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Exploring wintertime regional haze in northeast China: role of coal and biomass burning

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1. ECD vs. ESD

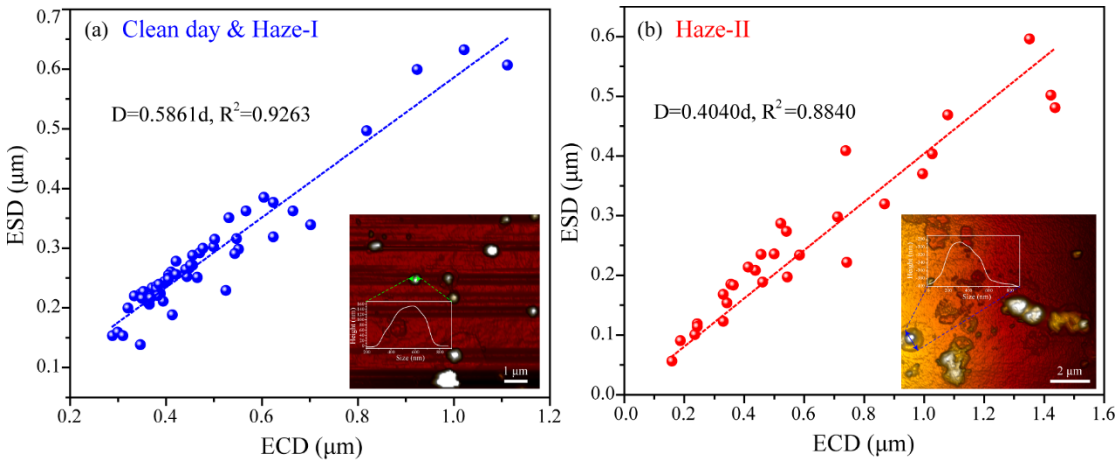

Figure S1. Linear correlations between equivalent circle diameter (ECD, d) and equivalent sphere diameter (ESD, D) and atomic force microscopy (AFM) images of individual particles during the clean day and Haze-I **(a)** and Haze-II **(b)**.

