Unbalanced emission reductions of different species and sectors in China during COVID-19 lockdown derived by multi-species surface observation assimilation

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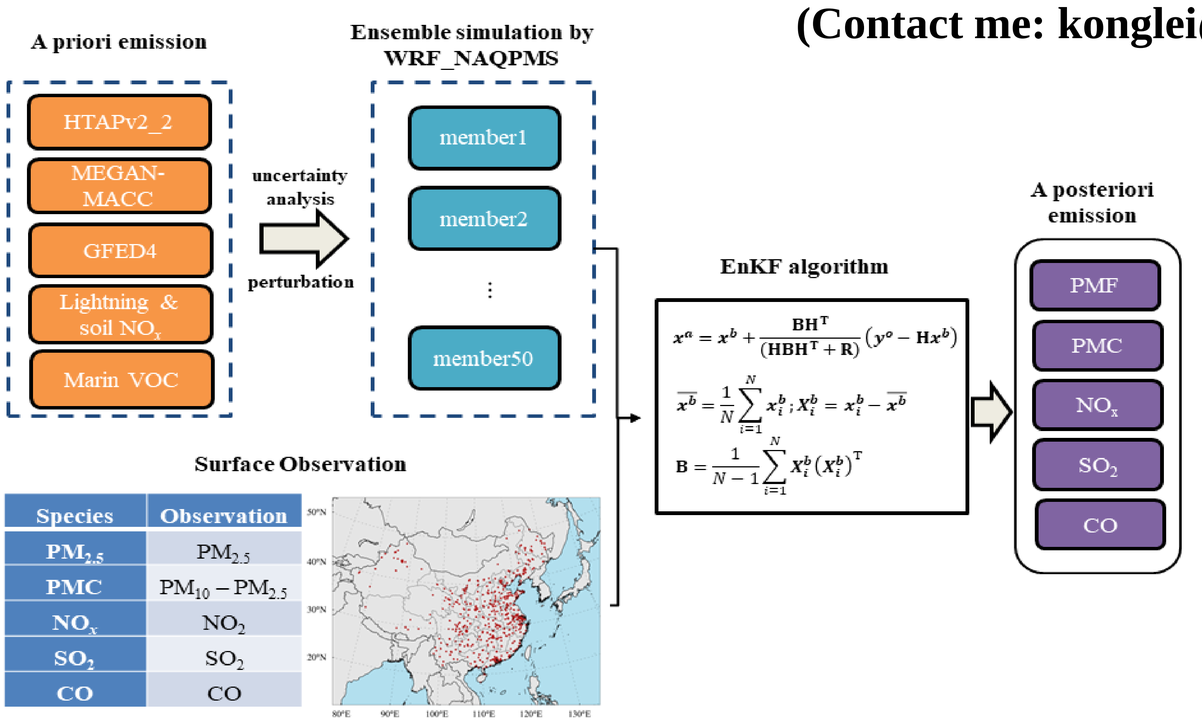

Fig.1 Basic flow of the emission inversion

- We developed a high-resolution multi-air pollutant inversion system to estimate the daily emissions of NO_x, SO_2, CO, $PM_{2.5}$ and PM_{10} in China during the COVID-19 restrictions. This system uses the WRF-NAQPMS (Nested Air Quality Prediction Modelling System) model as the forecast model and the EnKF with the state argumentation method as the inversion method. The assimilated observations include surface observations obtained from the China National Environmental. Monitoring Centre (CNEMC).

