

Supplementary Information

Insights into aerosol chemistry during the 2015 China victory day parade: results from simultaneous measurements at ground level and 260 m in Beijing

Jian Zhao^{1,3}, Wei Du^{1,3}, Yingjie Zhang^{4,1}, Qingqing Wang¹, Chen Chen¹, Weiqi Xu^{1,3}, Tingting Han^{1,3}, Yuying Wang⁵, Pingqing Fu¹, Zifa Wang¹, Zhanqing Li⁵, Yele Sun^{1,2*}

¹State Key Laboratory of Atmospheric Boundary Layer Physics and Atmospheric Chemistry, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing 100029, China

²Center for Excellence in Urban Atmospheric Environment, Institute of Urban Environment, Chinese Academy of Sciences, Xiamen 361021, China

³College of Earth Sciences, University of Chinese Academy of Sciences, Beijing 100049, China

⁴Collaborative Innovation Center on Forecast and Evaluation of Meteorological Disasters, Nanjing University of Information Science & Technology, Nanjing 210044, China

⁵College of Global Change and Earth System Science, Beijing Normal University, Beijing 100875, China

*Correspondence to: Y. L. Sun (sunyele@mail.iap.ac.cn)

Table S1. Summary of the average meteorological parameters and mass concentrations of PM₁ species during the five polluted episodes and two clean periods (Fig. 6) at ground level and 260 m.

	260 m							Ground						
	PE1	PE2	C1	PE3	PE4	PE5	C2	PE1	PE2	C1	PE3	PE4	PE5	C2
Meteorological Parameters														
<i>T</i> (°C)	22.72	21.94	21.84	20.40	21.72	20.70	18.49	24.90	24.38	23.73	22.67	23.35	22.19	20.01
RH (%)	78.44	77.25	75.16	96.26	63.91	65.75	55.13	67.26	66.42	68.48	84.82	60.83	62.80	56.62
WS (m s ⁻¹)	2.14	2.82	4.44	3.08	3.06	3.12	4.88	1.34	1.26	1.17	1.29	1.06	1.08	1.41
Aerosol Species (µg m⁻³)														
Org	11.84	11.73	4.58	12.11	20.40	22.69	3.97	12.77	13.17	9.27	16.61	24.93	32.35	7.81
POA	3.92	3.99	1.57	3.95	6.94	7.42	1.47	4.02	3.28	4.32	4.07	7.33	8.49	4.01
SOA	7.93	7.73	3.01	8.16	13.45	15.27	2.49	8.75	9.89	4.94	12.54	17.59	23.86	3.81
SO ₄	6.68	3.93	1.02	5.11	6.16	12.42	0.70	10.41	6.31	2.53	11.18	9.37	23.46	1.22
NO ₃	10.03	5.07	0.79	10.43	10.02	15.79	0.54	10.85	5.49	1.51	14.96	9.38	19.96	0.94
NH ₄	4.69	2.69	0.68	4.52	4.62	8.28	0.48	6.53	3.48	1.13	8.20	5.73	13.36	0.56
Chl	0.45	0.24	0.08	0.69	0.44	0.72	0.07	0.28	0.13	0.05	0.65	0.39	0.85	0.05
BC	2.39	1.56	0.67	2.43	4.01	6.24	0.66	1.66	1.51	0.94	1.98	3.75	4.51	1.01
PM ₁	36.09	25.21	7.82	35.29	45.63	66.13	6.41	42.50	30.08	15.43	53.57	53.55	94.49	11.58

