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Atmospheric Chemistry and Physics Discussions

Supplement of

Size-resolved source apportionment of particulate matter in urban Beijing during haze and non-haze episodes

S. L. Tian et al.

Correspondence to: Y. S. Wang (wys@mail.iap.ac.cn) and Y. P. Pan (panyuepeng@mail.iap.ac.cn)

Table S1 Calculation methods of main components used in mass closure study

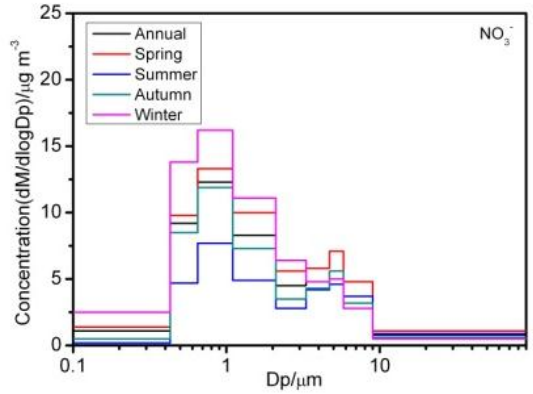
	Calculation Methods
CM	$CM=SiO_2+Al_2O_3+CaO+Fe_2O_3+K_2O+Na_2O+MgO=1.89[Al]+1.66[Mg]_n+1.21[K]+1.40[Ca]_n+1.43[Fe]_n+1.35[Na - ss\text{-}Na^+]+2.14[Si]$
OM	$OM=1.4\times OC$
HM	$HM=Cu+Pb+Zn+Cd+As+Cr+V+Mn$
SS	$SS=[Na^+]+[SS\text{-}Cl^-]+[SS\text{-}Mg^{2+}]+[SS\text{-}Ca^{2+}]+[SS\text{-}K^+]+[SS\text{-}SO_4^{2-}]=3.246[Na^+]$
SNA	$SNA=[NSS\text{-}SO_4^{2-}]+[NO_3^-]+[NH_4^+]$
UM	$UM=PM-CM-OM-HM-SS-SIA-EC-LW$

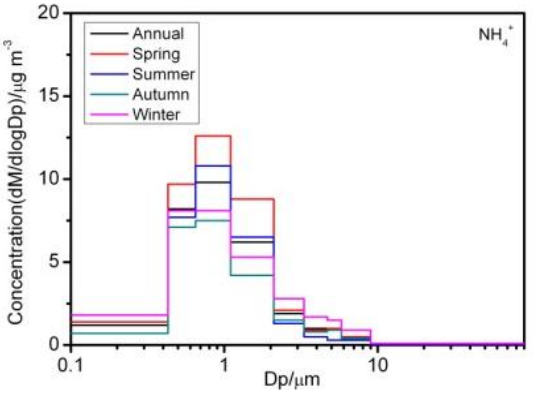
The calculation method for secondary inorganic aerosol and sea salt can be found in (Terzi et al., 2010). Moreover, $[NSS\text{-}SO_4^{2-}]$ refers to water-soluble SO_4^{2-} apart from sea salt; $[SS\text{-}Na^+]$ refers to water-soluble Na^+ in sea salt. The calculation method for crustal materials can be found in (Hueglin et al., 2005); $[Si_n]$, $[Fe_n]$, $[Ca_n]$ and $[Mg_n]$ were calculated based on the ratio to Al in the crustal materials. Liquid water (LW) was calculated using an aerosol thermodynamic model of E-AIM II (Extended Aerosol Inorganic Model, http://www.aim.env.uea.ac.uk/aim/aim.php) (Clegg et al., 1998)

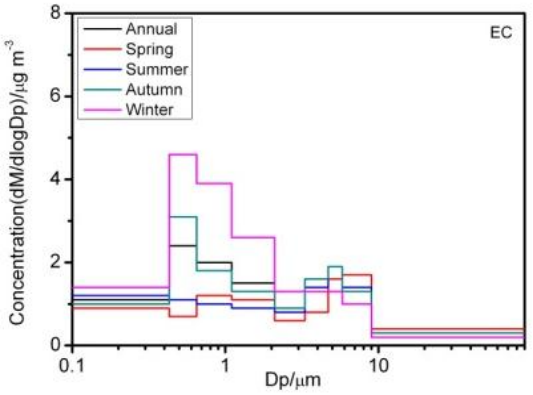
Table S2 Concentrations of different chemical compositions in size-resolved particles during entire sampling period (annual) and four seasons ($\mu g\ m^{-3}$).

