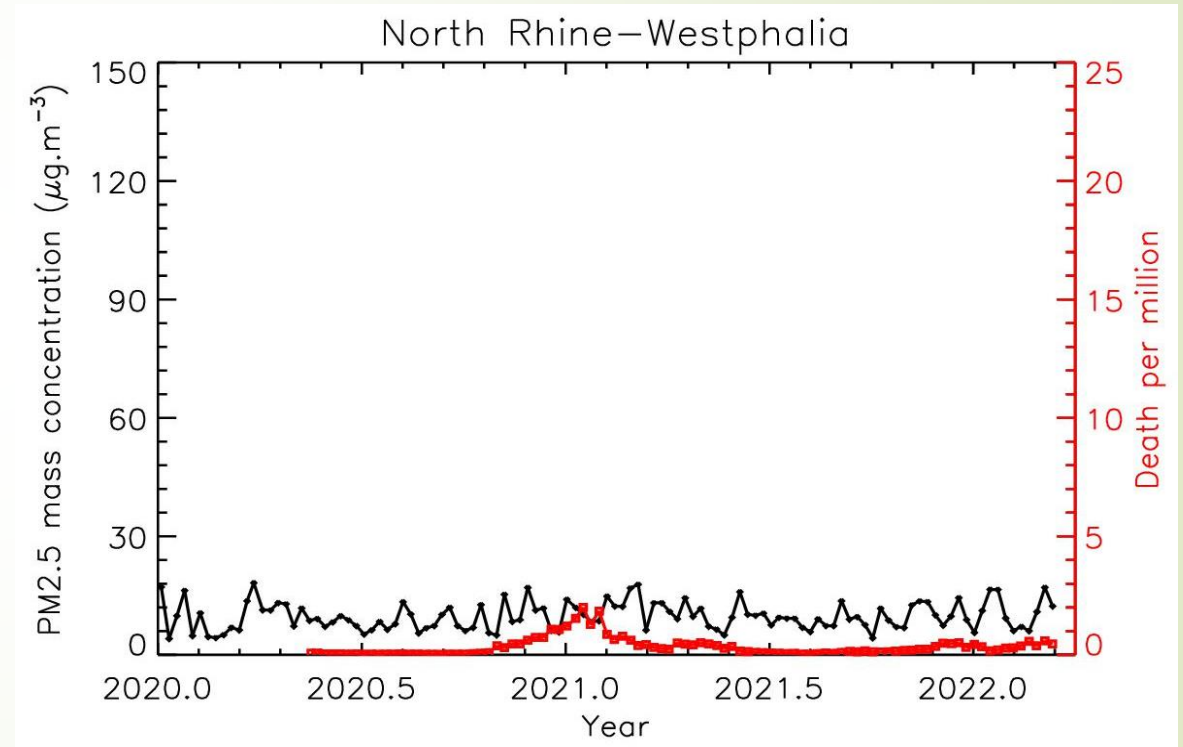
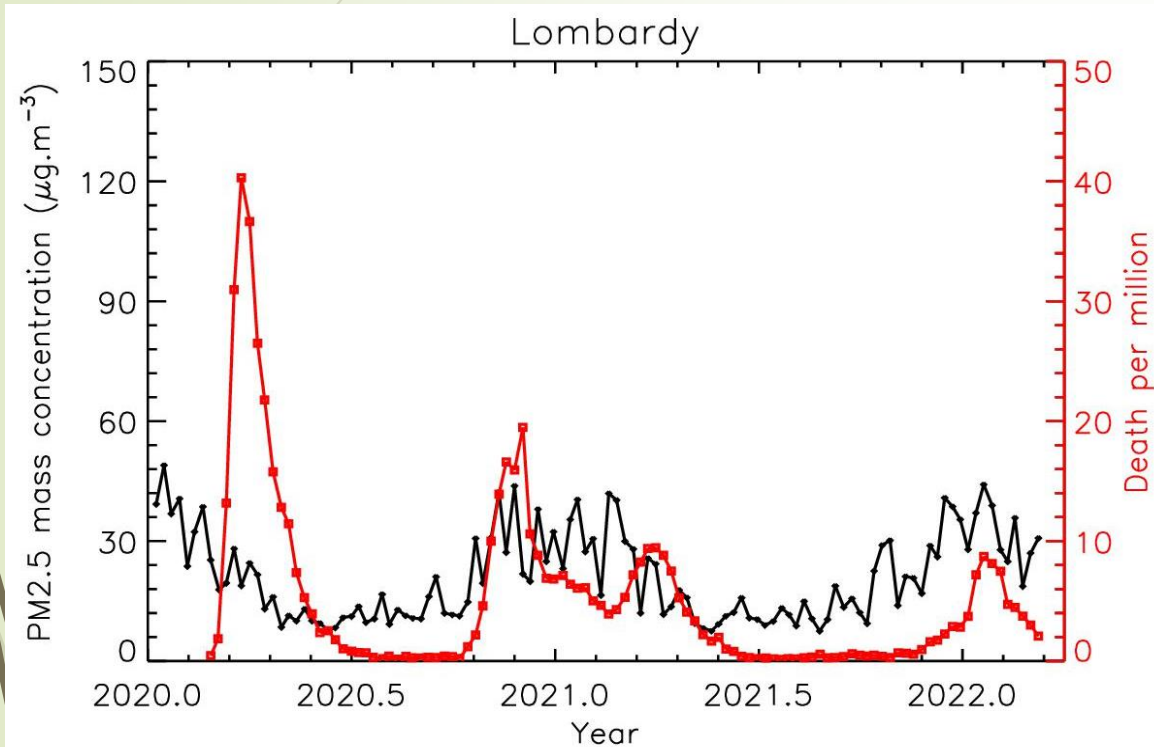


Paris Case Study (a “compact city”)