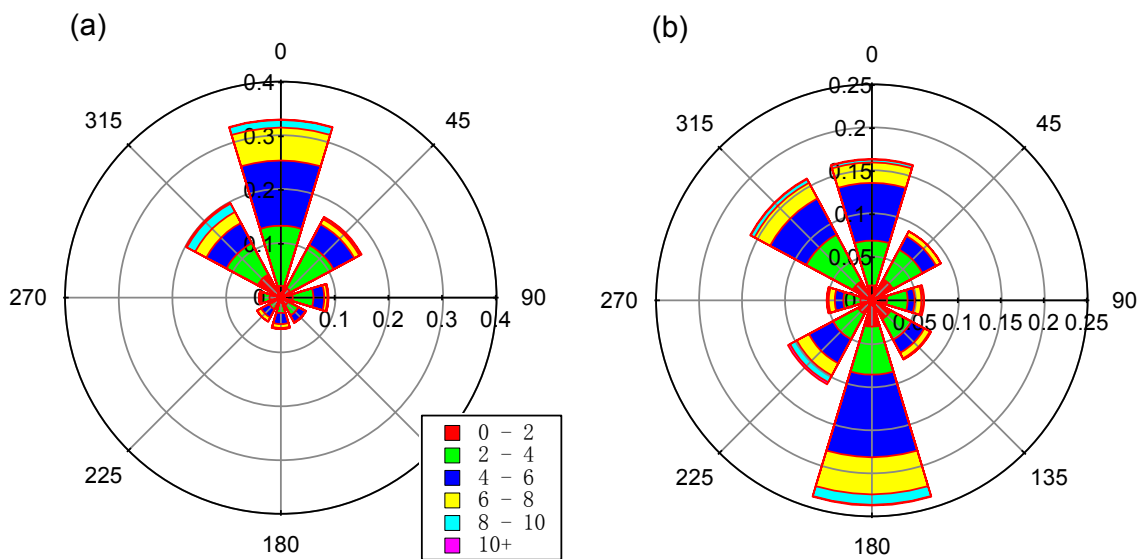
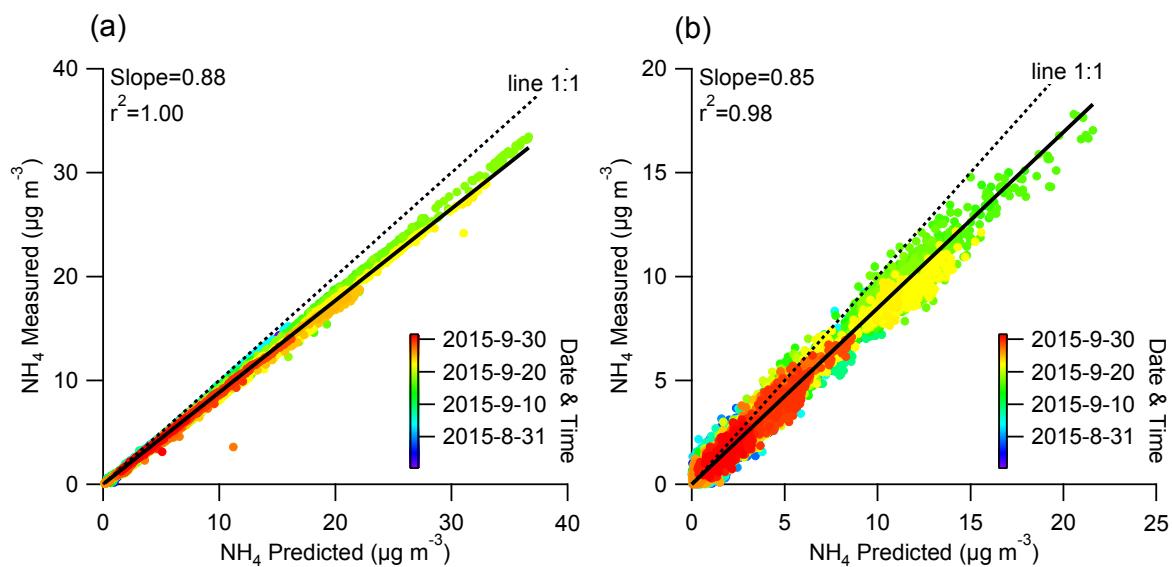


Figure S1. Wind rose plots (a) during the control period (20 August – 3 September) and (b) after the control period (4 September – 30 September), which are colored by wind speed (m s^{-1}).



5 **Figure S2.** Scatter plots of measured ammonium versus the predicted ammonium that requires to fully neutralize sulfate, nitrate and chloride at (a) ground level and (b) 260 m.