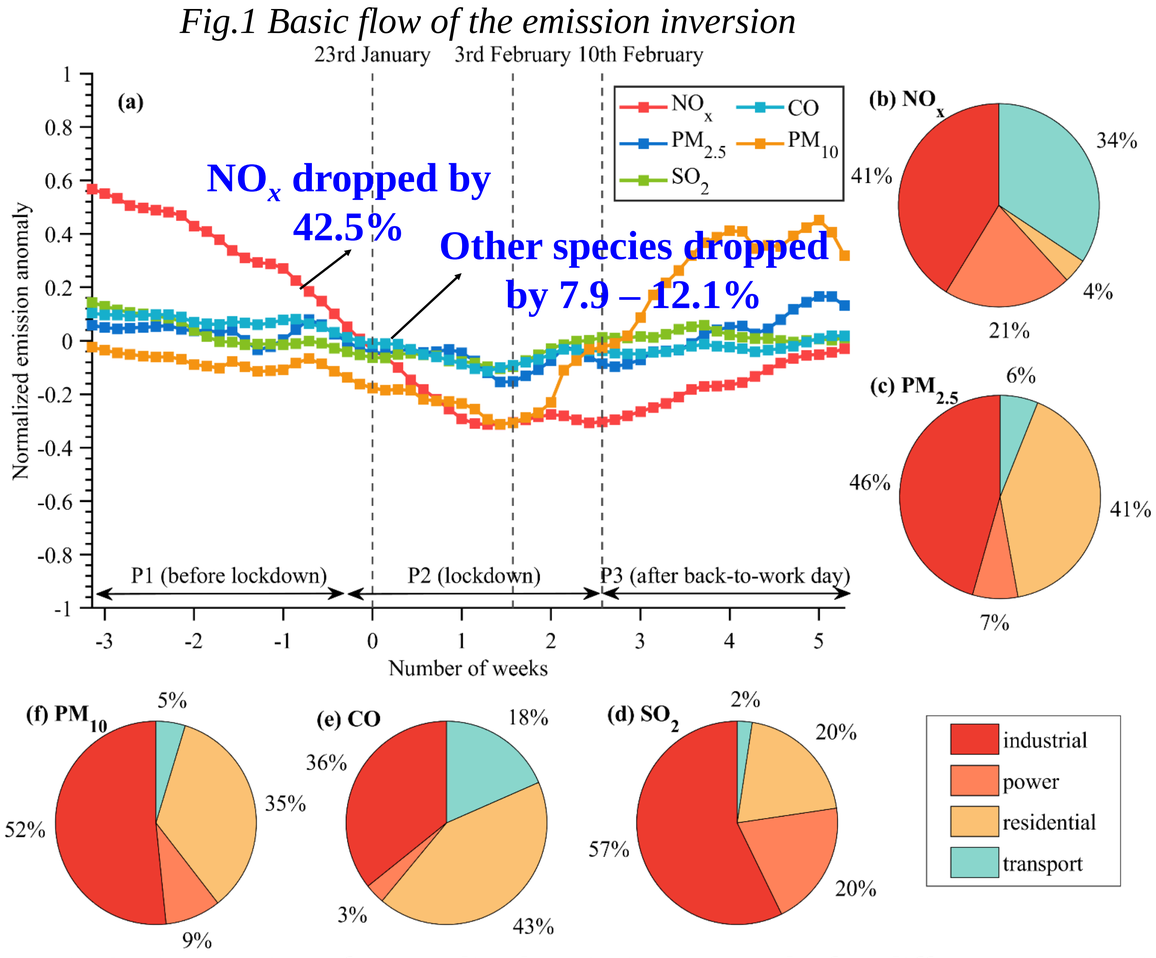

Fig.2 Time series of normalized emission anomaly for different species in China from 1st January to 29th February 2020, and Relative contributions of different sectors to the total anthropogenic emissions of different species

