Supplementary Information for

The large proportion of black carbon (BC)-containing aerosols in the urban atmosphere

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1. Supplementary text

1.1 Measurements

During the field measurements, the ambient aerosols enter the $PM_{2.5}$ inlet, then the collected sample aerosols are passed through a drying tube to reduce the humidity to less than 20%. After drying, the dry aerosols enter a neutralizer to balance the charge of the particles (Wiedensohler, 1988), then enter the first DMA and select mono-disperse aerosol of a specific particle size. We set the mobility diameter (D_p) from 40 to 300 nm (40, 60, 80, 110, 150, 200, 250, and 300 nm). The selected mono-disperse aerosols go via two path. The first is to directly enter the condensation particle counter (CPC) to obtain the particle number size distribution of the dry aerosols. The second is to enter a heating tube to remove the volatile substances. The heated aerosols pass through the second DMA and CPC so that the number size distribution could be measured (Fig. S1). Here we set 4 heating temperature gradients, including 80 ℃, 150 ℃, 200 ℃, and 300 ℃. This study focuses on data obtained only at 300 ℃, because the residual material after volatilization at this temperature is considered to be mainly BC (Burtscher et al., 2001; Cheng et al., 2009; Frey et al., 2008; Kondo et al., 2006; Philippin et al., 2004; Smith and O'Dowd, 1996; Wehner et al., 2009). More details about the VTDMA system used in our study were described by Wang et al. (2017).

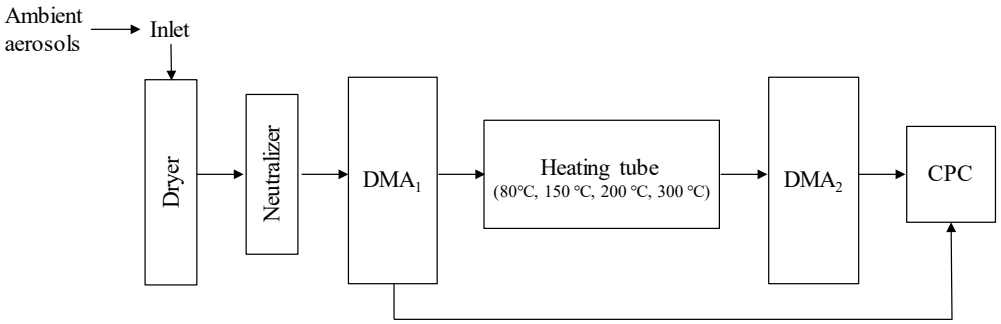

Figure S1. A schematic diagram of the volatility tandem differential mobility analyzer (VTDMA).