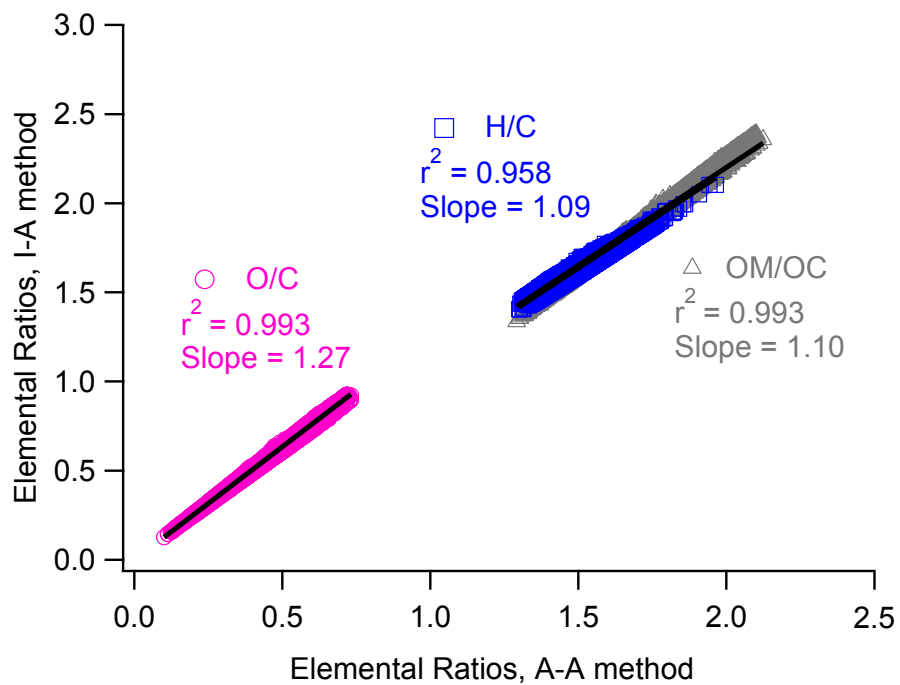


Figure S3. Scattering plot of elemental ratios, including oxygen-to-carbon (O/C), hydrogen-to-carbon (H/C) and organic mass-to-organic carbon (OM/OC) ratio calculated from the I-A method (Canagaratna et al., 2015) versus those from the A-A method (Aiken et al., 2007; Aiken et al., 2008).