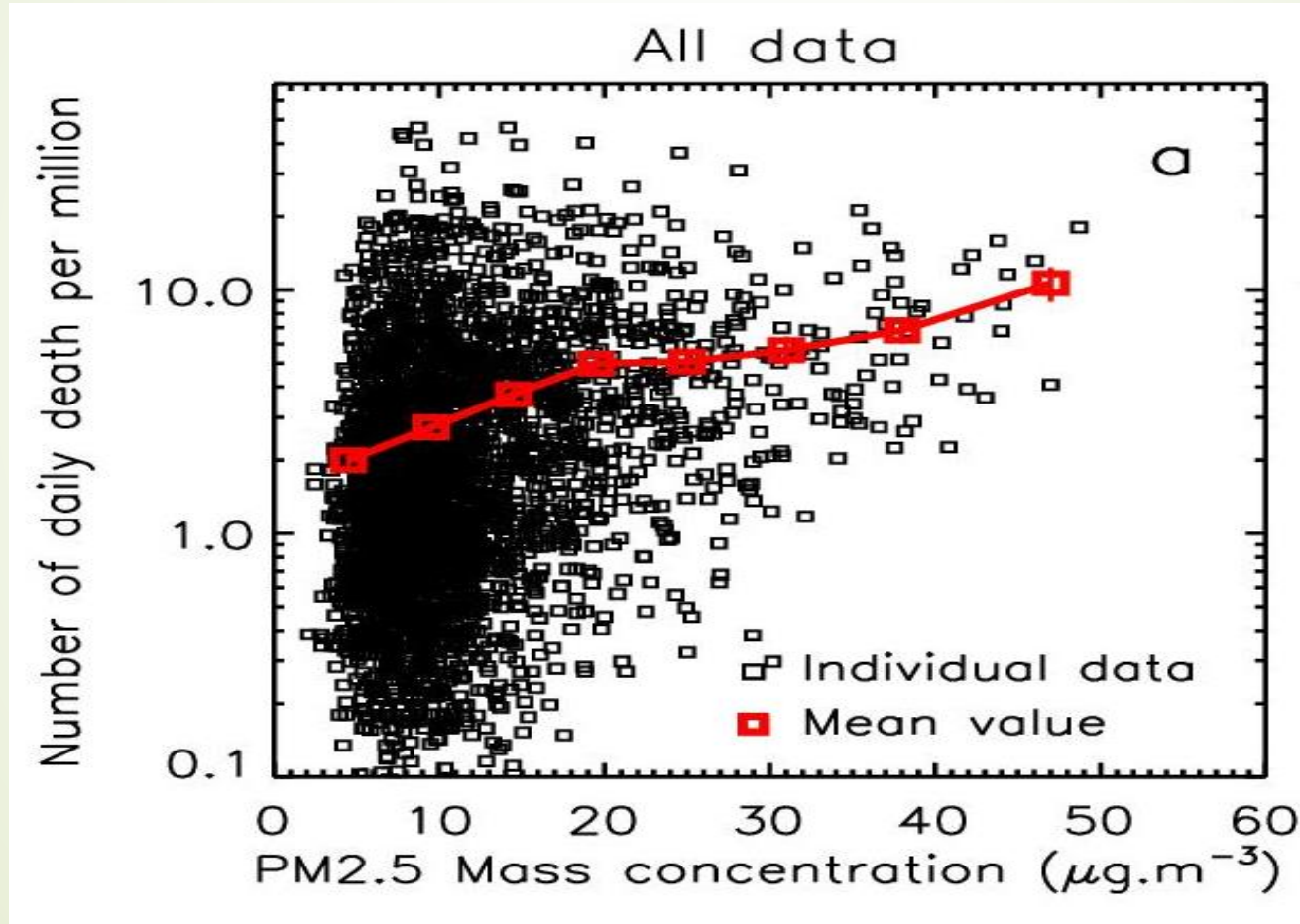
- PM2.5 data collected by using Pollutrack mobile high resolution sensors Increase of Covid-19 mortality for each PM2.5 mass concentration increase above $\sim 15 \mu\text{g.m}^{-3}$, partly counteracted by the effects of the lockdowns
- Drop of mortality when the PM2.5 mass concentration strongly decreases



- Similar effect for the highly polluted Lombardy region (Italy)
- Almost no effect for low-pollution regions (as for Nordrhein-Westfalen, Germany)



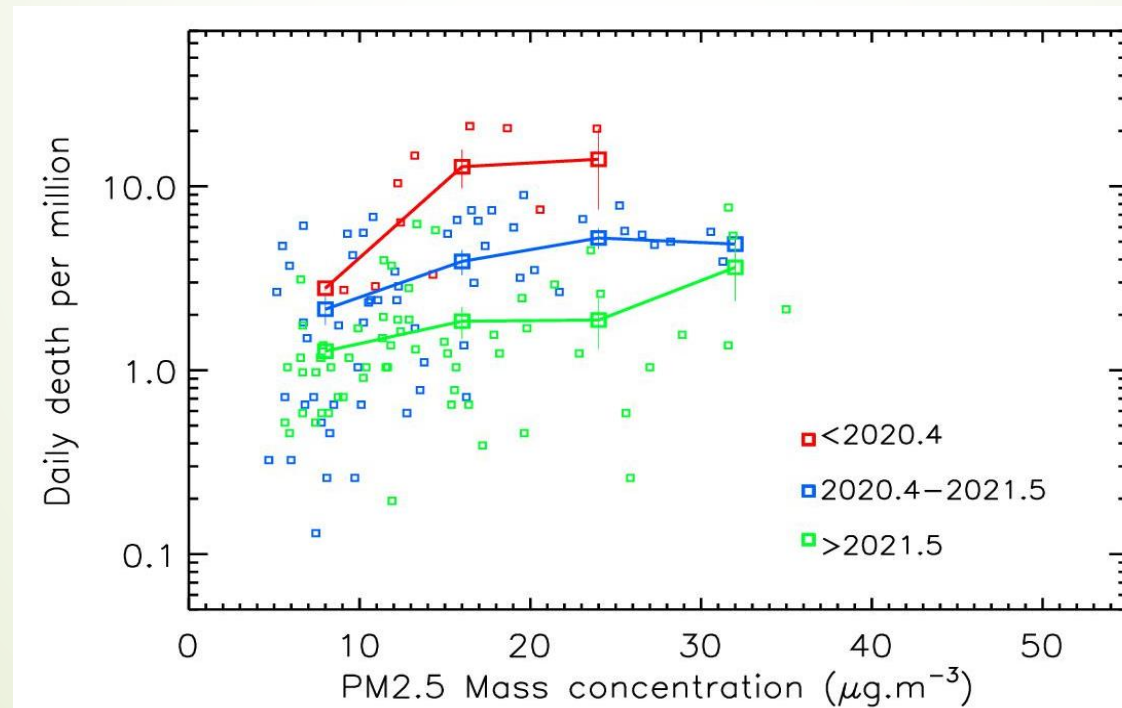
- Combining all measurements, and using 2 different statistical approaches, the same trend is obtained: the mortality increases by a factor 5 when PM2.5 pollution increases from 5 to 45 $\mu\text{g.m}^{-3}$