2. Concentrations of $PM_{2.5}$ and its chemical compositions

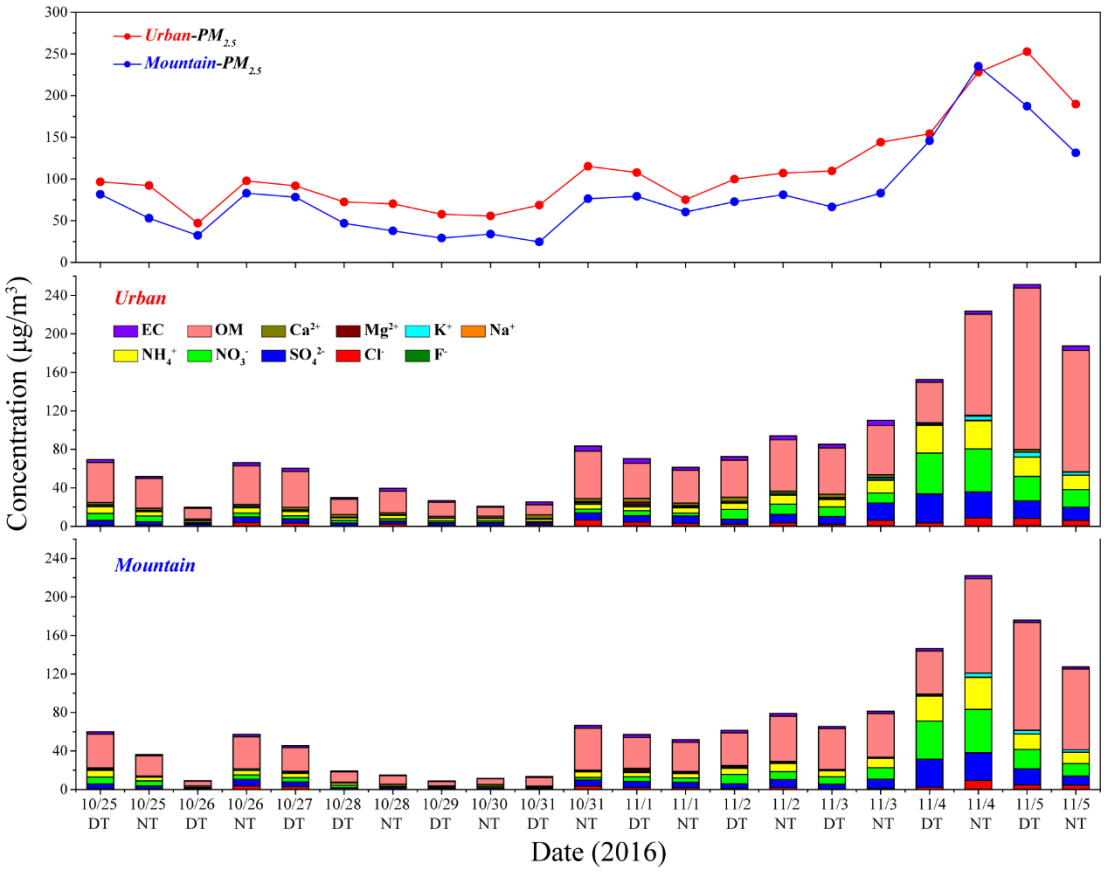

Figure S2. Time series of mass concentrations of $PM_{2.5}$ and its chemical compositions at the urban

and mountain sites during the sampling period.

3. Air quality map in Northeast China

Figure S3 shows three typical air quality maps of Northeast China on 31 October, 3 November, and 4 November, suggesting that a regional haze pollution occurred in Northeast China during 31 October-5 November.

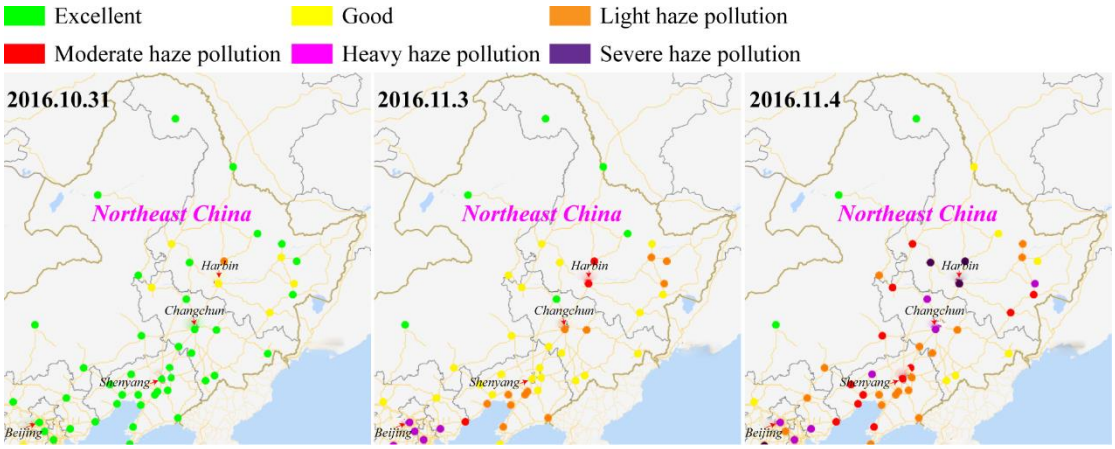

Figure S3. Daily air quality in many cities in Northeast China on 31 October, 3 November, and 4 November 2016 during the sampling period. The data are derived from China's Air Quality Online Monitoring and Analysis Platform (https://www.aqistudy.cn/), while the maps are from © Baidu and © OpenStreetMap contributors 2019 distributed under a Creative Commons BY-SA License (https://www.openstreetmap.org/).