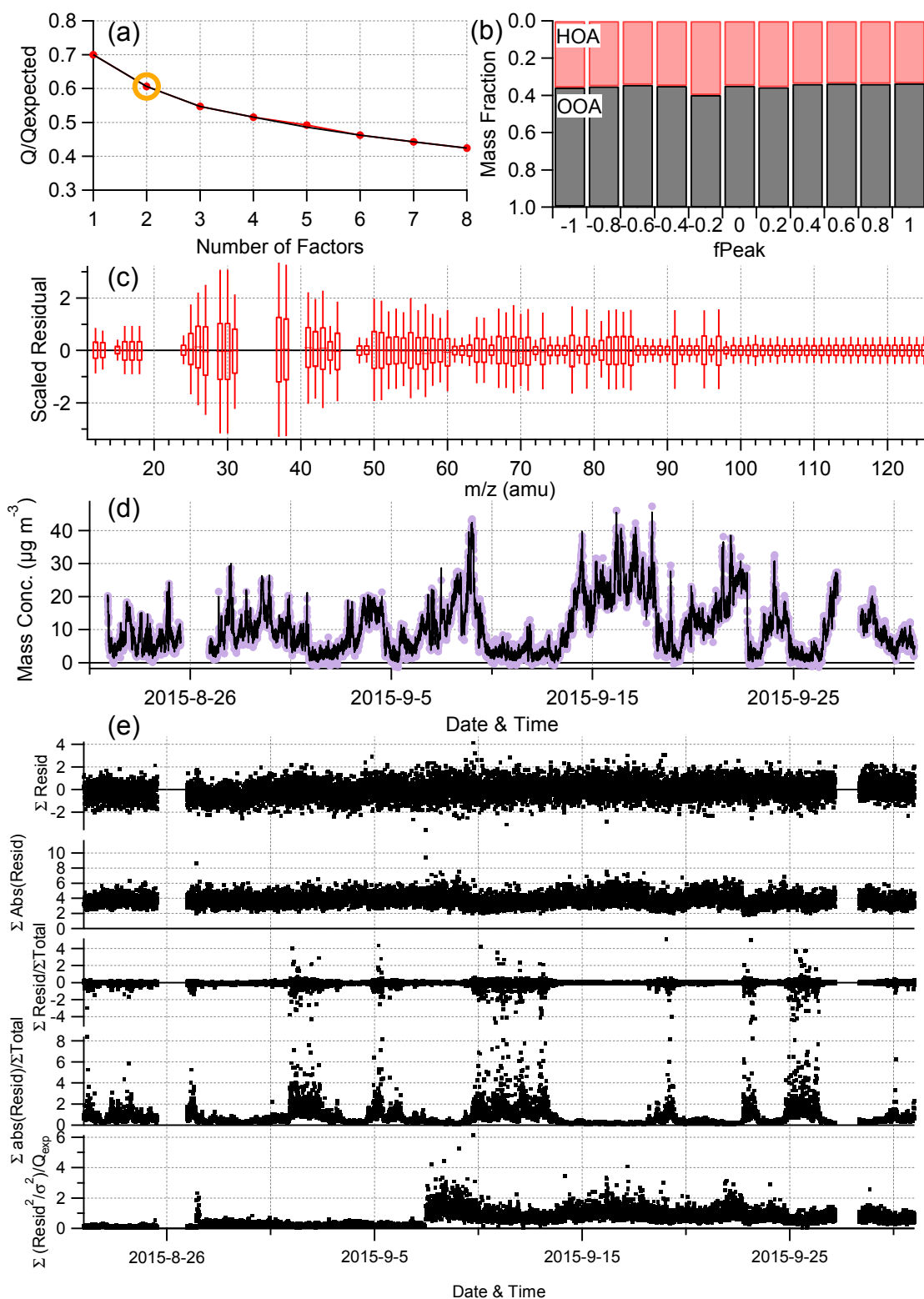
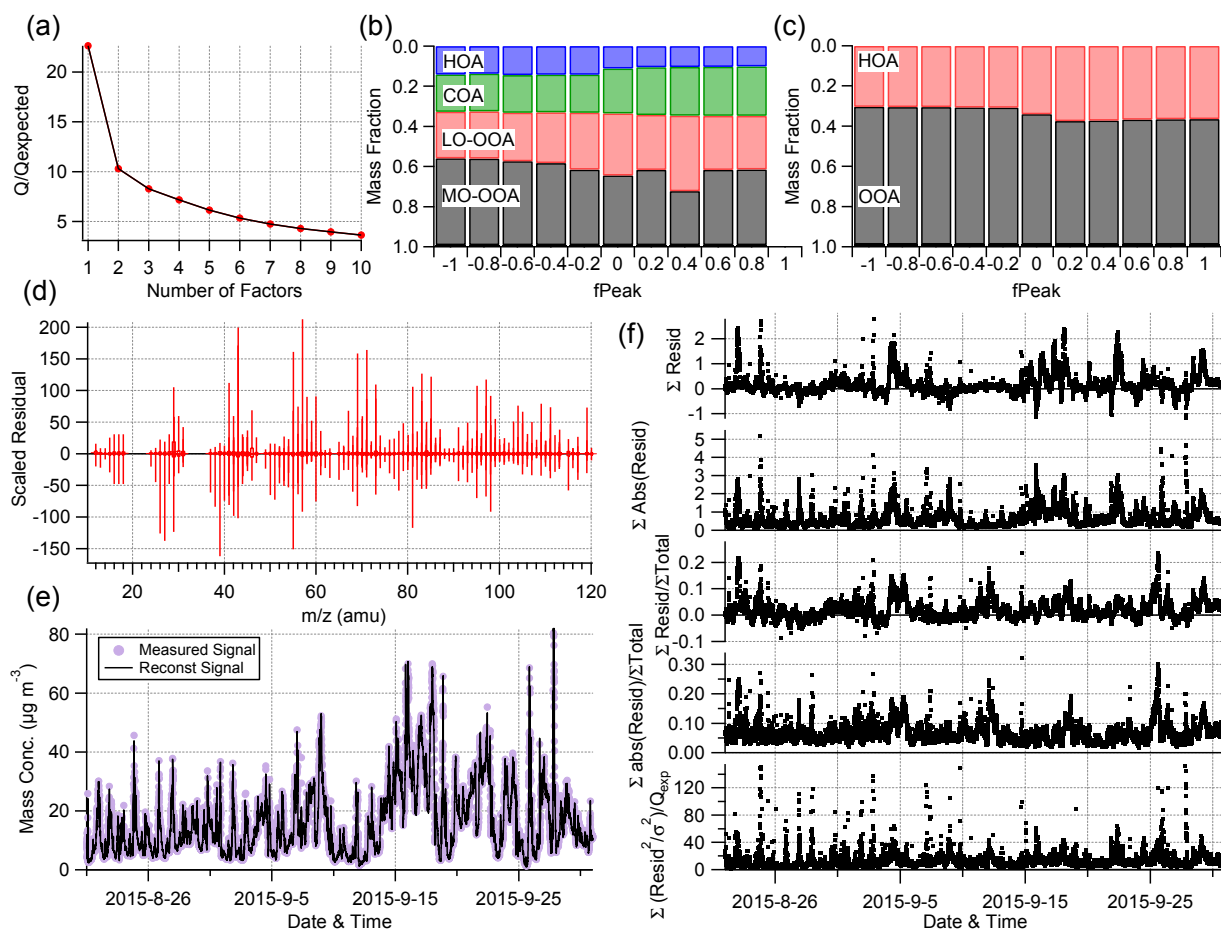