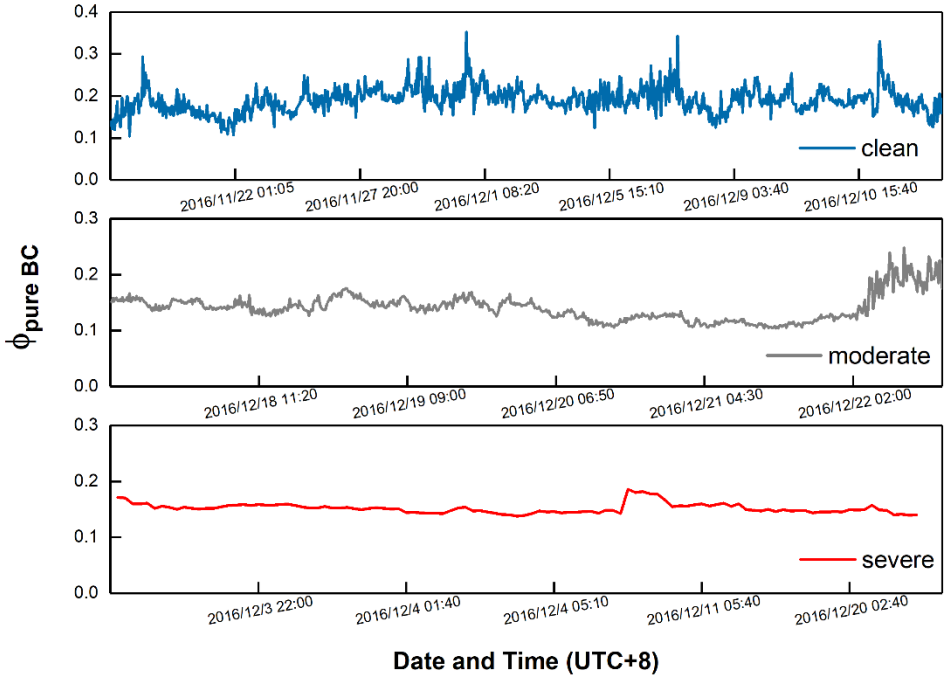

Figure S2. The time series of $\phi_{\text{pure BC}}$ during clean (blue), moderate (grey) and severe (red) periods measured by SP-AMS.

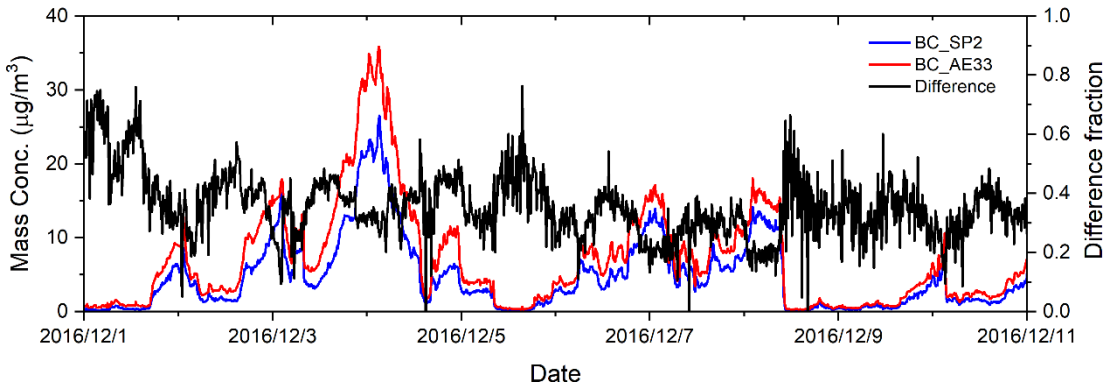

Figure S3. Time series of mass concentration of BC measured by SP2 (in blue) and AE33 (in red), and the difference between the two instruments (in black).