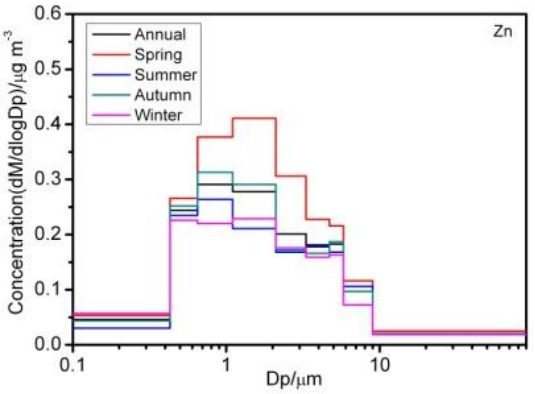
	Annual		Spring		Summer		Autumn		Winter	
Size	$PM_{2.1}$	$PM_{2.1\text{-}9}$	$PM_{2.1}$	$PM_{2.1\text{-}9}$	$PM_{2.1}$	$PM_{2.1\text{-}9}$	$PM_{2.1}$	$PM_{2.1\text{-}9}$	$PM_{2.1}$	$PM_{2.1\text{-}9}$
Mass	67.27	62.33	64.65	68.05	65.05	57.97	62.52	62.87	76.84	60.41
OC	16.50	9.63	16.26	10.44	20.19	16.68	13.40	6.76	16.16	4.64
EC	2.01	0.77	1.28	0.71	1.47	0.81	1.99	0.82	3.32	0.75
Na^+	0.79	0.66	0.48	0.57	0.27	0.31	1.67	0.92	0.74	0.82
NH_4^+	6.17	0.70	8.00	0.74	6.11	0.41	4.65	0.56	5.92	1.08
K^+	0.72	0.29	0.83	0.49	0.33	0.12	0.60	0.09	1.12	0.46
Mg^{2+}	0.21	0.40	0.30	0.41	0.14	0.36	0.20	0.42	0.20	0.40
Ca^{2+}	1.01	3.38	1.25	3.98	0.67	2.69	1.00	3.77	1.10	3.08

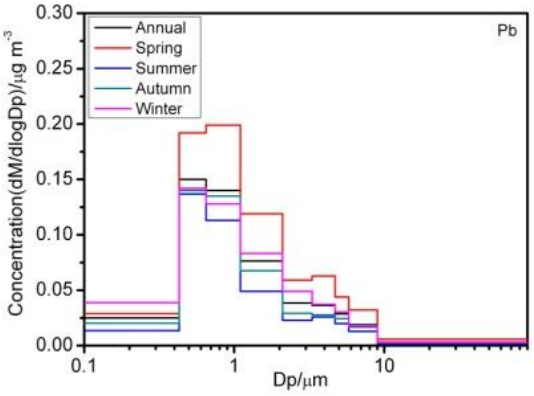
Cl^-	1.58	0.81	1.98	1.19	0.17	0.31	1.23	0.46	2.95	1.28
NO_3^-	7.51	2.78	8.51	3.56	4.08	2.33	6.60	2.46	10.84	2.76
SO_4^{2-}	9.87	2.17	11.02	2.80	10.02	1.47	9.28	2.08	9.16	2.35
Na	1.78	1.34	1.77	1.33	1.81	1.12	1.81	1.29	1.73	1.64
Mg	0.45	1.19	0.51	1.63	0.49	1.08	0.46	1.14	0.35	0.91
Al	0.65	1.39	0.73	2.06	0.60	0.90	0.69	1.32	0.59	1.29
K	0.69	0.62	0.88	0.98	0.49	0.49	0.74	0.59	0.65	0.42
Ca	3.54	10.17	4.03	16.31	4.63	10.20	3.21	8.63	2.30	5.55
V	0.10	0.05	0.07	0.02	0.06	0.02	0.14	0.08	0.15	0.08
Cr	0.36	0.18	0.25	0.07	0.21	0.07	0.48	0.30	0.50	0.29
Mn	0.04	0.04	0.05	0.06	0.03	0.03	0.04	0.04	0.03	0.04
Fe	1.23	2.58	1.55	3.66	1.43	2.08	1.36	2.62	0.58	1.98
Co	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Ni	0.013	0.014	0.011	0.012	0.014	0.010	0.014	0.018	0.014	0.015
Cu	0.026	0.020	0.030	0.020	0.015	0.015	0.029	0.022	0.029	0.023
Zn	0.21	0.10	0.24	0.12	0.18	0.09	0.23	0.09	0.19	0.09
As	0.010	0.006	0.008	0.002	0.008	0.005	0.010	0.007	0.014	0.013
Mo	0.006	0.006	0.002	0.001	0.002	0.002	0.002	0.001	0.002	0.002
Cd	0.001	0.000	0.001	0.000	0.001	0.000	0.001	0.000	0.001	0.000
Ba	0.017	0.043	0.018	0.057	0.014	0.032	0.018	0.044	0.017	0.039
Tl	0.001	0.000	0.001	0.000	0.001	0.000	0.001	0.000	0.001	0.000
Pb	0.089	0.018	0.094	0.022	0.071	0.013	0.088	0.015	0.103	0.022
Th	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.001
U	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