4. Meteorological fields

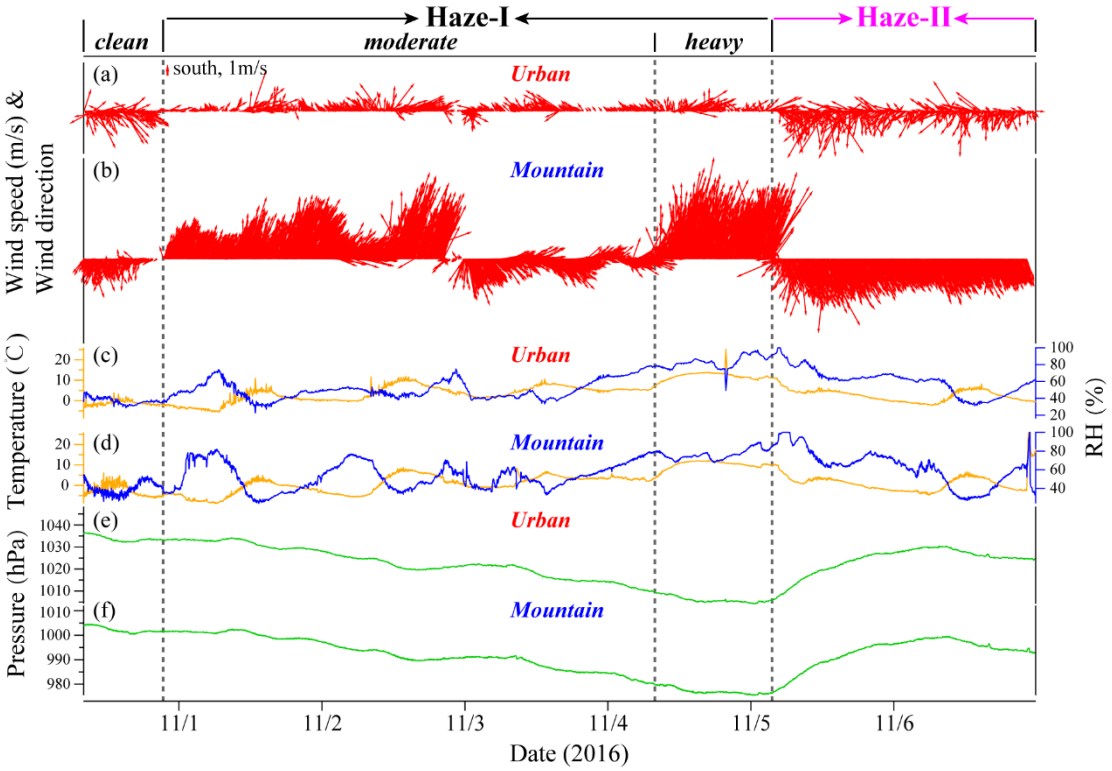

Figure S4. Time series of meteorological parameters at the urban and mountain sites from 31 October to 6 November 2016: **(a-b)** wind speed and wind direction; **(c-d)** temperature and relative humidity (RH); **(e-f)** pressure.