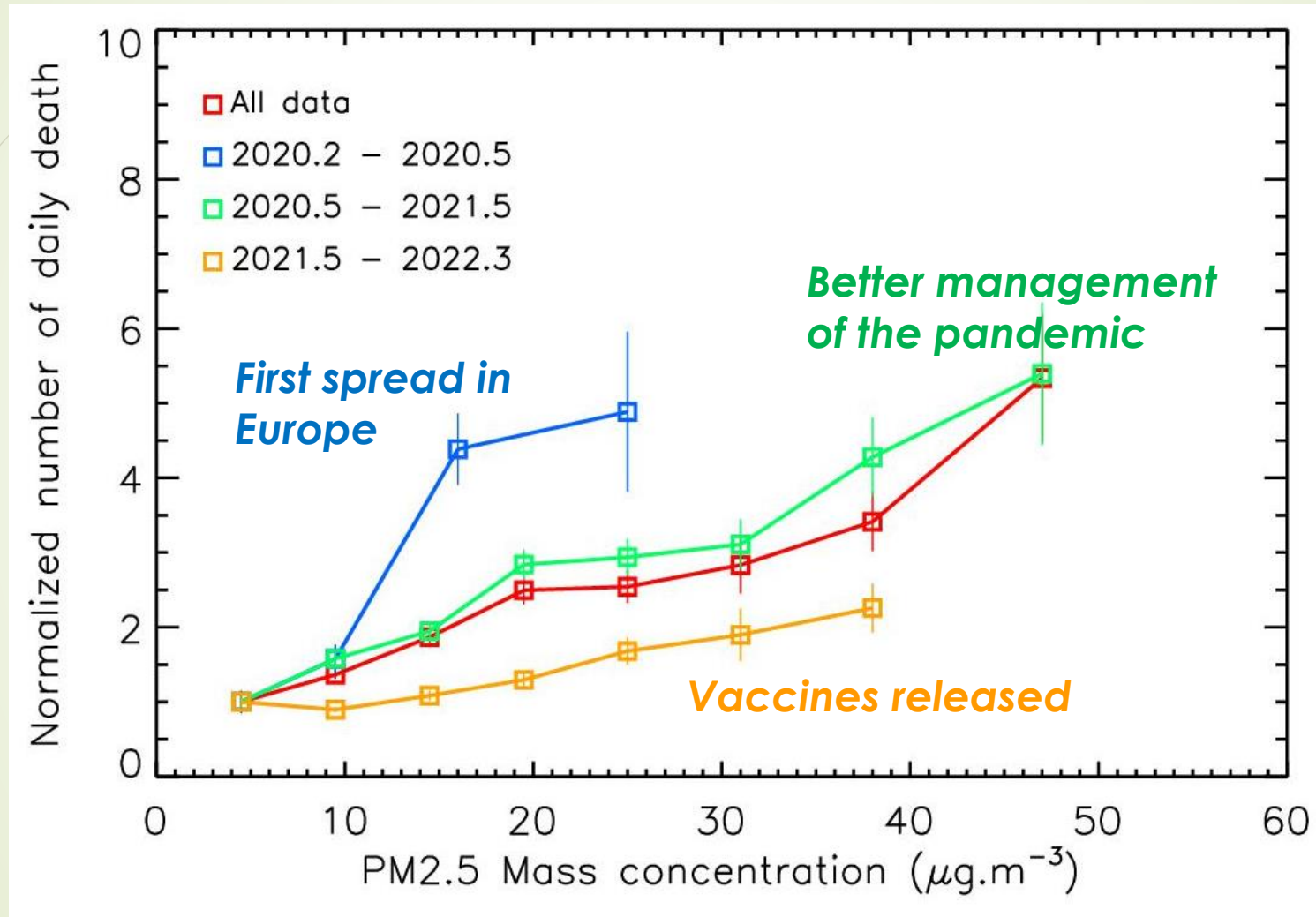
➤ 3 different periods to be studied :

- Initial spread of the pandemic in Spring 2020 when little was known about the virus
- Mid 2020 – mid 2021 period where the pandemic was better understood and managed
- Post vaccination release after mid-2021

