# Assessing the efficacy of air quality policies in the Jing-Jin-Ji region using satellite observations

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## 1. INTRODUCTION

- ❑ The Beijing-Tianjin-Hebei (Jing-Jin-Ji) region experiences severely degraded air quality in autumn-winter due to anthropogenic emissions from various sources and stagnant conditions that lead to buildup of pollution.
- ❑ In autumn-winter 2017-2018, strict short-term mitigation strategies were imposed to address poor air quality.
- ❑ Here we use surface observations of air pollutants from the national air quality monitoring network to assess the efficacy of these short-term pollution controls and test the skill of satellite observations in detecting changes in air quality in the Jing-Jin-Ji region.

## 2. METHODOLOGY

- ❑ Validate national air quality surface observations of $PM_{2.5}$ with U.S. Embassy $PM_{2.5}$ in Beijing.
- ❑ Estimate the effect of short-term emission controls on air pollutant concentrations by comparing autumn-winter 2016-2017 (AW2016) and autumn-winter 2017-2018 (AW2017) concentrations of fine particles ($PM_{2.5}$), nitrogen dioxide ($NO_2$), sulfur dioxide ($SO_2$), carbon monoxide (CO), and ozone ($O_3$).
- ❑ Compare surface and satellite observation changes in concentrations of $NO_2$, $SO_2$ and CO. $NO_2$ and $SO_2$ are from the Ozone Monitoring Instrument (OMI) and CO is from the Measurements of Pollution in the Troposphere (MOPITT).

## 3. VALIDATION OF SURFACE OBSERVATIONS

Nongzhanguan and U.S. Embassy are 2 km apart.

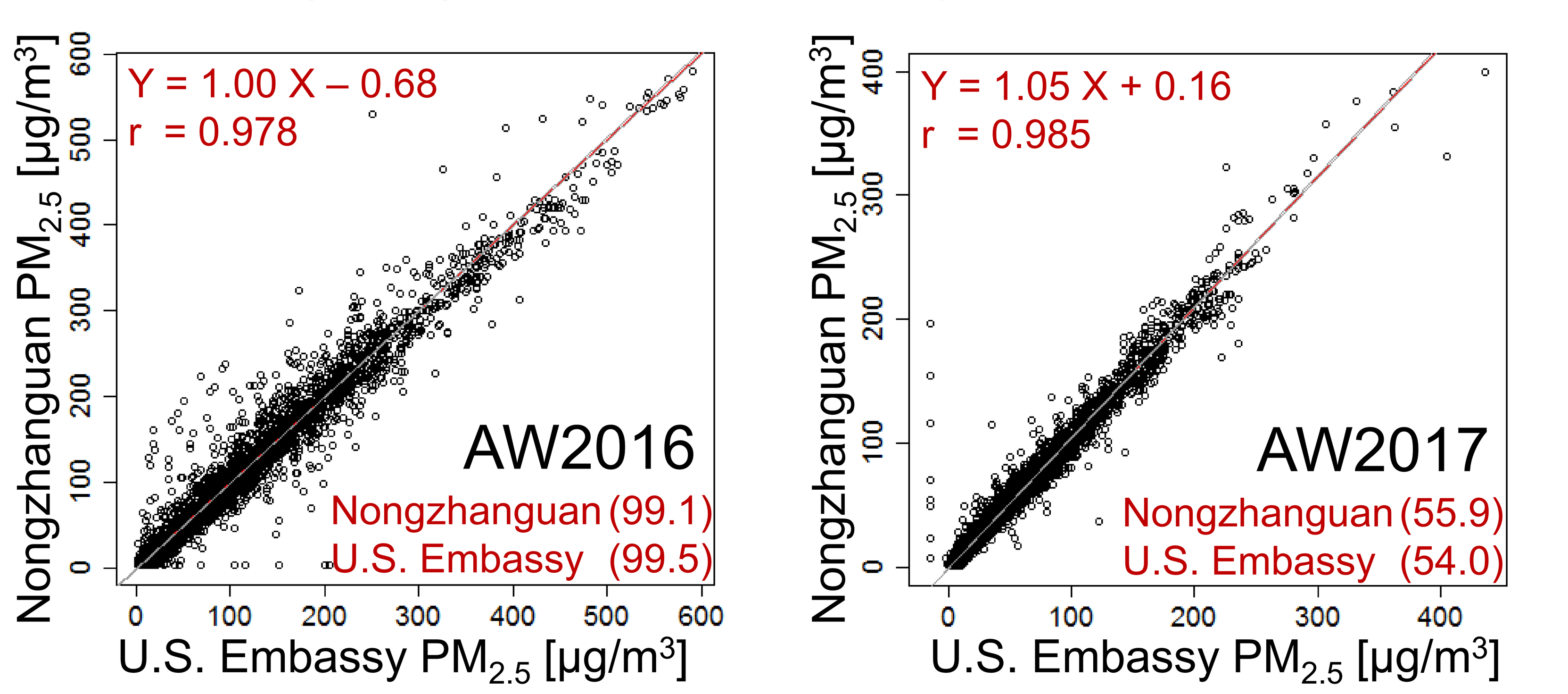


**Figure 1.** Comparisons of hourly $PM_{2.5}$ observations at Nongzhanguan (from Sinaapp) and U.S. Embassy during AW2016 and AW2017.