Figure S4. Summary of the main diagnostic plots of the two-factor PMF resolution of ACSM organic matrix at 260 m: (a) Q/Q_{expected} varied as a function of the number of factors, (b) mass fraction of the two OA factors (i.e. HOA and OOA) as a function of f_{Peak} , (c) box plot of scaled residual for each m/z , (d) time series of measured mass concentrations comparing with the reconstructed ones by the two-factor PMF solution at $f_{\text{Peak}}=0$, (e) time series of the residual diagnostics.



5 **Figure S5.** Summary of the main diagnostic plots of the four-factor PMF resolution of HR-AMS organic matrix at ground: (a) Q/Q_{expected} varied as a function of the number of factors, (b) mass fraction of four OA factors as a function of f_{Peak} , (c) mass fraction of two OA factors as a function of f_{Peak} , (d) box plot of scaled residual for each fragment ion, (e) time series of measured mass concentrations comparing with that reconstructed by the four-factor PMF solution at $f_{\text{Peak}}=0$, (f) time series of the residual diagnostics.

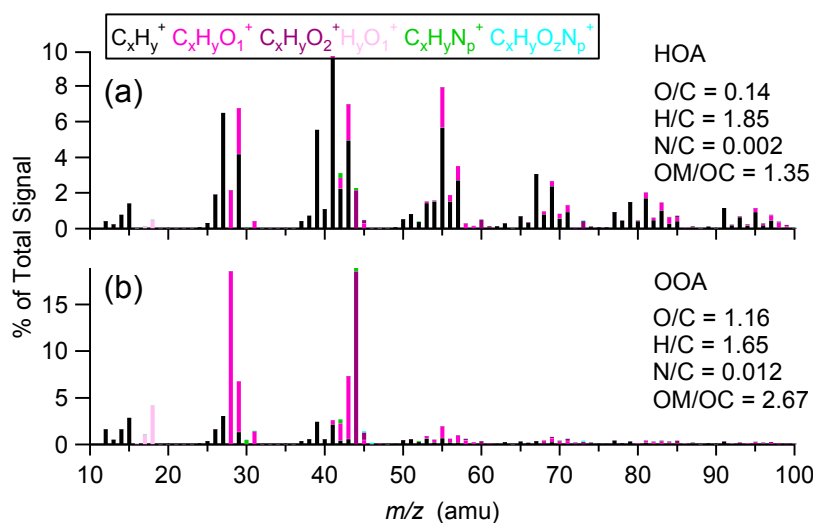


Figure S6. High resolution mass spectra of OA factors from two-factor PMF solution at ground level.

