Validation of the Chinese National Environmental Monitoring Network with Measurements from the APHH campaign

Gongda Lu[1], Eloïse A. Marais[2], Zongbo Shi[1], Tuan Vu[1], Dongsheng Ji[3], James Lee[4], Qiang Zhang[5], Lu Shen[6]

[1]University of Birmingham, Birmingham, UK (gxl642@bham.ac.uk); [2]University of Leicester, Leicester, UK; [3]Chinese Academy of Sciences, Beijing, China; [4]University of York, York, UK; [5]Tsinghua University, Beijing, China; [6]Harvard University, Cambridge, USA

Abstract

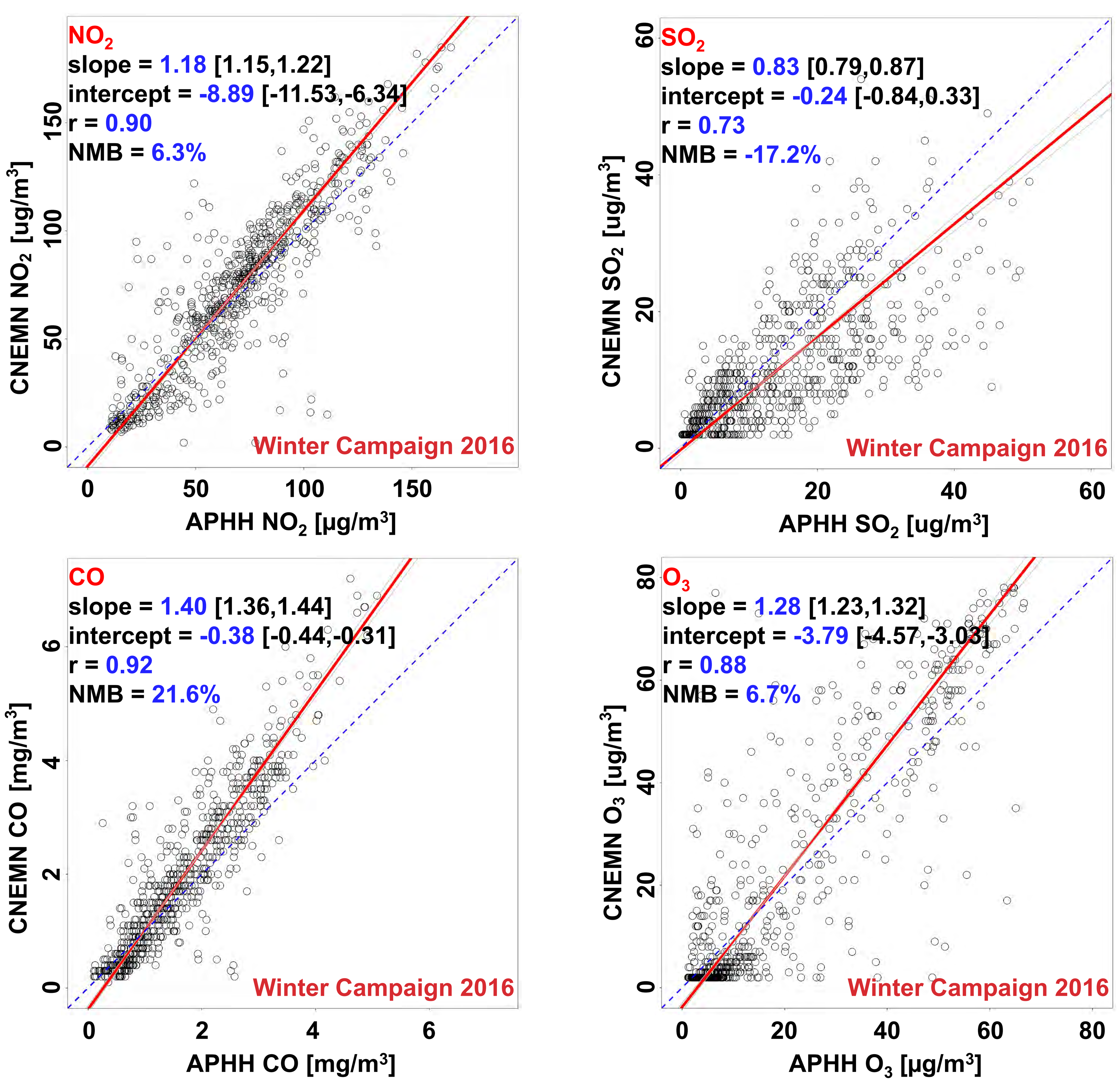
The Chinese National Environmental Monitoring Network (CNEMN) is used extensively by the atmospheric chemistry community to assess air quality policies, evaluate models and emission inventories, and interpret factors that determine variability in air pollution in China. Here we conduct an independent validation of CNEMN measurements of $PM_{2.5}$ and trace gases (CO, NO_2, O_3, and SO_2) at sites close to the U.S. Embassy in Beijing and to the intensive Atmospheric Pollution and Human Health in a Chinese Megacity (APHH) field campaign. We go on to use the CNEMN measurements to assess the Multi-resolution Emission Inventory for China (MEIC) in GEOS-Chem. We find that the CNEMN $PM_{2.5}$ measurements are consistent with the observations for $PM_{2.5}$ (r > 0.95; NMB of -0.4% and -10.2%) and trace gases (r ≥ 0.73; NMB = -17.2% - 21.6%). The MEIC is biased low for NO_x and SO_x.