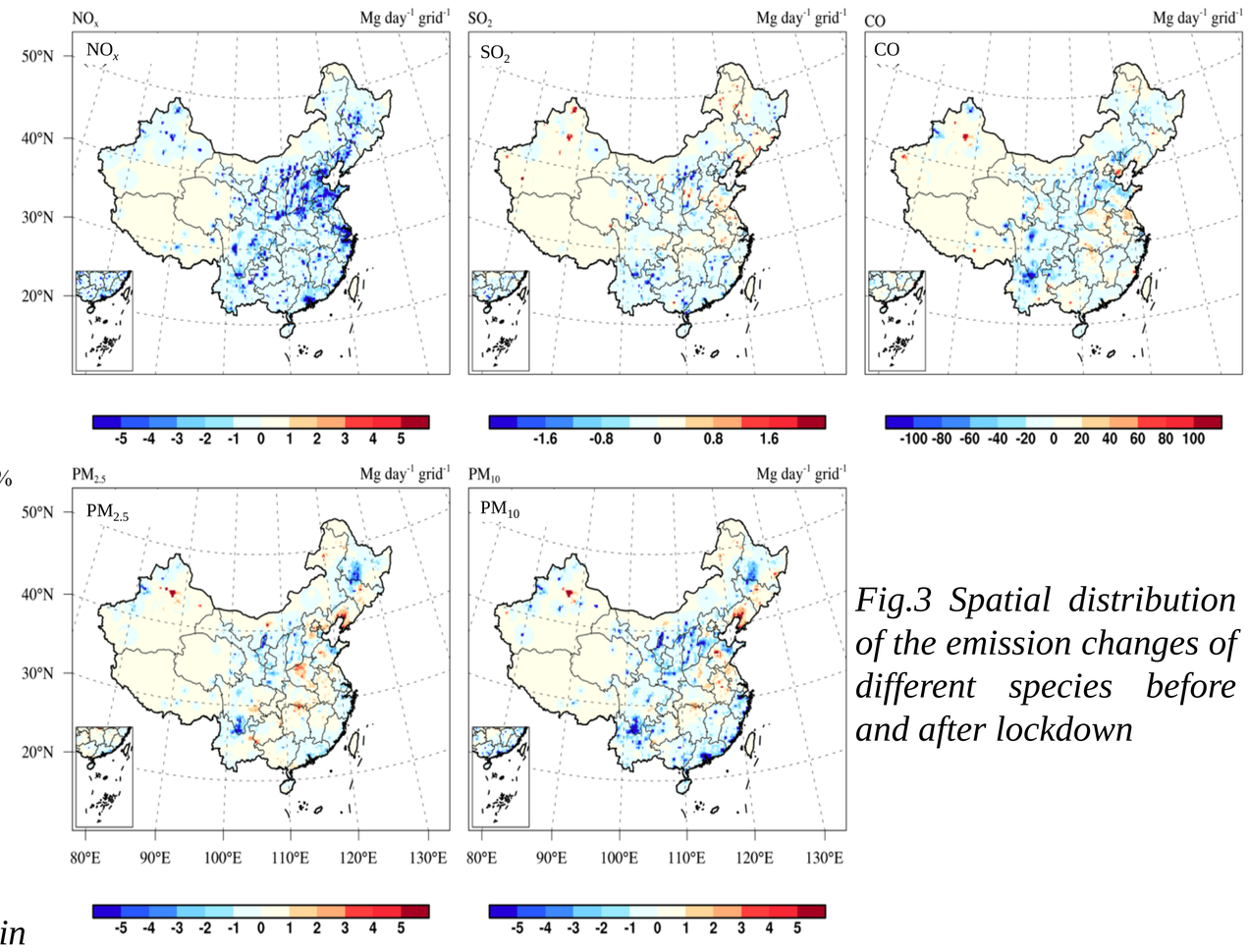

Fig.3 Spatial distribution of the emission changes of different species before and after lockdown

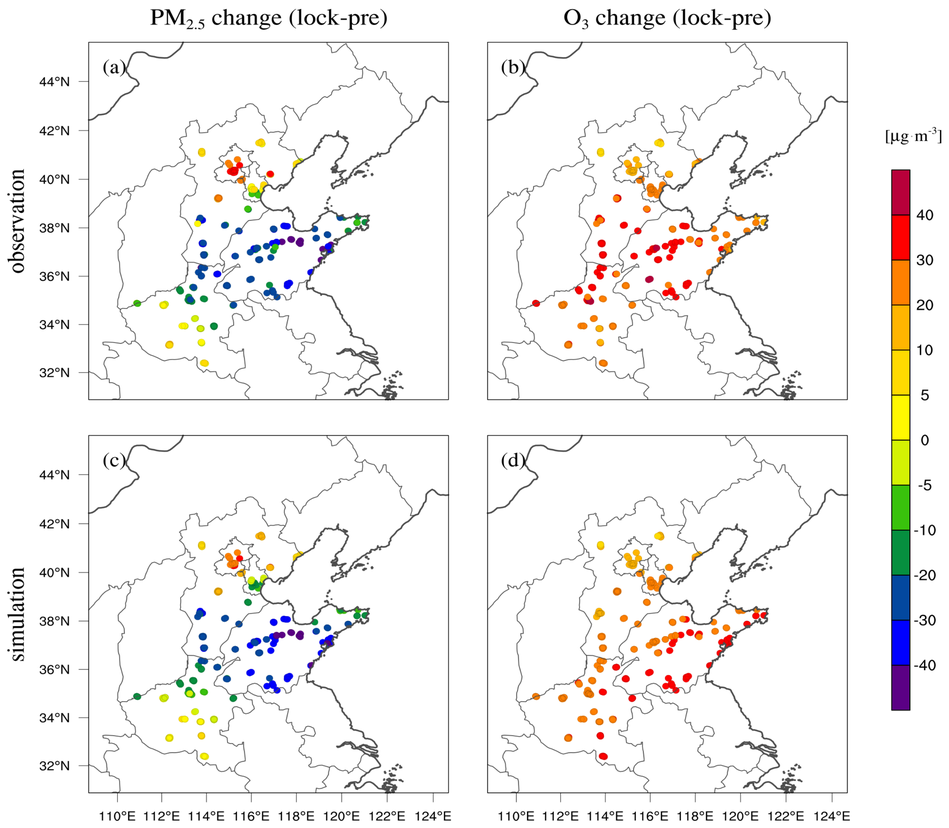

Fig. 4 Changes in the observed and simulated concentrations of $PM_{2.5}$ and O_3 over the NCP region before and after lockdown