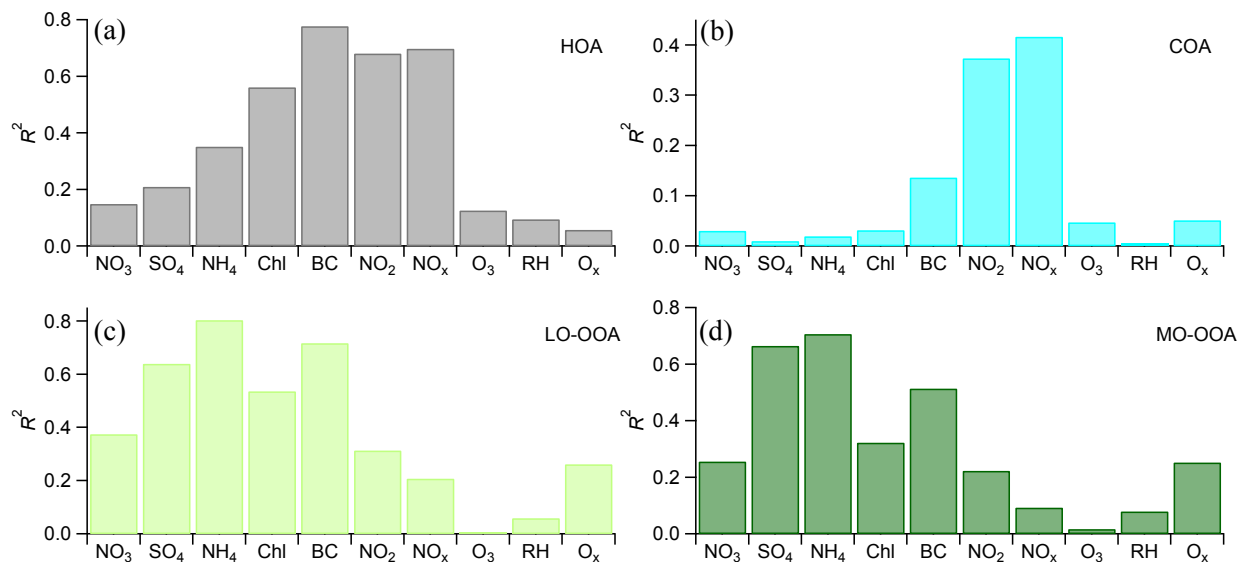
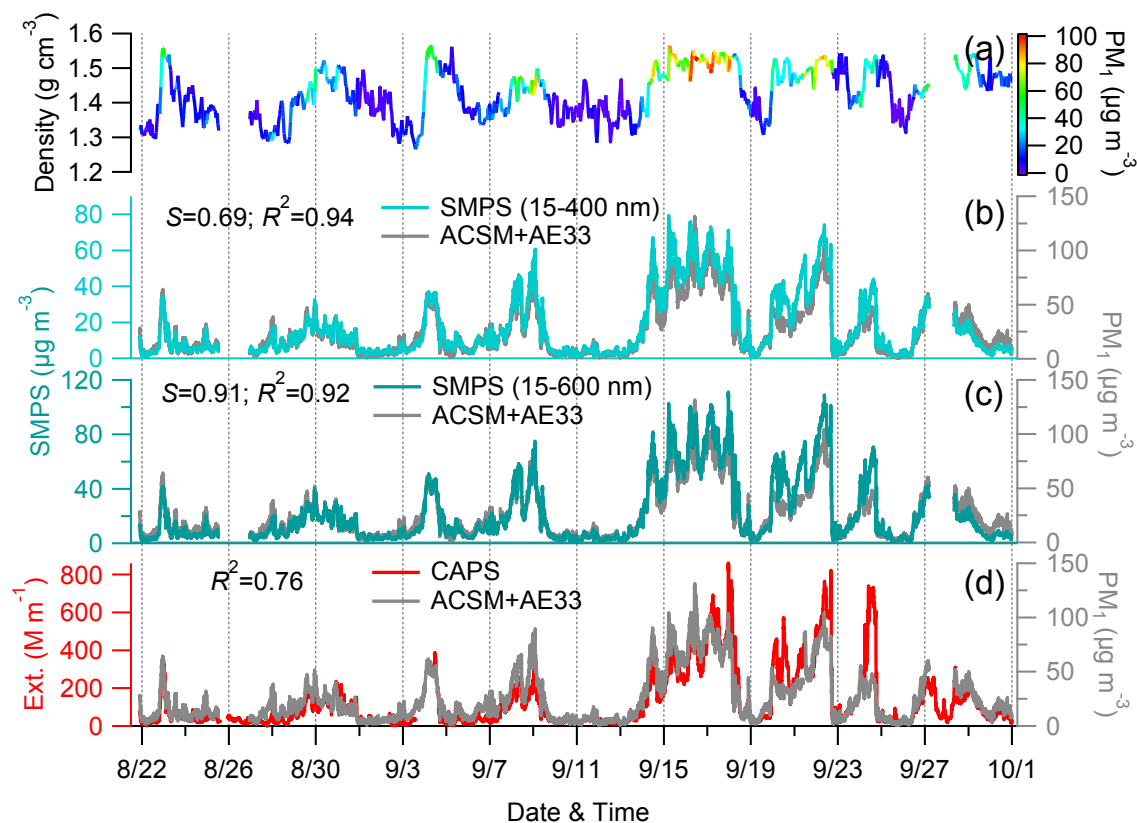


Figure S7. Correlations of the four OA factors of HR-AMS: (a) HOA, (b) COA, (c) LO-OOA and (d) MO-OOA with external tracers during the entire study.



5 **Figure S8.** (a) Time series of particle density, and inter-comparisons between PM_1 (= NR- PM_1 + BC) and (b) mass concentrations converted from 10-400 nm and (c) from 15-600 nm particles that derived from SMPS measurements, and (d) light extinction coefficient of $\text{PM}_{2.5}$. The correlation coefficients (R^2) and regression slopes (S) are also given in (b-d).