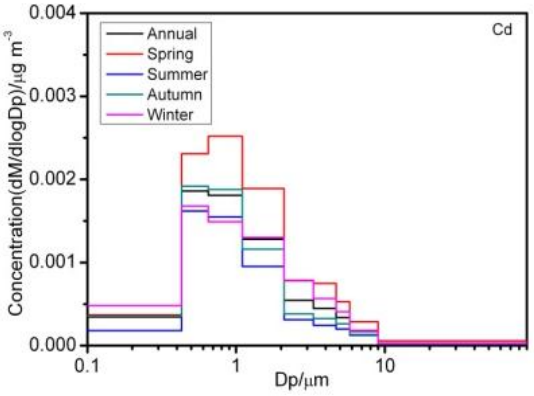

Annual
Spring
Summer
Autumn
Winter
NO_3^-
Concentration(dM/dlogDp)/μg m^{-3}
Dp/μm

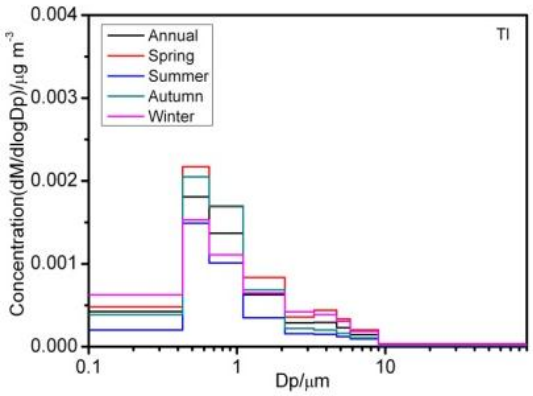

Annual
Spring
Summer
Autumn
Winter
NH_4^+
Concentration(dM/dlogDp)/μg m^{-3}
Dp/μm