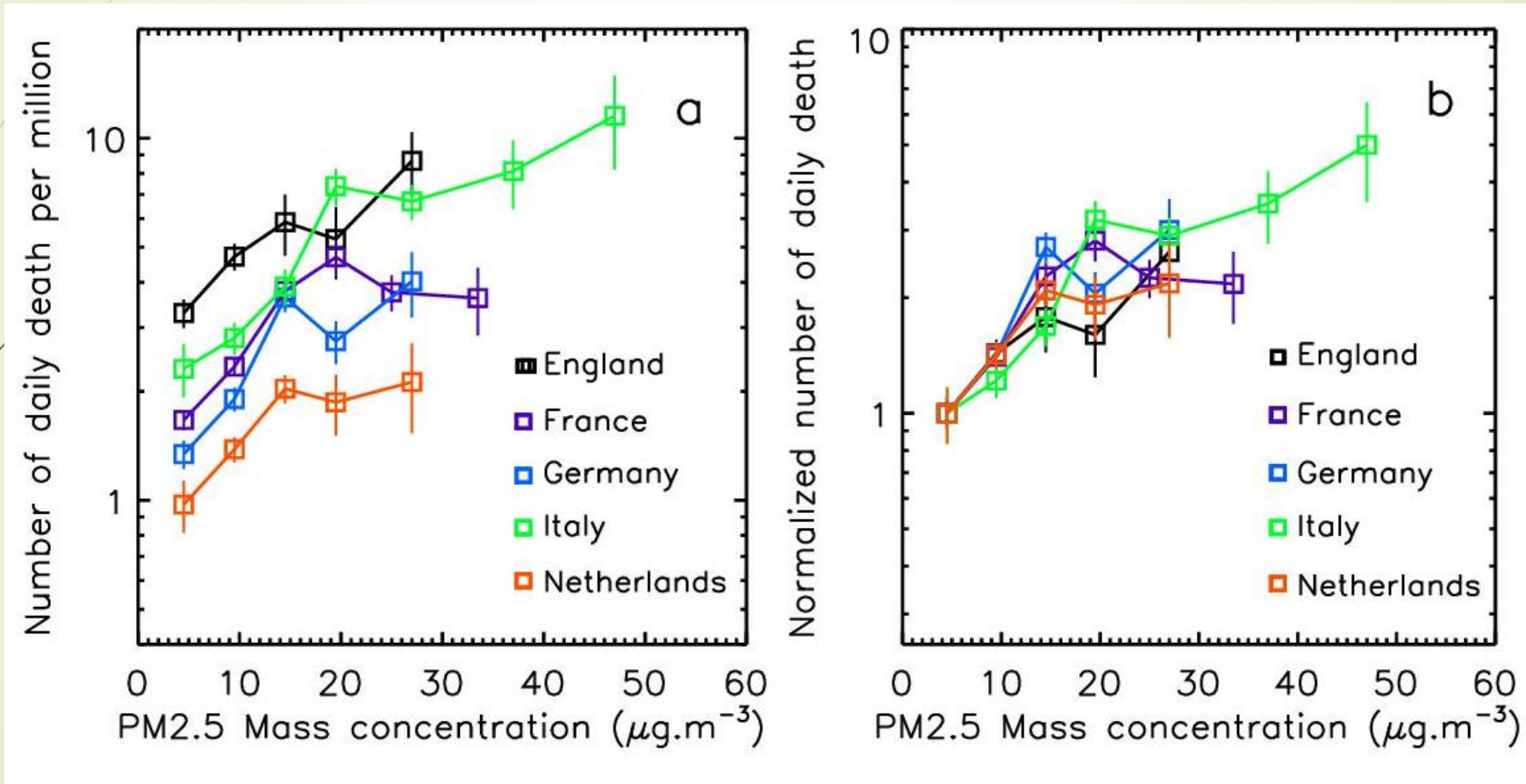
➤ Trend for Paris, increase of mortality with increasing PM pollution



- This effect depends on the period of the pandemic



- Similar trend for the country (about 10.5 ± 2.5 % per $\mu\text{g.m}^{-3}$), whatever are the initial conditions depending of the local management of the pandemic

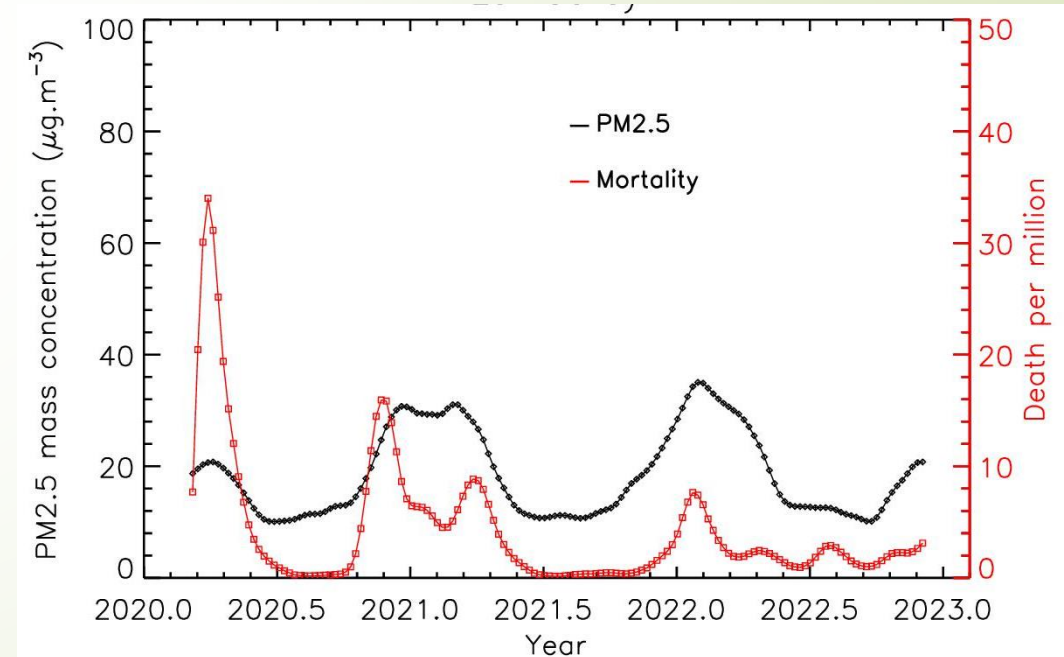
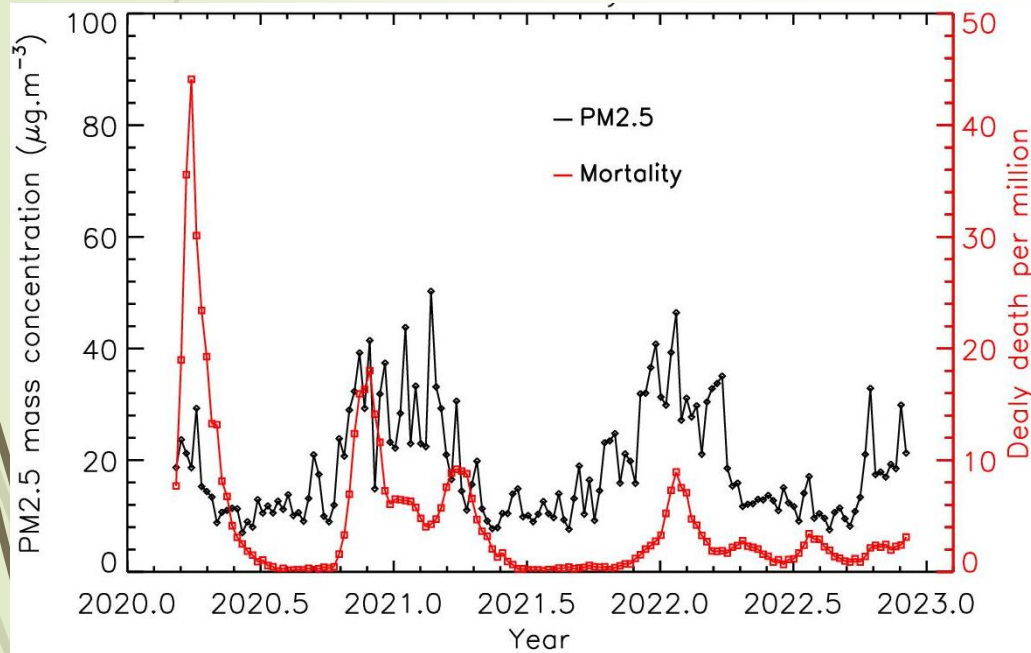