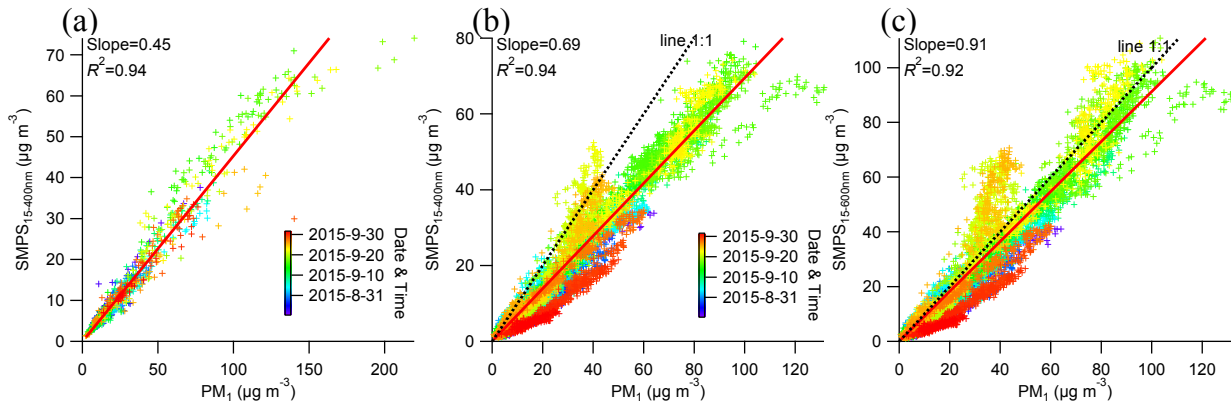


Figure S9. Scattering plots of PM_{10} measured by HR-AMS/ACSM and AE versus the mass concentrations converted from the number concentrations of SMPS measurements in different size ranges: (a) 15-400 nm at ground level, (b) 15-400 nm at 260 m, and (c) 15-600 nm at 260 m.