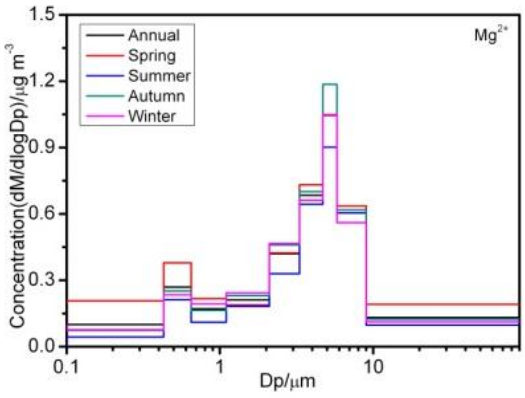

Annual
Spring
Summer
Autumn
Winter
EC
Concentration(dM/dlogDp)/μg m^{-3}
Dp/μm

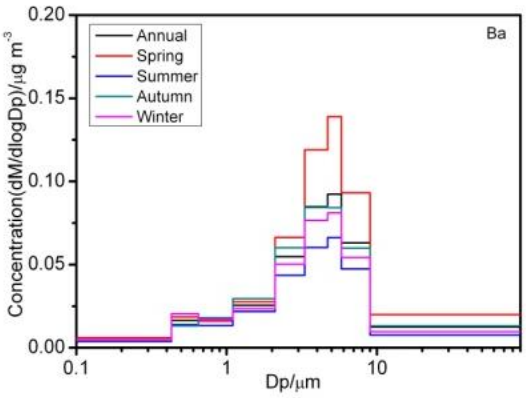

Annual
Spring
Summer
Autumn
Winter
Zn
Concentration(dM/dlogDp)/μg m^{-3}
Dp/μm

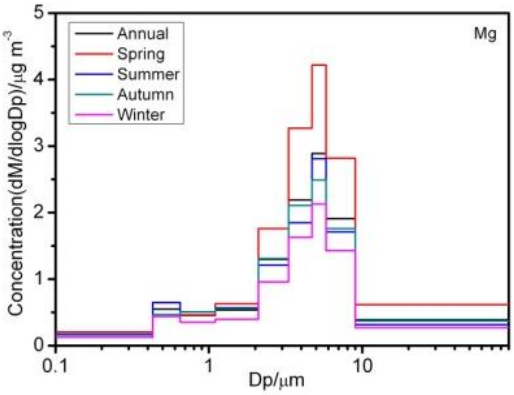

Annual
Spring
Summer
Autumn
Winter
Pb
Concentration(dM/dlogDp)/μg m^{-3}
Dp/μm

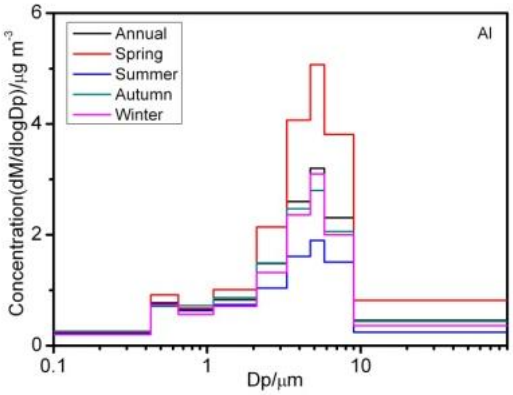

Annual
Spring
Summer
Autumn
Winter
Cd
Concentration(dM/dlogDp)/μg m^{-3}
Dp/μm

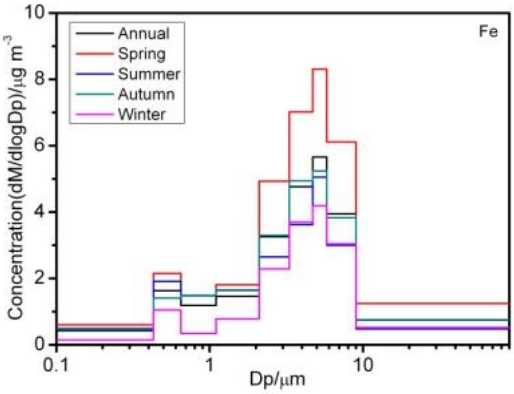

Annual
Spring
Summer
Autumn
Winter
Tl
Concentration(dM/dlogDp)/μg m^{-3}
Dp/μm

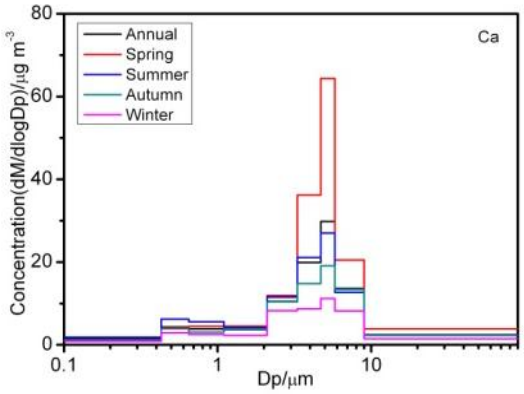

Annual
Spring
Summer
Autumn
Winter
Mg^{2+}
Concentration(dM/dlogDp)/μg m^{-3}
Dp/μm