Raw data

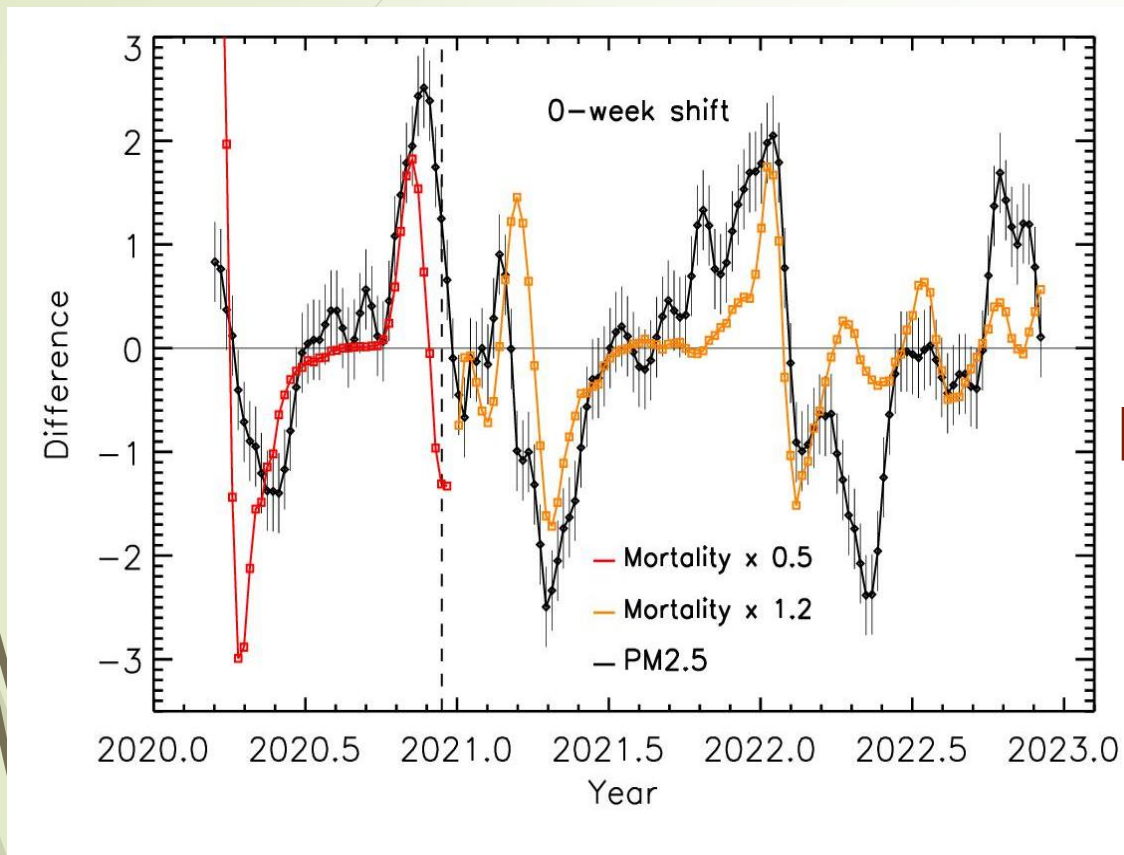
*Data divided by the value
at $5 \mu\text{g.m}^{-3}$*

➤ Further analysis for the 2020-2022 period

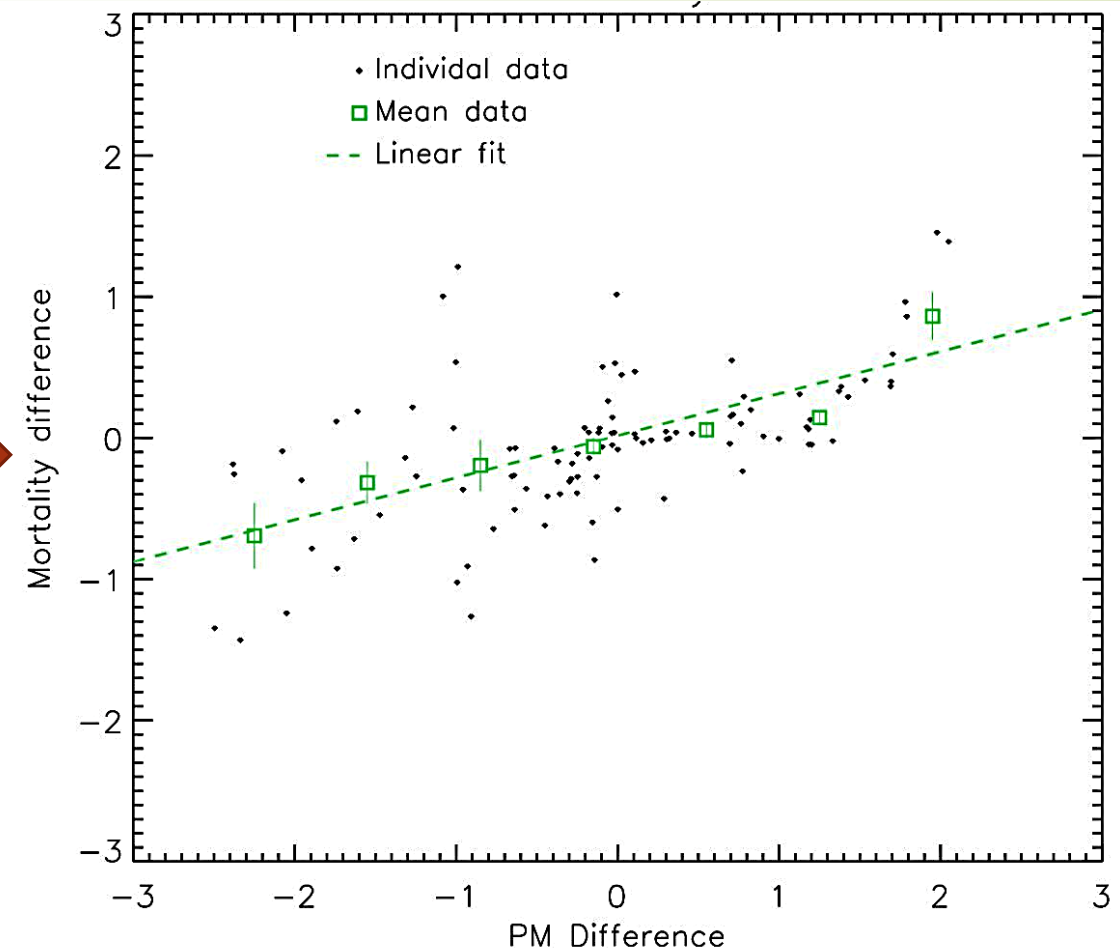
- New studies for 16 cities / regions / countries with low, medium and high PM2.5 pollution levels
- Improved correlation between pollution events and Covid-19 mortality when integrating the pollution data over a 2-month period