5. Air mass backward trajectories and CWT plots of $PM_{2.5}$

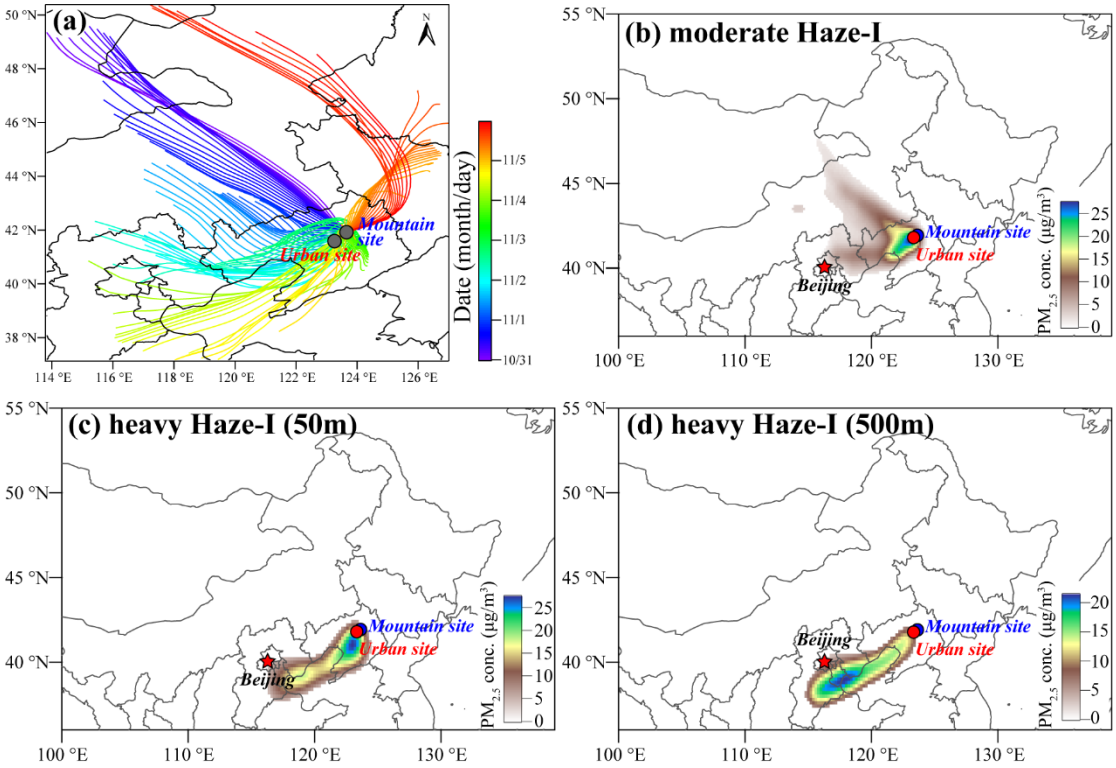

Figure S5. (a) 24-h air mass backward trajectories on 500 m height before arriving at Shenyang during 31 October-5 November. Concentration-weighted trajectory (CWT) plots of $PM_{2.5}$ at the urban and mountain sites during the Haze-I event: **(b)** moderate Haze-I on 500 m height; **(c-d)** heavy Haze-I on 50 m and 500 m heights.