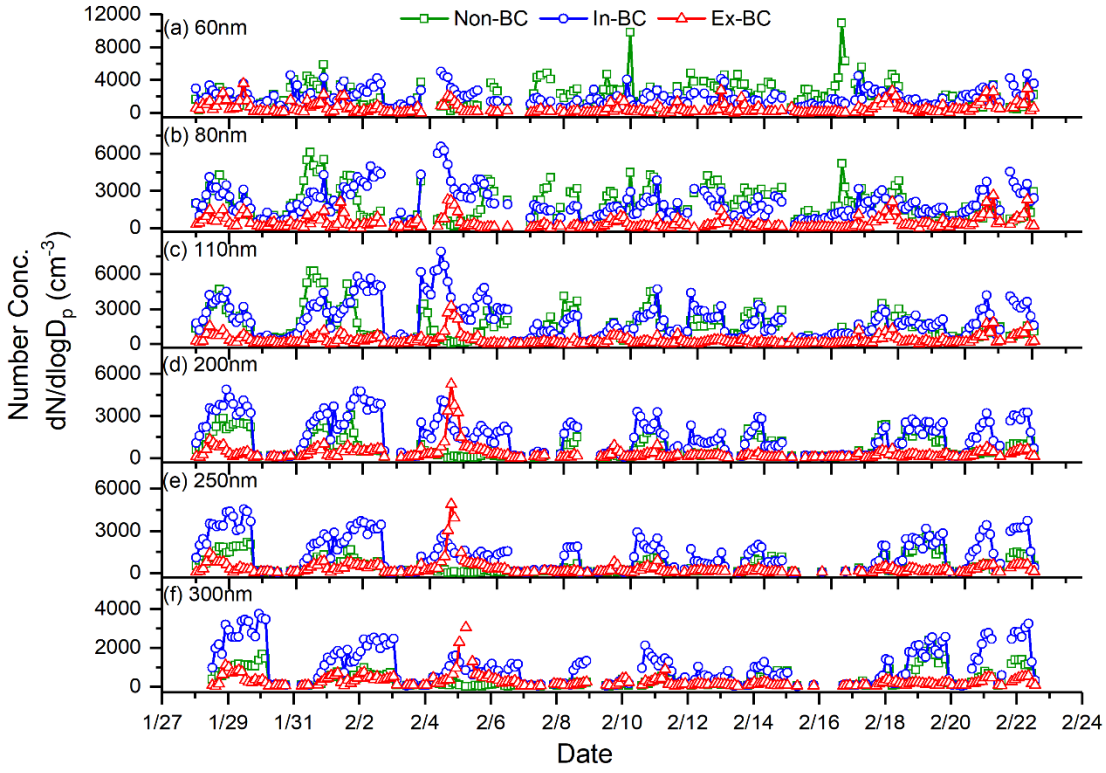

Figure S4. Temporal variation of number concentration of Non-BC (in green), In-BC (in blue), and Ex-BC (in red) in the range of 60-300 nm particles.

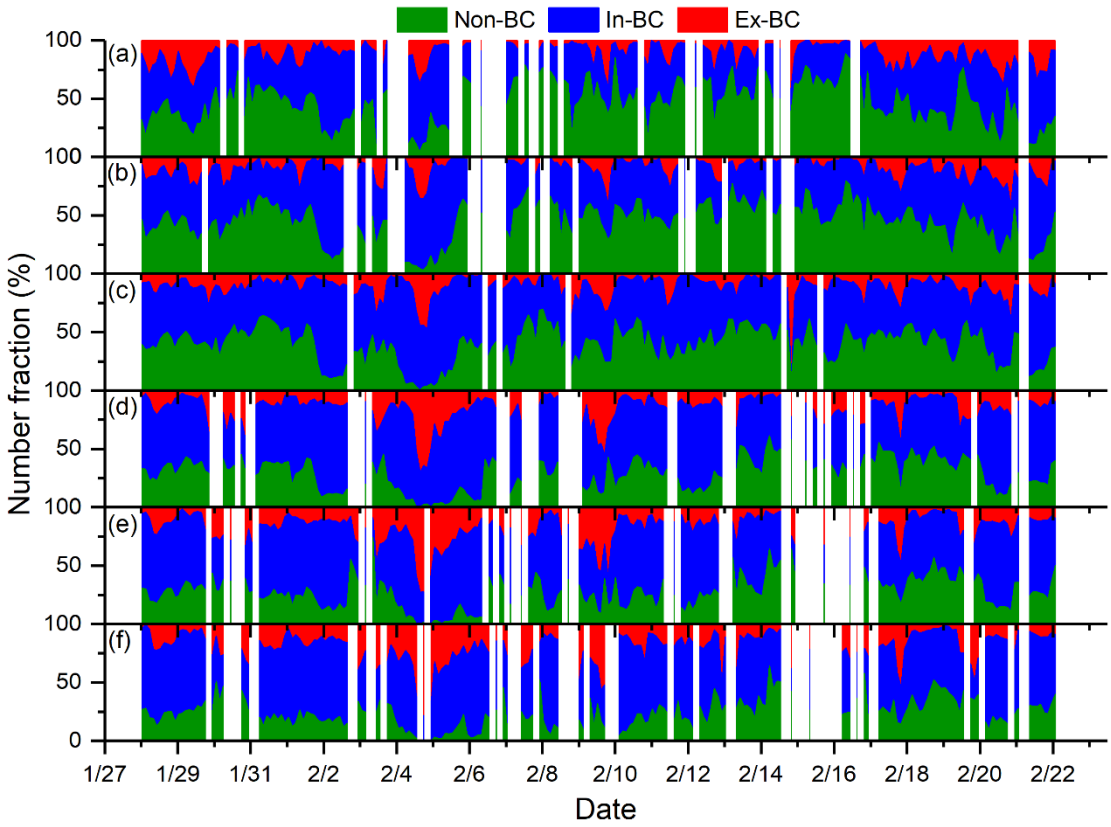

Figure S5. Temporal variation of number fraction of Non-BC (in green), In-BC (in blue), and Ex-BC (in red) in the range of 60-300 nm particles.

