# Supporting Information

## Heavy particulate matter pollution during the 2014–2015 winter in Tianjin, China

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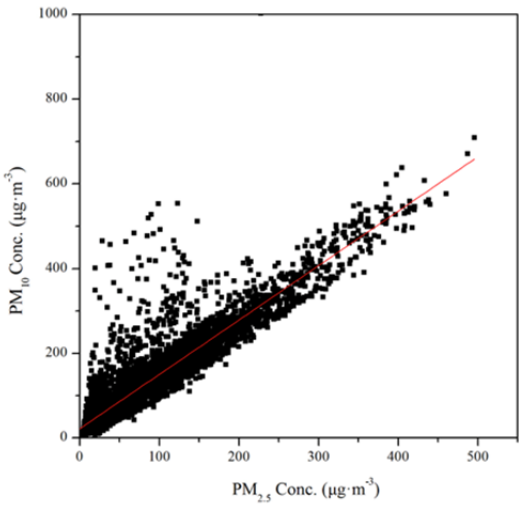


Figure S1. The relationship between $PM_{2.5}$ and $PM_{10}$ during the 2014–2015 winter in Tianjin, China.

Table S1. Summary of the correlation between $PM_{2.5}$ concentration and meteorological parameters at Tianjin during the 2014–2015 winter (December-January-February).

| | $PM_{2.5}$ | Temp | RH | WD | WS |
|---|---|---|---|---|---|
| $PM_{2.5}$ | 1 | | | | |
| Temp | 0.22 | 1 | | | |
| RH | 0.41 | -0.92 | 1 | | |
| WD | -0.12 | -0.14 | -0.24 | 1 | |
| WS | -4.0 | -0.93 | -0.31 | 0.25 | 1 |

Table S2. Summary of the correlation between $PM_{2.5}$ concentration and meteorological parameters when $PM_{2.5}$ concentrations were increasing and decreasing at Tianjin in January 2015.

| | | Temp | RH | WD | WS |
|---|---|---|---|---|---|
| EP I | $PM_{2.5}$ Increasing | 0.33 | 0.30 | 0.37 | -0.38 |
| | $PM_{2.5}$ Decreasing | 0.17 | 0.87 | -0.71 | -0.83 |
| EP II | $PM_{2.5}$ Increasing | 0.03 | 0.10 | -0.13 | -0.37 |
| | $PM_{2.5}$ Decreasing | 0.80 | -0.71 | 0.49 | -0.61 |
| EP III | $PM_{2.5}$ Increasing | 0.20 | 0.48 | 0.04 | -0.28 |
| | $PM_{2.5}$ Decreasing | -0.35 | 0.94 | -0.87 | -0.62 |
| EP IV | $PM_{2.5}$ Increasing | 0.09 | 0.44 | 0.23 | -0.28 |
| | $PM_{2.5}$ Decreasing | 0.53 | 0.92 | -0.02 | -0.40 |

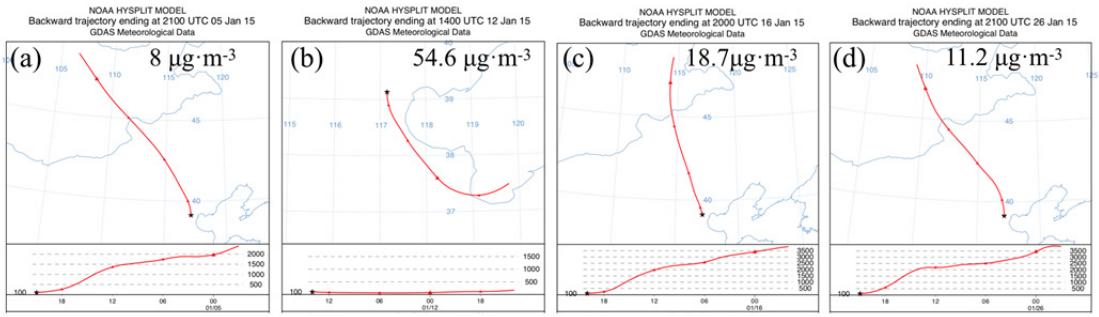


Figure S2. 24-hour back-trajectories for air masses arriving at Tianjin during the relatively clean days between episodes o*f the pollution episo*des on (a) January 6, (b) January 12, (c) January 17, and (d) January 27 in 2015. Calculations begin at 100 m above ground and continue for 24 h.