Introduction

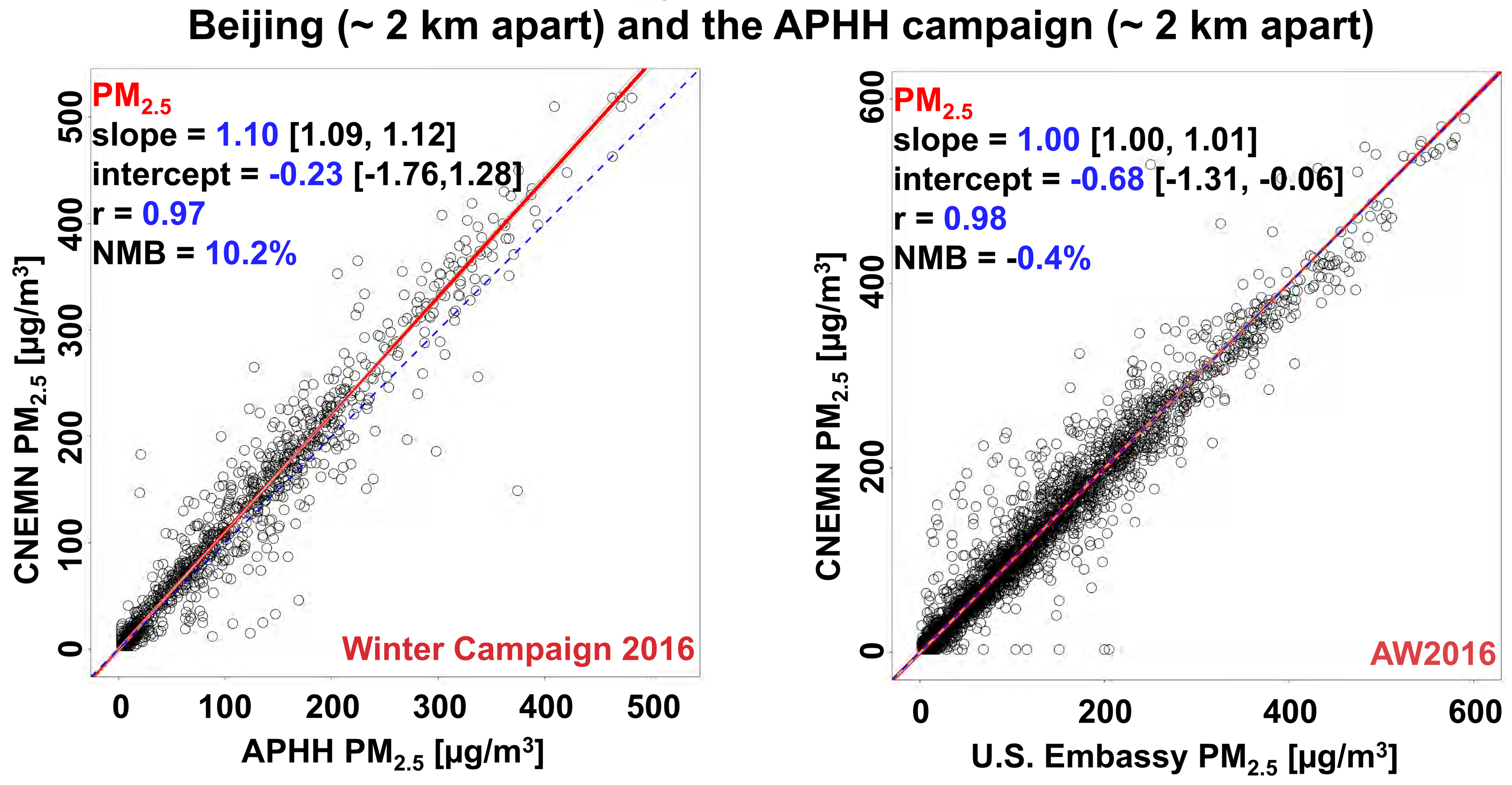
The Beijing-Tianjin-Hebei (BTH) region experiences severely degraded air quality in autumn-winter due to anthropogenic emissions from various sources. In autumn-winter 2017-2018 (AW2017), strict 10-25% $PM_{2.5}$ reduction targets were imposed in 28 cities to address poor air quality in BTH. These regional emission controls are now implemented throughout China. Here we independently assess the air quality monitoring network in China to use this data with GEOS-Chem to quantify changes in emissions in BTH due to emission controls.