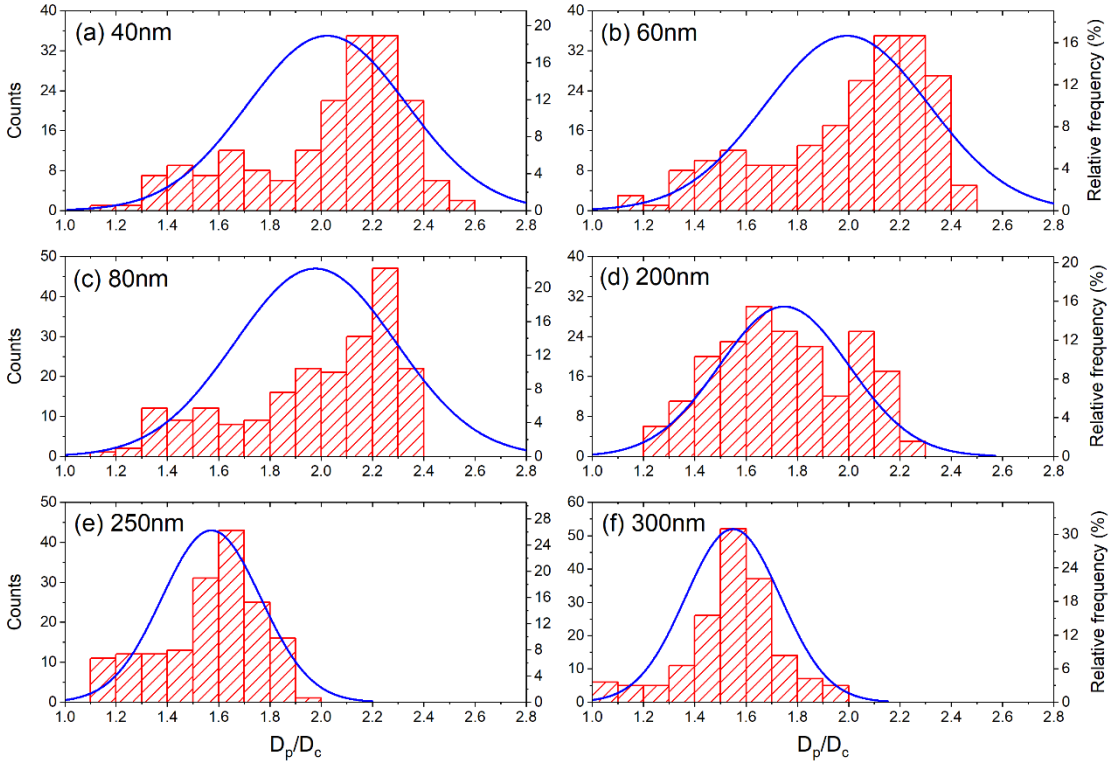

Figure S6. The counts (red) and frequency (blue) distribution of the ratios of D_p/D_c of BC-containing particles with D_p of 40-300 nm.

Table S1. A summary of E_{abs} at different sites derived from previous studies.

Site	Type	Method	λ (nm)	D_p/D_c	E_{abs}	Reference
Beijing	Urban	MAE ratio	550	~2.2	~2.1	This study
Beijing	Urban	MAE ratio	365	2.25	3.2-5.3	Cheng et al. (2017)
Beijing	Urban	MAE ratio	880	1.5-2.3	1.5-2.0	Zhang et al. (2018)
Beijing	Urban	TD	630	1.27-1.35	1.59±0.26	Xie et al. (2019)
Guangzhou	Suburban	MAE ratio	550	1.5	1.5±0.48	Wu et al. (2018)
Xianghe	Suburban	MAE ratio	550	2.1-2.7	1.6-1.9	Zhang et al. (2016)
Shouxian	Rural	TD	532	2.4-2.8	2.3±0.9	Xu et al. (2018)
Toronto	Suburban	TD	550	2.1-2.6	1.6-1.9	A. Knox et al. (2009)
California	Urban	TD	532	2	1.06	Cappa et al. (2012)
Boulder	Forest fire	TD	532	1.45	1.4	Lack et al. (2012)
Costa Rica	troposphere	TD	550	~1.15	1.31±0.1	Schwarz et al. (2008)

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