*Supplementary Information of*

# Severe winter haze days in the Beijing-Tianjin-Hebei region from 1985-2017 and the roles of anthropogenic emissions and meteorological parameters

Ruijun Dang[1,2], Hong Liao[3*]

[1]State Key Laboratory of Atmospheric Boundary Layer Physics and Atmospheric Chemistry (LAPC), Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, 10029, China
[2]University of Chinese Academy of Sciences, Beijing, 10049, China
[3]Collaborative Innovation Center of Atmospheric Environment and Equipment Technology/Joint International Research Laboratory of Climate and Environment Change, School of Environmental Science and Engineering, Nanjing University of Information Science and Technology, Nanjing, 210044, China

*Correspondence to*: Hong Liao (hongliao@nuist.edu.cn)

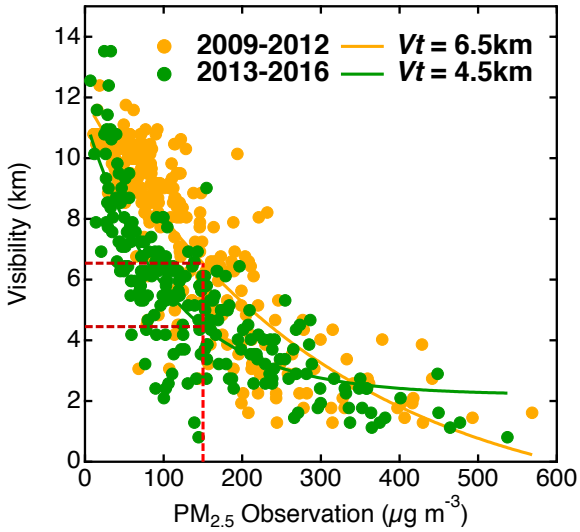


**Figure S1.** Approach for obtaining the visibility threshold (*Vt*, km) at the Beijing site for defining SWHD based on atmospheric visibility. 1) Select the period with observations of both $PM_{2.5}$ (from U.S. embassy) and atmospheric visibility (from NCDC database) available at the Beijing site: 2009-2016; 2) scatterplot the daily atmospheric visibility vs. daily mean $PM_{2.5}$ for all samples over the manual period of 2009-2012 (yellow) and the automatic period of 2013-2016 (green); 3) for each period, perform an exponential fit as $Vis = C_1 + C_2\ exp\ (C_3 * PM_{2.5\_obs})$, where $C_1$, $C_2$ and $C_3$ are all parameters, and obtain the *Vt* that corresponds to the observed $PM_{2.5}$ concentration of 150 μg $m^{-3}$. Also presented here are the *Vt* values. The *Vt* values obtained from the 2009-2012 period were used to obtain the SWHDs for the entire manually observed period of 1985-2012, and the *Vt* values obtained from the 2013-2016 period were used for the automatically observed period of 2013-2017.

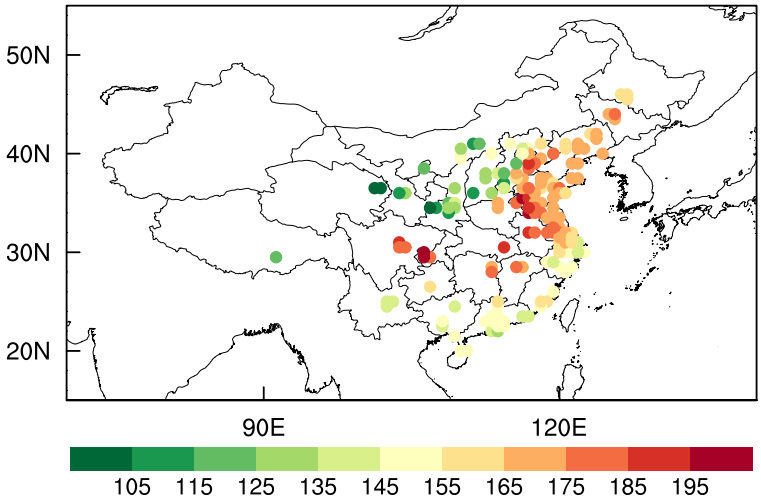


**Figure S2.** Obtained threshold concentrations (*Ct*, μg $m^{-3}$) for simulated $PM_{2.5}$ at 161 grids in China. Red/green circles indicate grids with high/low biases in simulated $PM_{2.5}$. The *Ct* values are used to obtain the SWHDs at each of the grids from 1985-2017.

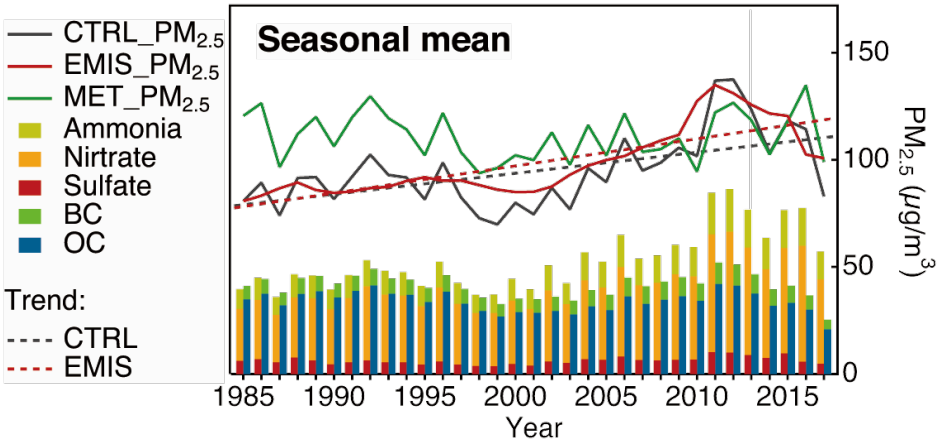


**Figure S3.** Time series of simulated seasonal mean concentrations of $PM_{2.5}$ (μg $m^{-3}$, CTRL: black line, EMIS: red line, MET: green line) and its components (μg $m^{-3}$, bars) in BTH from 1985-2017. Also shown are the linear trends (dashed lines) calculated for the results of the CTRL and EMIS simulations, which are statistically significant above the 95 % confidence level. The MET simulation results do not pass the significance test.