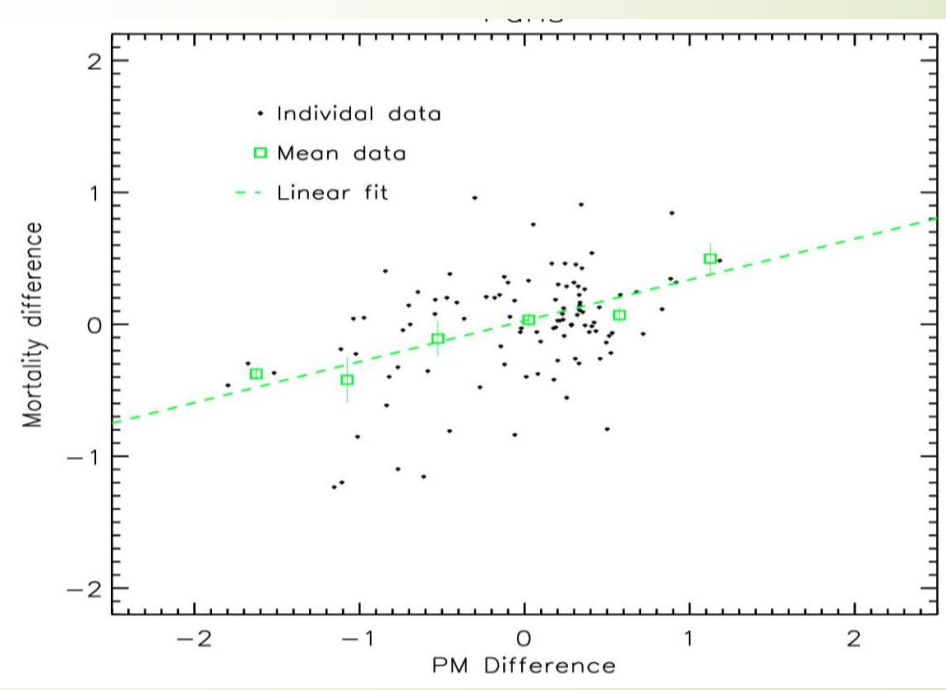
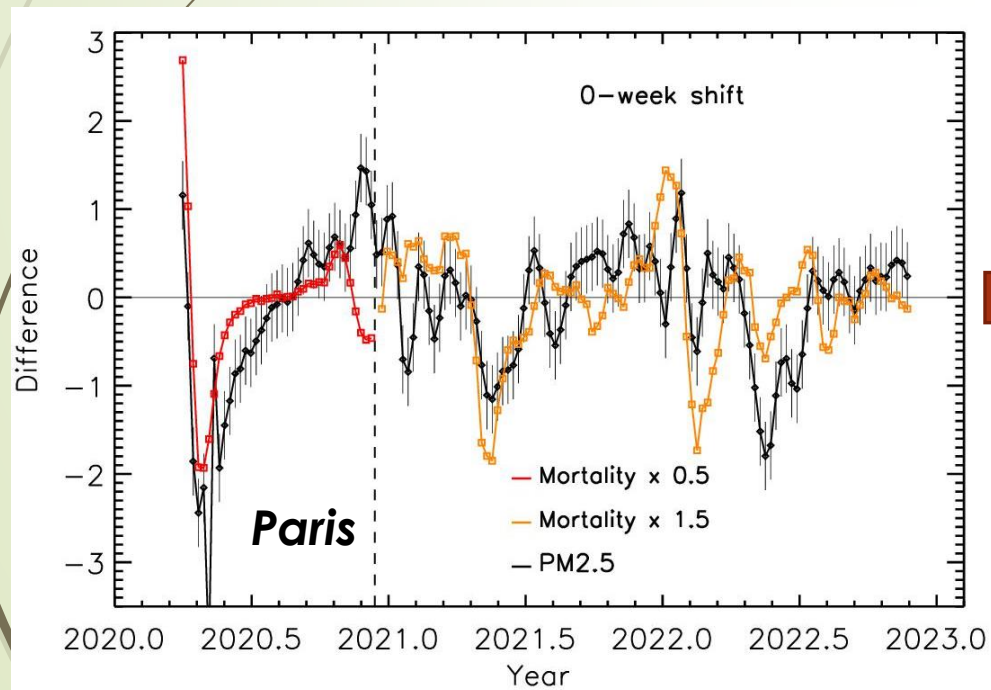