- Sinaapp $PM_{2.5}$ at Nongzhanguan is consistent with U.S. Embassy $PM_{2.5}$.
- $PM_{2.5}$ decreased by 44% at Nongzhanguan and 46% at U.S. Embassy.

## 4. PRELIMINARY RESULTS FROM SURFACE DATA

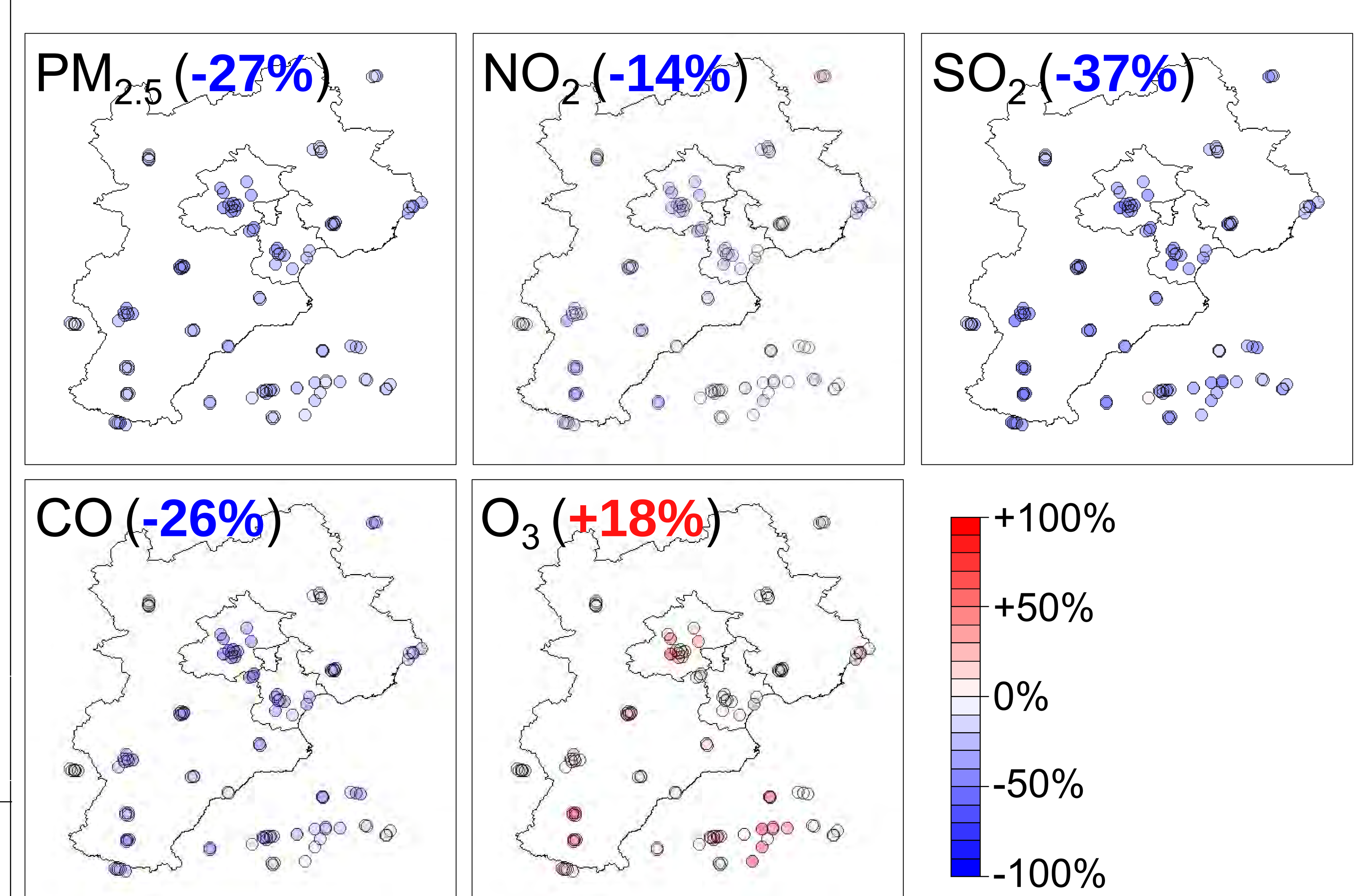


**Figure 2.** Relative changes in surface observations of $PM_{2.5}$, $NO_2$, $SO_2$, CO and $O_3$ at 72 sites within the Jing-Jin-Ji region and 49 sites in the surrounding area. Points show (AW2017 – AW2016)/AW2016. Values inset are domain means.

- Strict emission controls were successful in reducing surface concentrations of $PM_{2.5}$, $NO_2$, $SO_2$, and CO.
- Ozone increases with a decrease in $NO_x$, as there is less NO available to titrate ozone.