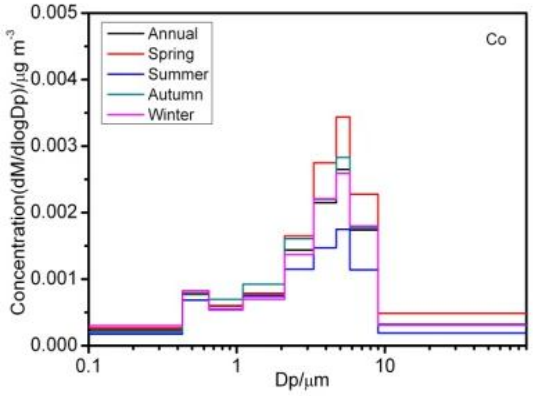

Annual
Spring
Summer
Autumn
Winter
Ba
Concentration(dM/dlogDp)/μg m^{-3}
Dp/μm

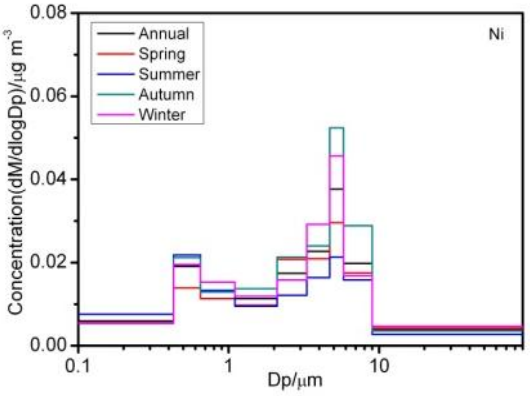

Annual
Spring
Summer
Autumn
Winter
Mg
Concentration(dM/dlogDp)/μg m^{-3}
Dp/μm

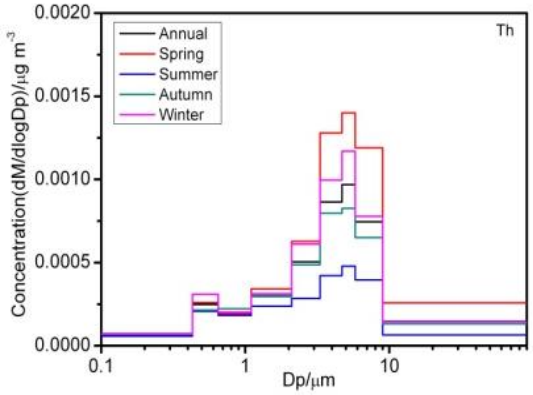

Annual
Spring
Summer
Autumn
Winter
Al
Concentration(dM/dlogDp)/μg m^{-3}
Dp/μm

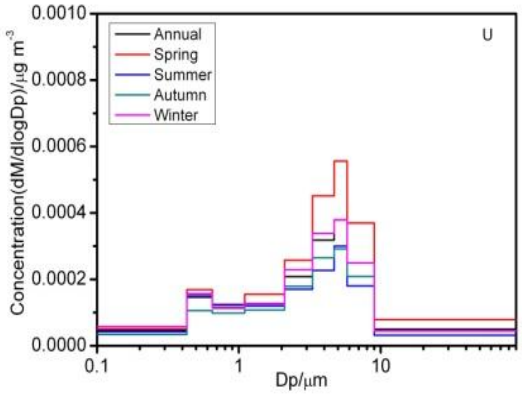

Annual
Spring
Summer
Autumn
Winter
Fe
Concentration(dM/dlogDp)/μg m^{-3}
Dp/μm

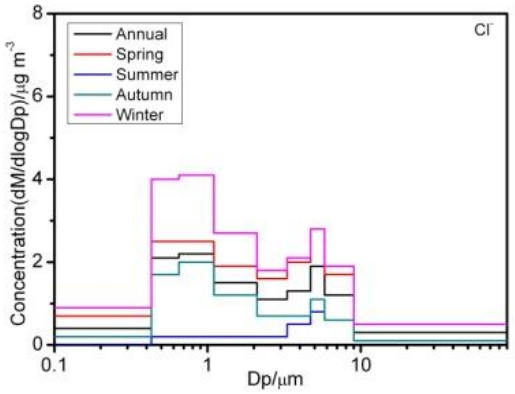

Annual
Spring
Summer
Autumn
Winter
Ca
Concentration(dM/dlogDp)/μg m^{-3}