Validation of China National Environmental Monitoring Network

Comparisons of CNEMN gaseous pollutants to measurements at the APHH campaign (~ 2 km apart)



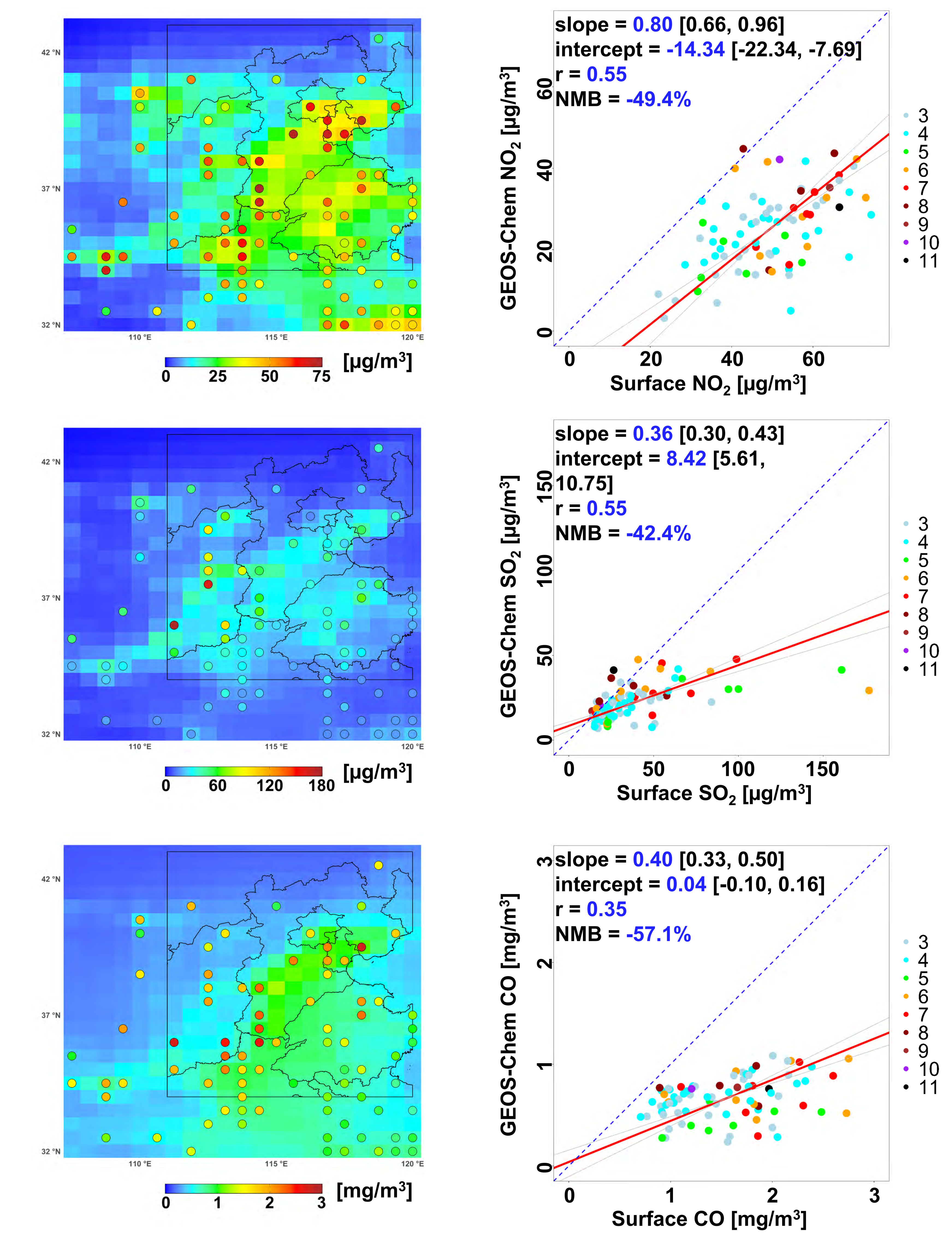
Comparisons of CNEMN $PM_{2.5}$ to measurements at the U.S. Embassy in Beijing (~ 2 km apart) and the APHH campaign (~ 2 km apart)



The CNEMN $PM_{2.5}$ is consistent with observations from the U.S. Embassy in Beijing (r = 0.98; NMB = -0.4%) and the APHH campaign (r = 0.97; NMB = -10.2%). So too are all the gas measurements (r ≥ 0.73; NMB = -17.2% - 21.6%).

Assessment of the nested GEOS-Chem Asia model against CNEMN

Points show averaged CNEMN measurements within the GEOS-Chem grids.



GEOS-Chem details: version 12.0.0 driven with MERRA-2 meteorology at 0.5° × 0.625° horizontal resolution with the MEIC inventory averaged over October 2016 to March 2017.

Scaling factors are required to reproduce conditions in 2016/2017 (assumes primary sources are the cause for the bias): Increase NO_x emissions by 25% and apply spatially varying scale factors for SO_x emissions.

Next steps : Apply scale factors for NO_x and SO_x emissions for the GEOS-Chem nested Asia model, update the wet scavenging to Luo et al. (2019) and use the model to estimate the changes in emissions during October 2017 and March 2018, due to aggressive air quality policies in the BTH region.

References:

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