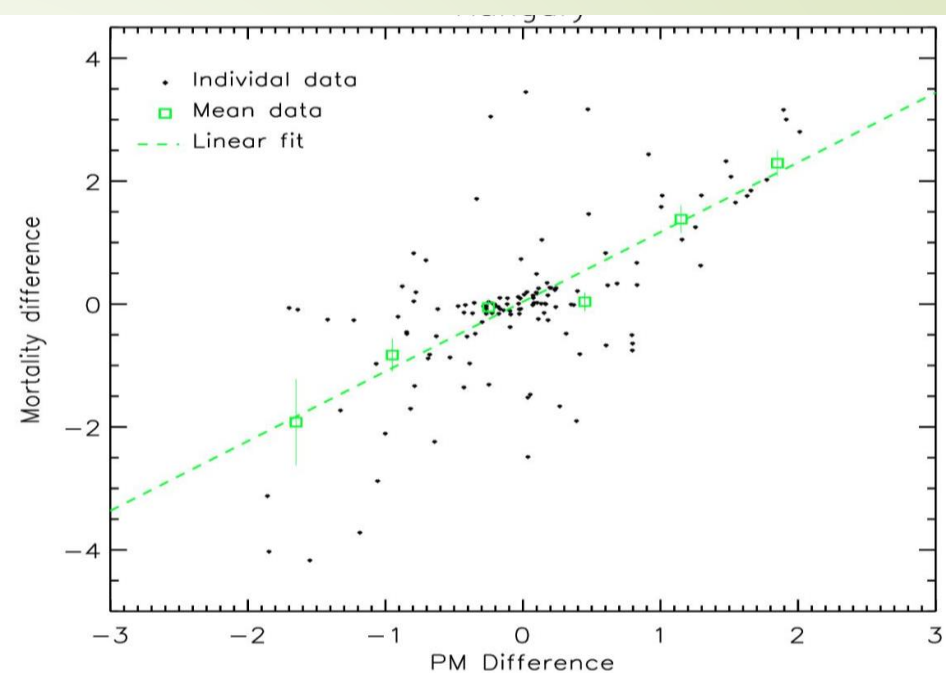
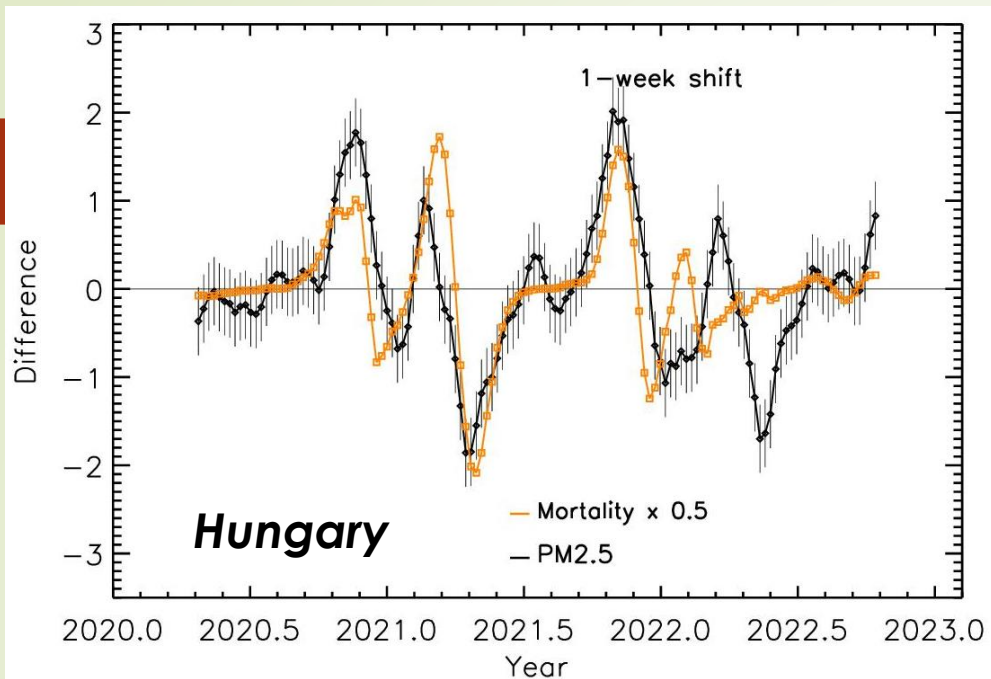