Dp/μm

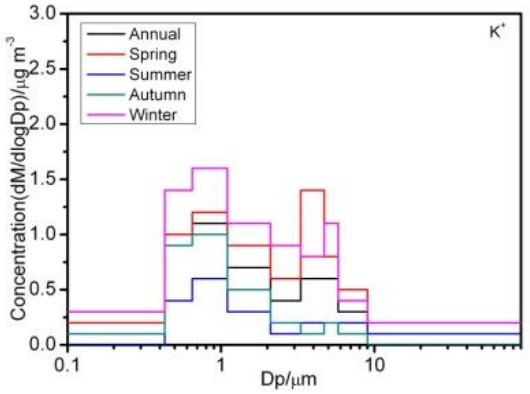

Co
Annual
Spring
Summer
Autumn
Winter
Concentration(dM/dlogDp)/μg m-3
Dp/μm

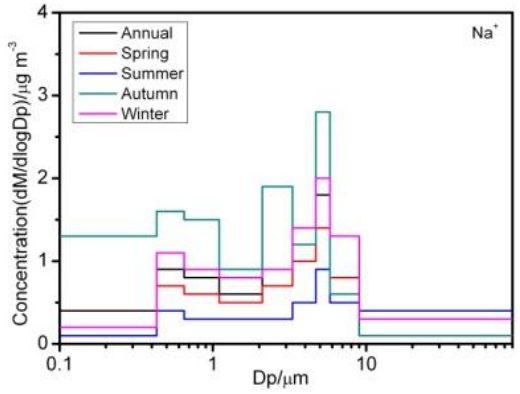

Ni
Annual
Spring
Summer
Autumn
Winter
Concentration(dM/dlogDp)/μg m-3
Dp/μm

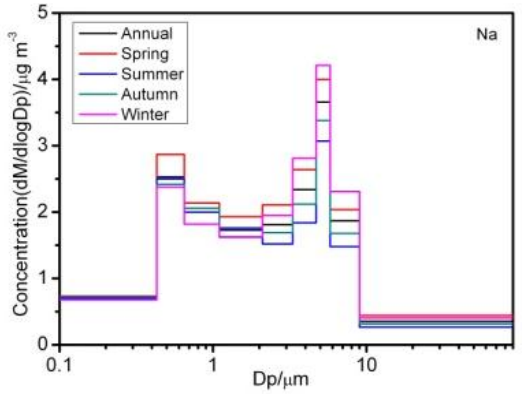

Th
Annual
Spring
Summer
Autumn
Winter
Concentration(dM/dlogDp)/μg m-3
Dp/μm


U
Annual
Spring
Summer
Autumn
Winter
Concentration(dM/dlogDp)/μg m-3
Dp/μm


Cl-
Annual
Spring
Summer
Autumn
Winter
Concentration(dM/dlogDp)/μg m-3
Dp/μm


K+
Annual
Spring
Summer
Autumn
Winter
Concentration(dM/dlogDp)/μg m-3
Dp/μm


Na+