Correlations of chemical components in $PM_{2.5}$ at Tianjin were determined by regression analysis. Their correlation coefficients (r) are shown in Table S3. $SO_4^{2-}$, $NO_3^-$, and $NH_4^+$ (SNA) are secondary pollutants and arise from the oxidation of gaseous precursors ($SO_2$, $NO_x$, and $NH_3$, respectively). Correlation coefficients between SNA and $PM_{2.5}$ ranged from 0.82 to 0.96. Ammonium nitrate and ammonium sulfate could be present in fine aerosols due to the secondary formation from anthropogenic sources (Ho et al., 2006). Good correlations (r = 0.70-0.74) were also observed between $H_2O$ and the SNA components. It implies that water was absorbed by the preexisting SNA, enlarging the size of the particles and the surface area, and thus giving the particles more capacity to accommodate the secondary conversion of gaseous precursors (Cheng et al., 2015, Li et al., 2017a). A fairly good correlation was observed between WSOC and BC (r = 0.56) because WSOC is mainly associated with secondary formation and biomass burning, while BC is mostly water insoluble when directly emitted from the burning of fossil fuels(Zong et al., 2016).

Table S3. Summary of the correlation coefficients of chemical components of $PM_{2.5}$ at Tianjin in January 2015.

| | $PM_{2.5}$ | $SO_4^{2-}$ | $NO_3^-$ | $NH_4^+$ | $H_2O$ | BC | WSOC |
|---|---|---|---|---|---|---|---|
| $PM_{2.5}$ | 1 | | | | | | |
| $SO_4^{2-}$ | 0.82 | 1 | | | | | |
| $NO_3^-$ | 0.96 | 0.83 | 1 | | | | |
| $NH_4^+$ | 0.90 | 0.98 | 0.92 | 1 | | | |
| $H_2O$ | 0.76 | 0.70 | 0.73 | 0.74 | 1 | | |
| BC | 0.67 | 0.49 | 0.59 | 0.55 | 0.73 | 1 | |
| WSOC | 0.92 | 0.74 | 0.95 | 0.84 | 0.64 | 0.56 | 1 |

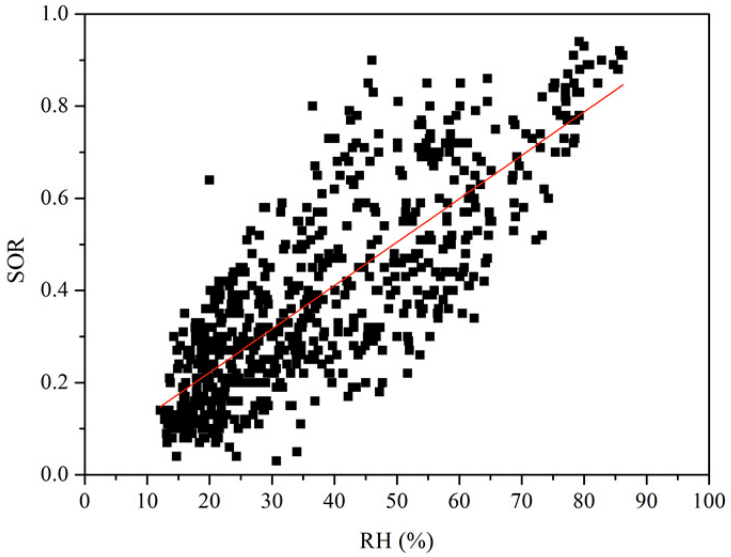


Figure S3 The relationship between sulfur oxidation ratio [SOR = n $SO_4^{2-}$ /(n $SO_4^{2-}$ + n$SO_2$), where n refers to the molar concentration] and RH in January 2015 in Tianjin, China.

**References:**

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