- High sensitivity of the Covid-19 mortality to strong variations of PM2.5 pollution levels (here, differences between consecutive weeks)

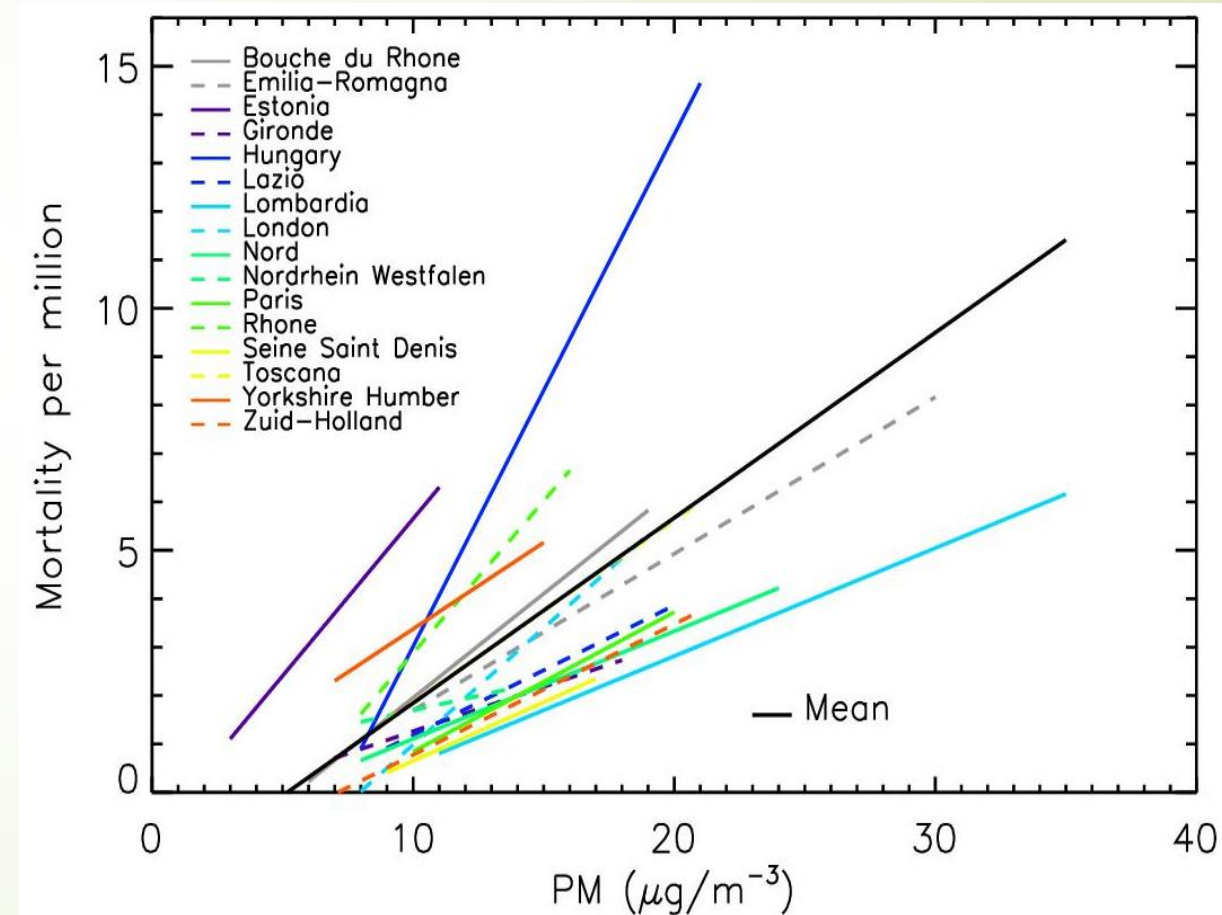
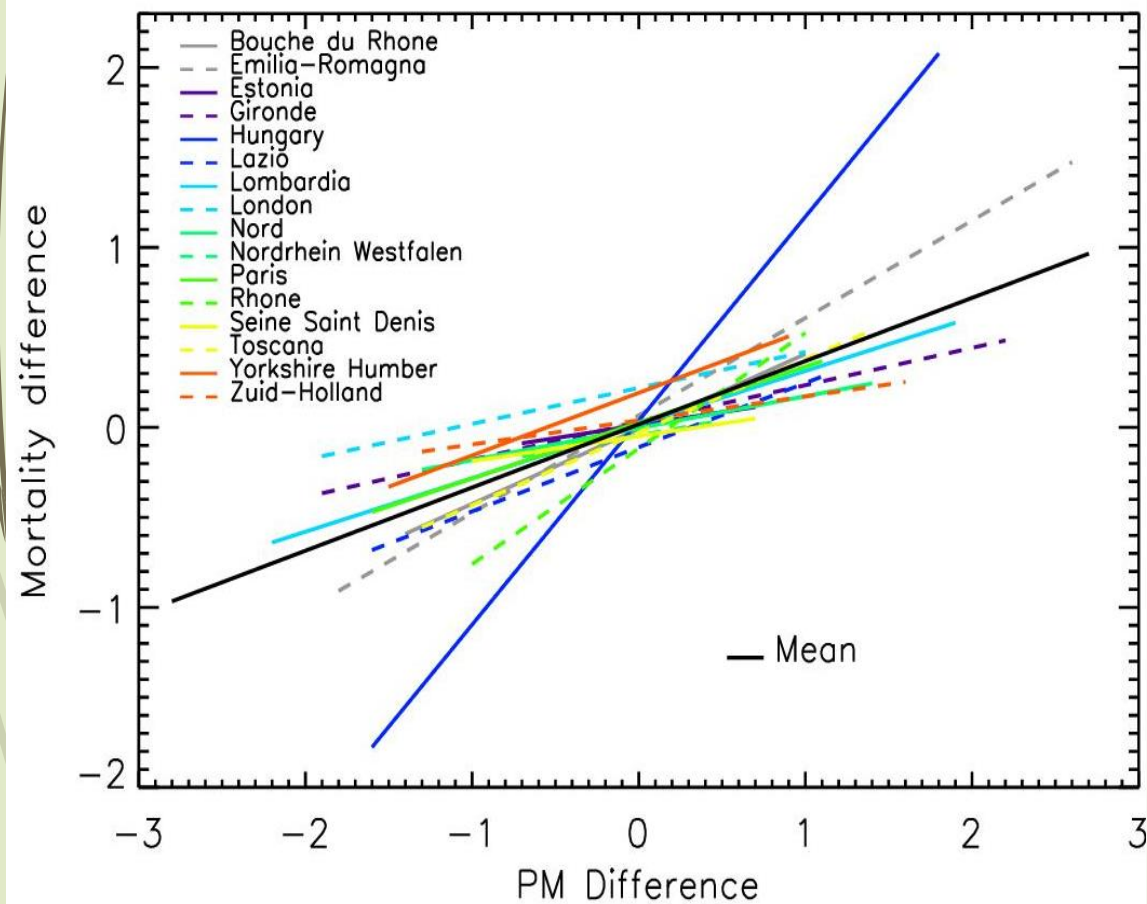


Lombardy





- Linear increase of Covid-19 mortality with PM 2.5 pollution increases
- Variability of the local linear trends depending on the local management of the pandemic





Analysis:

- “Integration effect” of PM2.5 pollution for Covid-19 mortality: necessity of considering the time exposition on PM2.5 pollution during the previous 2 months
- Maximum of Covid-19 mortality about 1 week after the main (integrated) pollution peaks
- Up to 40 % of mortality increase per $\mu\text{g.m}^{-3}$ of PM2.5 increase
- Decrease of Covid-19 mortality when the PM2.5 pollution decreases
- Less effect for the locations with almost constant pollution levels

Conclusions

- The inhalation of PM2.5 is an irritant for all the airways, which favors the penetration of airborne viruses and bacteria
- This study clearly shows that the greater levels of PM2.5 pollution produce the higher Covid-19 mortality rates
- New studies to be conducted for other respiratory diseases