Scenario simulation

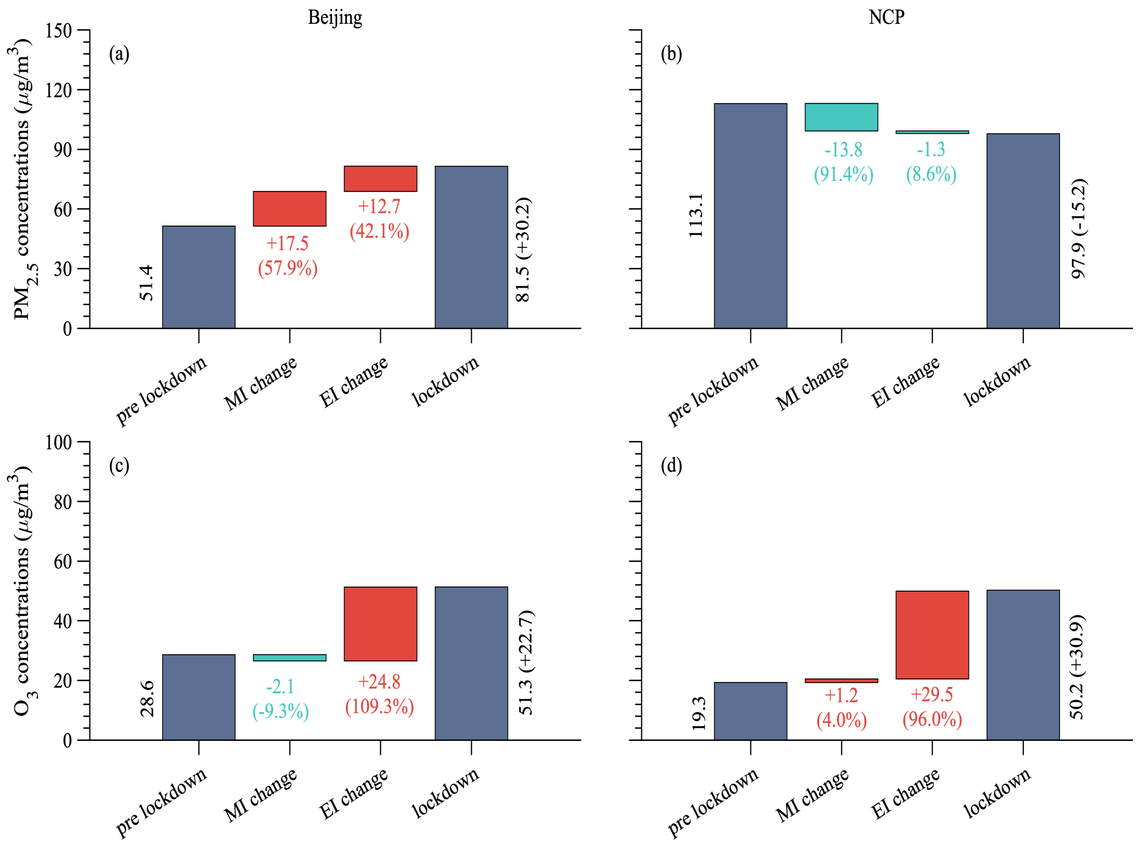

Fig.5 Contributions of the meteorological and emission changes to the $PM_{2.5}$ and O_3 over Beijing and the NCP region before and after lockdown

Conclusions:

- The lockdown in China is largely a nationwide road traffic control measurement**.**
- The NO_x emission (by ~40%) decreased more substantially than other species (by ~10%)
- The lockdown only contributed 8.6% to $PM_{2.5}$ reduction over NCP and led to significant increases in O_3
- The unexpected haze in Beijing is a combined effects of inefficient reductions in $PM_{2.5}$ emissions and unfavorable meteorological conditions.