## 5. CHANGES IN SATELLITE $NO_2$, $SO_2$ AND CO

Satellites measure column density in the troposphere ($NO_2$), planetary boundary layer ($SO_2$), and throughout the total column.

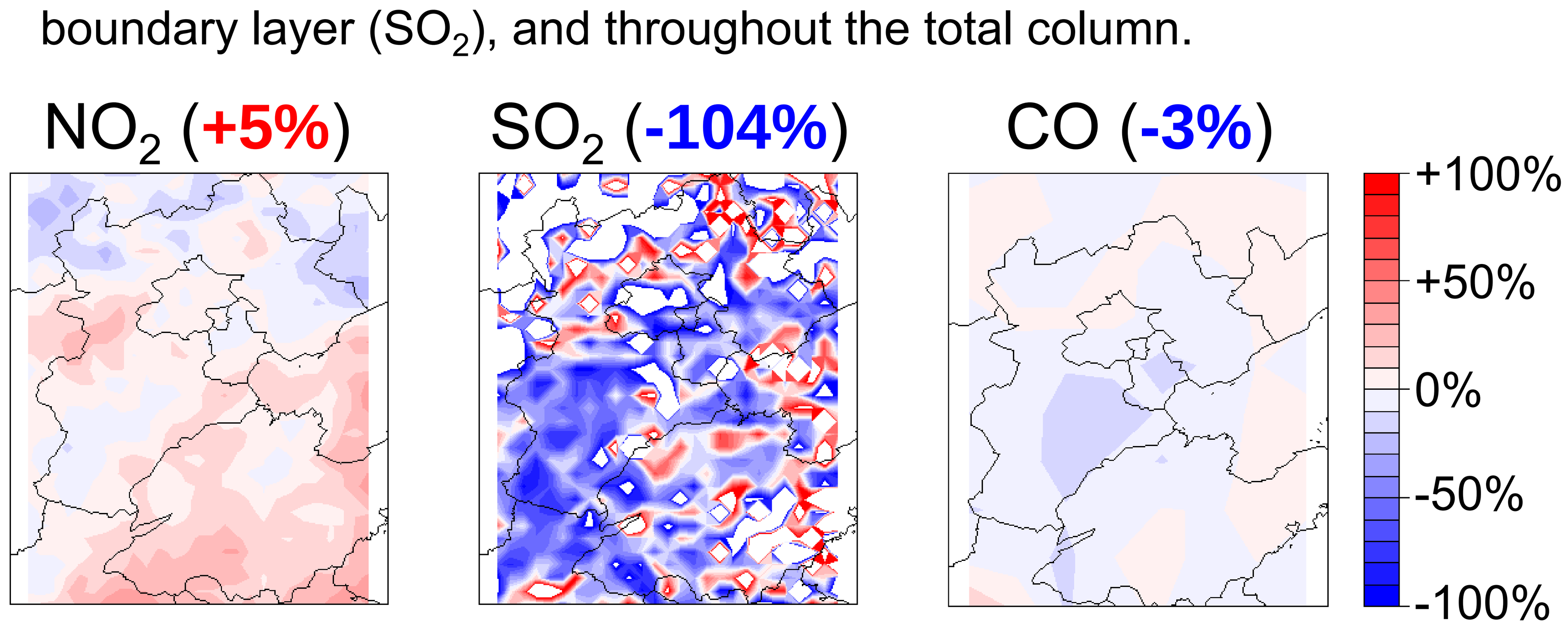


**Figure 3.** Relative changes in satellite observations of $NO_2$, $SO_2$ and CO over the Jing-Jin-Ji region and its surrounding areas. Results show (AW2017 – AW2016)/AW2016.

- $NO_2$ is stable in the Jing-Jin-Ji region and increases in the adjacent area.
- Satellite observations of $SO_2$ are too noisy to yield meaningful results.
- Slight reduction in CO is extensively observed within this domain.

**Data availability**

National Air Quality Historical Data: https://beijingair.sinaapp.com/
U.S. Embassy $PM_{2.5}$ Historical Data (Beijing): https://openaq.org/#/location/Beijing%20US%20Embassy?_k=lupud9
OMI $NO_2$ Data (OMNO2d): https://disc.gsfc.nasa.gov/datasets/OMNO2d_V003/summary
OMI $SO_2$ Data (OMSO2e): https://disc.gsfc.nasa.gov/datasets/OMSO2e_V003/summary
MOPITT CO Data (V7 TIR-NIR): https://www2.acom.ucar.edu/mopitt/products

## 6. NEXT STEPS

- ❑ Compare coincident surface and satellite observations and also analyse satellite observations of formaldehyde (HCHO) from OMI, and ammonia ($NH_3$) from the Atmospheric Infrared Sounder (AIRS).
- ❑ Conduct additional validation of national air quality surface observations with APHH campaign measurements.
- ❑ Use the GEOS-Chem chemical transport model to assess the contribution of interannual variability in meteorology to the changes in pollutant concentrations and interpret the results from the satellite observations.