Annual
Spring
Summer
Autumn
Winter
Concentration(dM/dlogDp)/μg m-3
Dp/μm


Na
Annual
Spring
Summer
Autumn
Winter
Concentration(dM/dlogDp)/μg m-3
Dp/μm

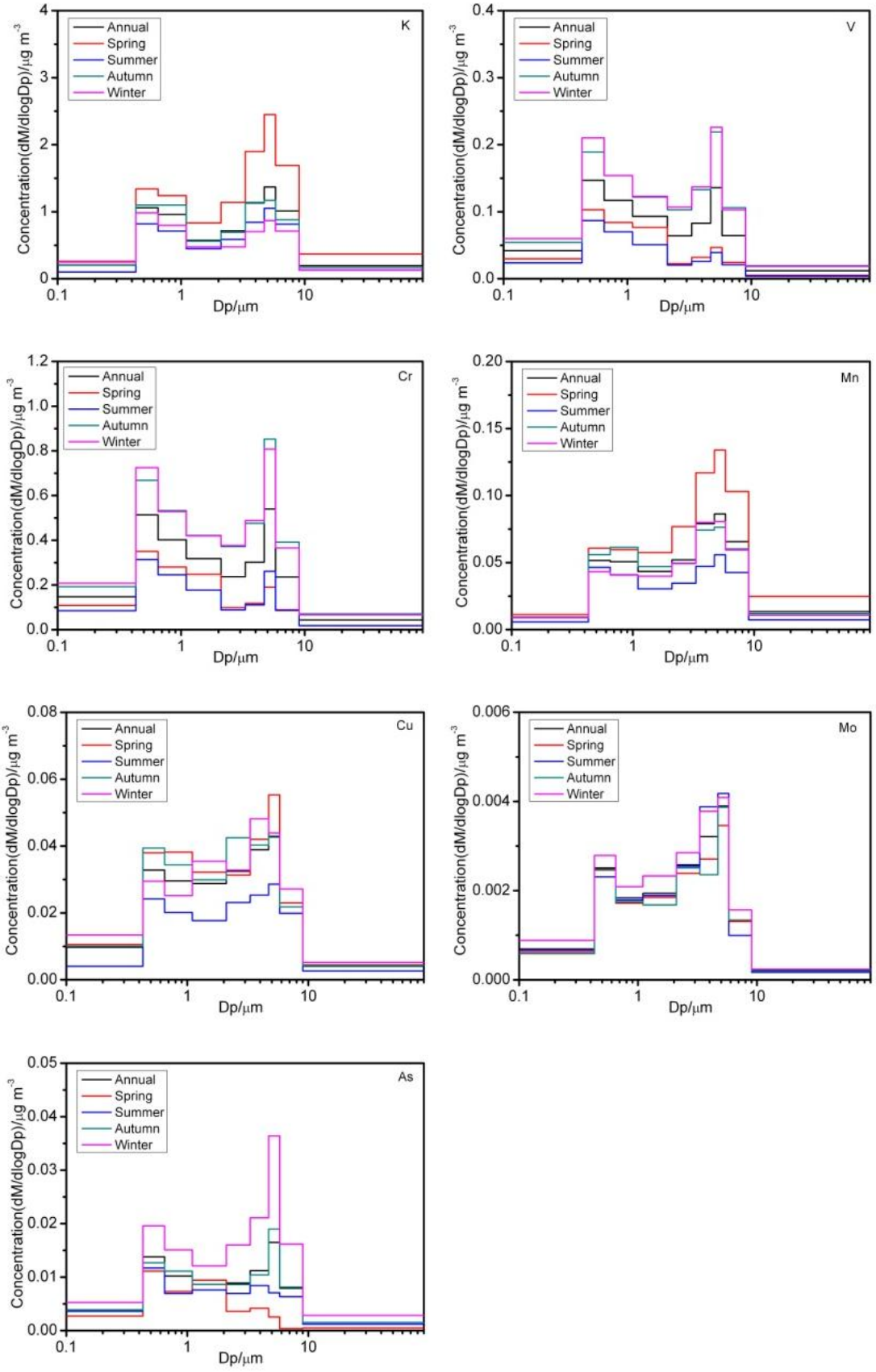


Figure S1 Size distributions of chemical species in different seasons.

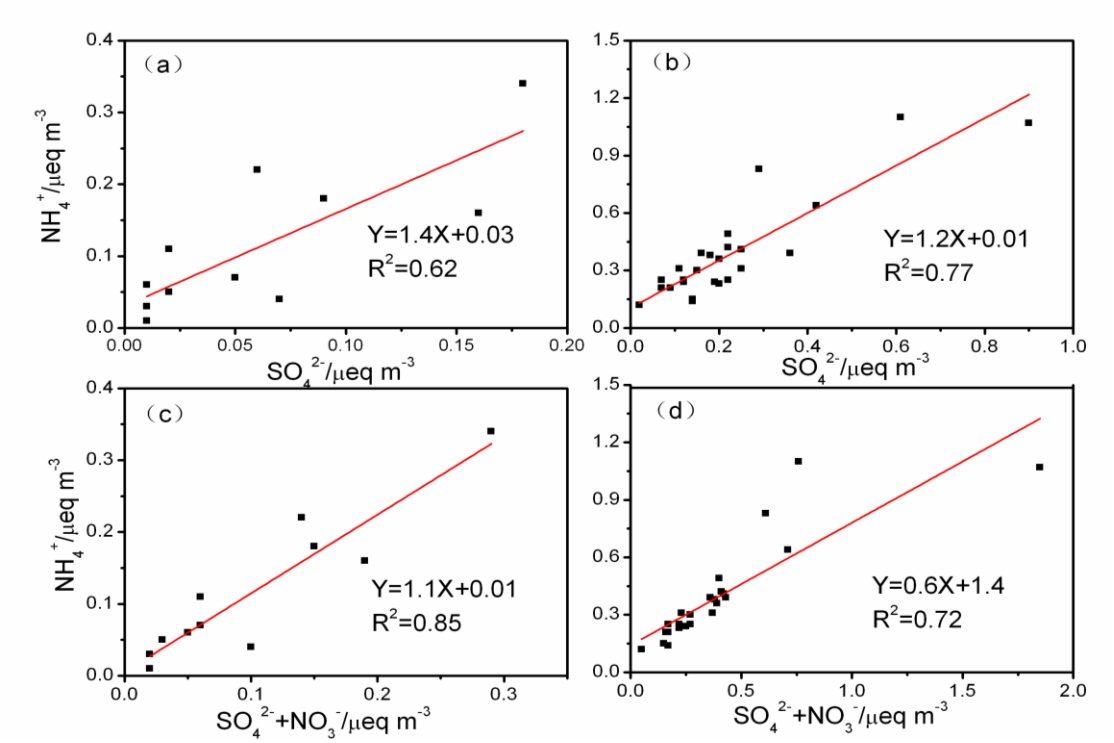


Figure S2 Correlations between certain cations and anions in fine particles on both non- haze and haze days: (a) NH_4^+ and SO_4^{2-} on non-haze days; (b) NH_4^+ and SO_4^{2-} on haze days; (c) NH_4^+ to [NO_3^- + SO_4^{2-}] on non-haze days; (d) NH_4^+ to [NO_3^- + SO_4^{2-}] on haze days.