6. Concentrations of trace gases

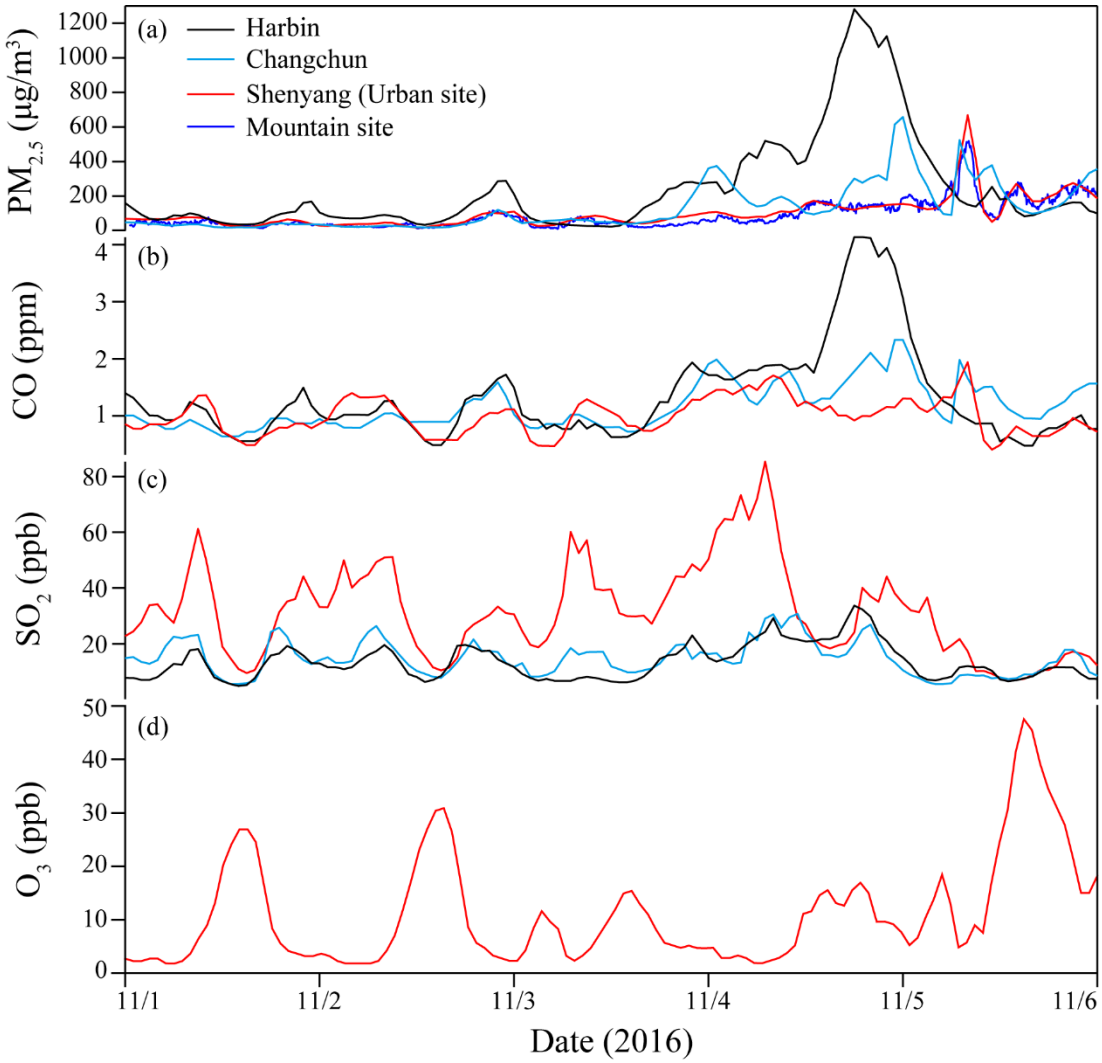

Figure S6. Time series of $PM_{2.5}$ and three trace gases (i.e., CO, SO_2, and O_3) in Harbin city, Changchun city, Shenyang city (the urban site), and the mountain site from 1 to 5 November 2016: **(a)** $PM_{2.5}$; **(b)** CO; **(c)** SO_2; **(d)** O_3. These data have been obtained from China's Air Quality Online Monitoring and Analysis Platform, except for the $PM_{2.5}$ at the mountain site.

7. Size distribution of individual particles

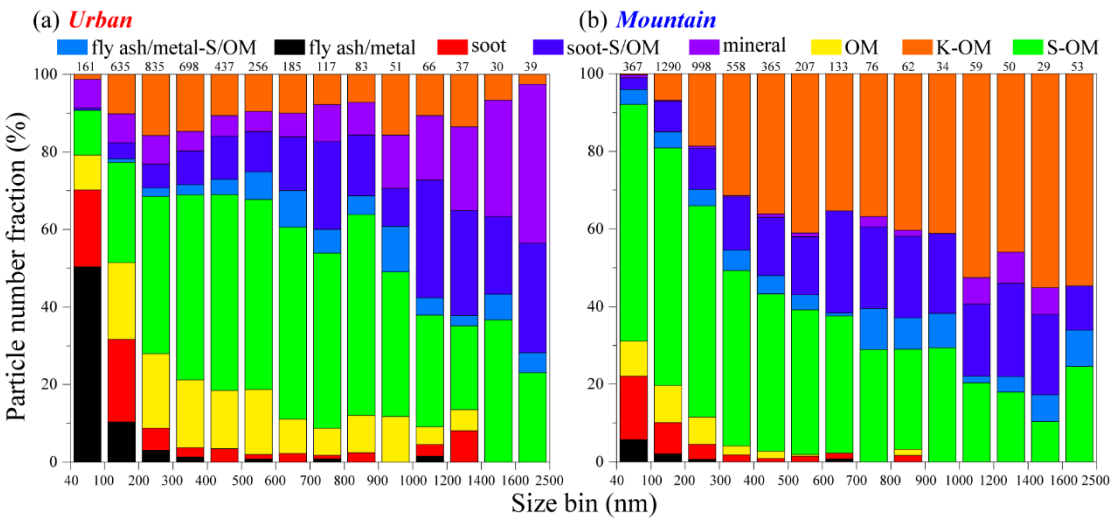

Figure S7. Size distribution of individual particles at **(a)** the urban site and **(b)** the mountain site. Analyzed particle numbers are listed on the top of each rectangle.

8. Comparison on $PM_{2.5}$ data

Table S1. Comparison on $PM_{2.5}$ mass concentrations from quartz filters and nearby monitoring station.

Date	Urban site (μg/m^3)	Nearby monitoring station (μg/m^3)	Deviation
10/31 DT	69	59	14%
10/31 NT	115	104	10%
11/1 DT	108	94	13%
11/1 NT	75	65	13%
11/2 DT	100	91	9%
11/2 NT	107	96	10%
11/3 DT	110	98	11%
11/3 NT	144	132	8%
11/4 DT	154	141	8%
11/4 NT	228	211	7%
11/5 DT	253	232	8%
11/5 NT	190	165	13%

9. OC/EC ratios

Table S2. The ratios of OC/EC in Northeast China and North China Plain (NCP) during winter haze days.

Sampling site	Period	OC/EC	References
Urban site	31/10-4/11/2016 (Haze-I)	8.0±1.5	This study
Urban site	4-5/11/2016 (Haze-II)	25.4±5.9	This study
Mountain site	31/10-4/11/2016 (Haze-I)	10.6±2.2	This study
Mountain site	4-5/11/2016 (Haze-II)	27.9±4.7	This study
Beijing city	16-19/1/2010	4.5	Zhao et al. (2013)
Jinan city	13-23/12/2014	5.5	Chen et al. (2017)
Tianjin city	10-12/1/2013	5.3	Han et al. (2014)

References

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