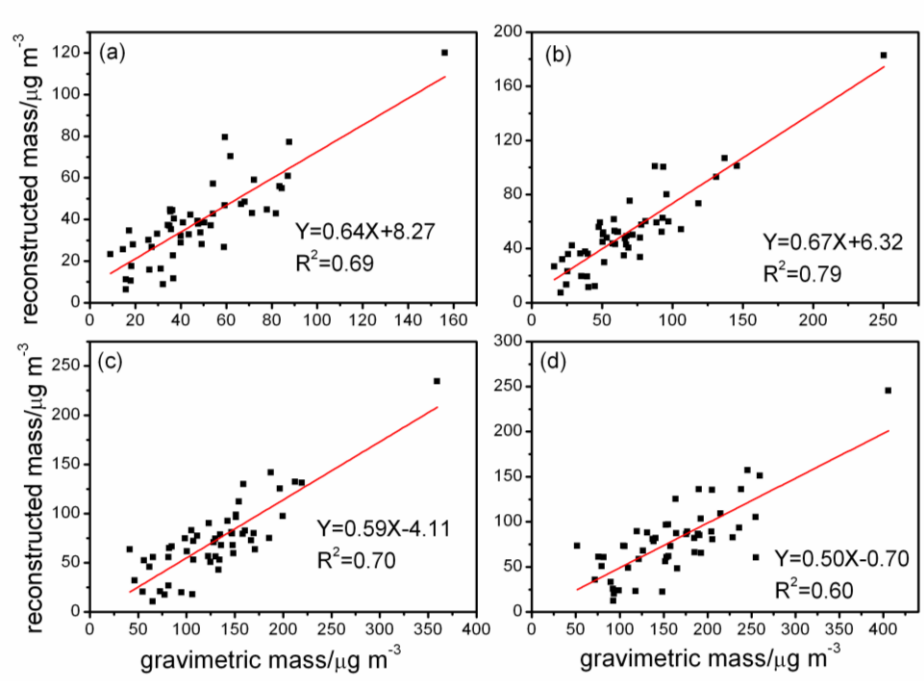


Fig. S3 The relationship between reconstructed PM mass concentrations and the gravimetric PM mass concentrations: (a) $PM_{1.1}$; (b) $PM_{2.1}$; (c) PM_9; (d) TSP.

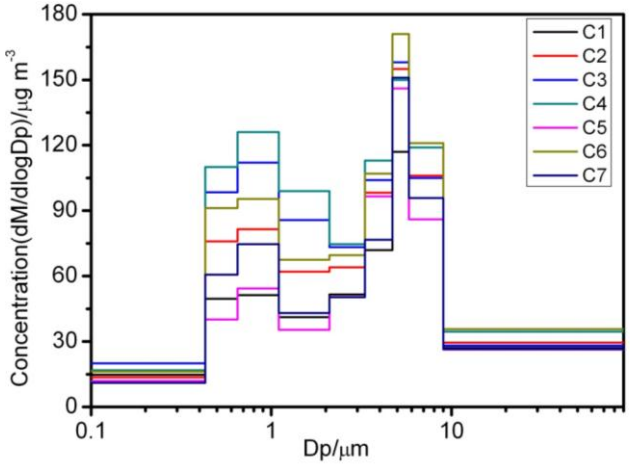


Fig. S4 Mass concentration size distributions within each trajectory cluster.

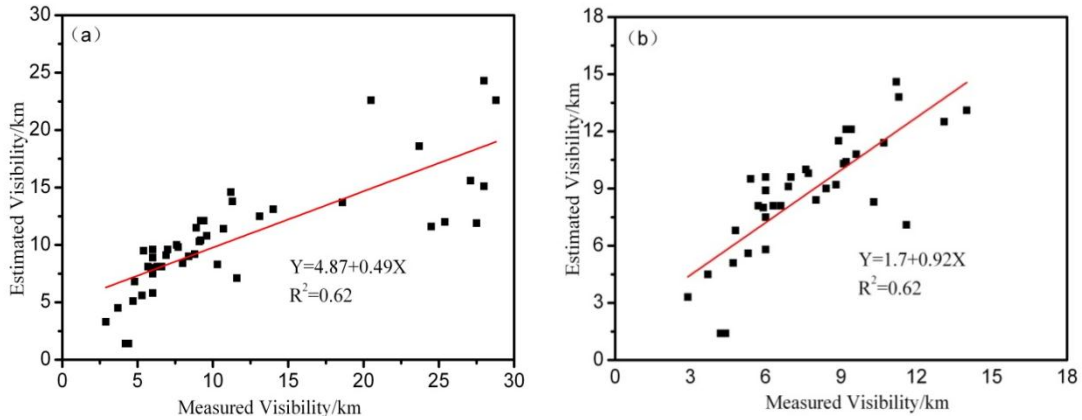


Fig. S5 Correction between estimated visibility and measured visibility (a) all the datasets in 2012-2013; (b) datasets with visibility lower than 15 km in 2012-2013.

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Terzi, E., Argyropoulos, G., Bougatioti, A., Mihalopoulos, N., Nikolaou, K., and Samara, C.: Chemical composition and mass closure of ambient PM_{10} at urban sites, Atmos Environ, 44, 2231-2239, 2010.