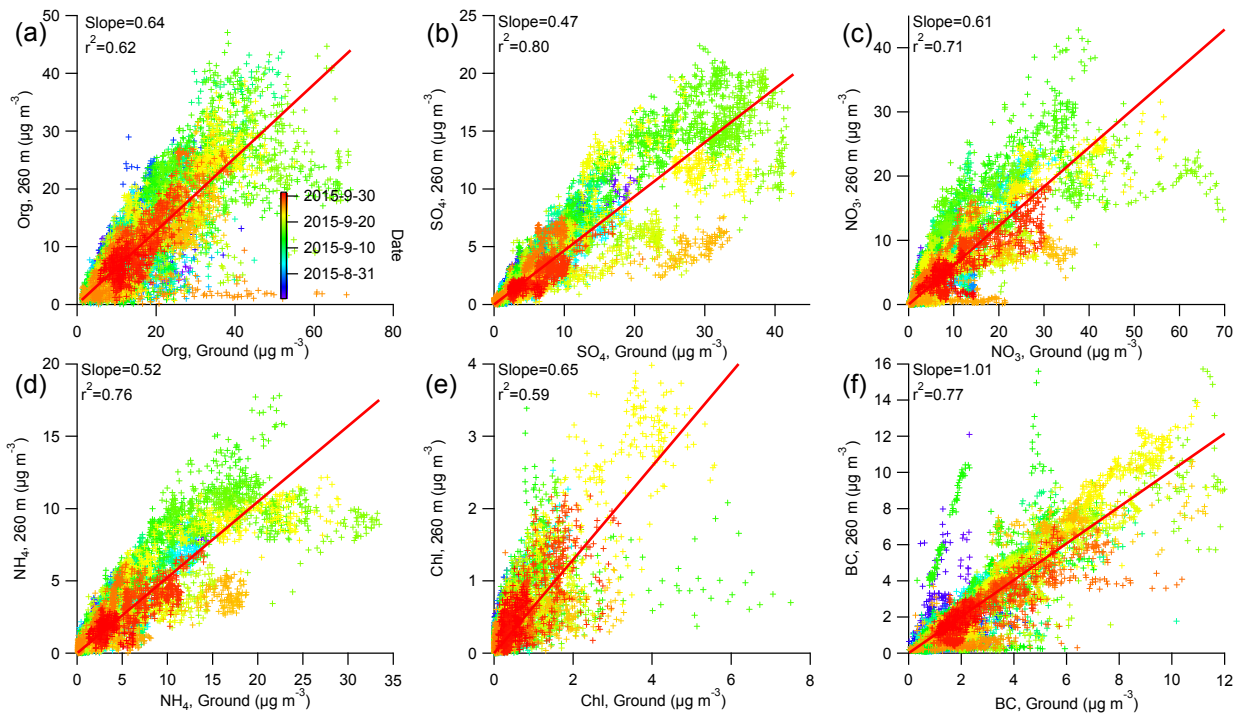


Figure S10. Scattering plots of PM_{10} species measured at 260 m versus those measured at ground.

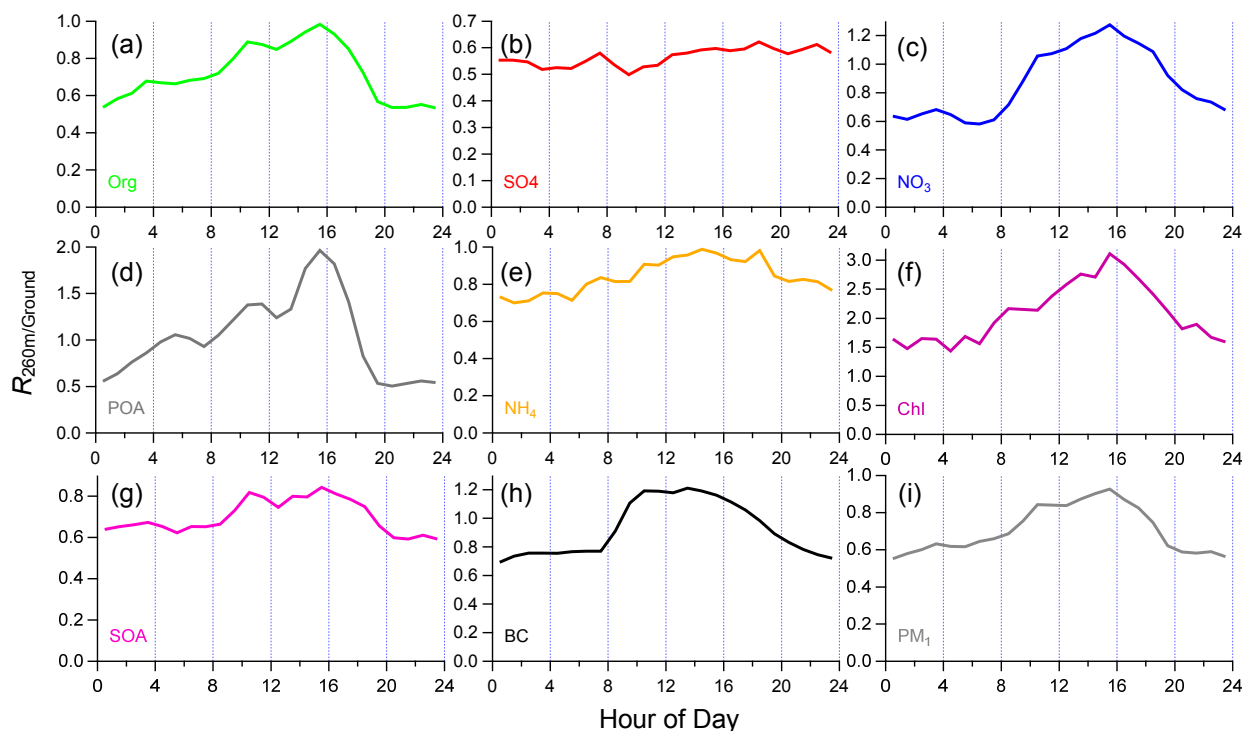


Figure S11. Diurnal variations of the ratios of 260 m to ground ($R_{260m/ground}$) for each species.

References

- 5 Aiken, A. C., DeCarlo, P. F., and Jimenez, J. L.: Elemental analysis of organic species with electron ionization high-resolution mass spectrometry, *Anal. Chem.*, 79, 8350-8358, 2007.
- Aiken, A. C., Decarlo, P. F., Kroll, J. H., Worsnop, D. R., Huffman, J. A., Docherty, K. S., Ulbrich, I. M., Mohr, C., Kimmel, J. R., and Sueper, D.: O/C and OM/OC ratios of primary, secondary, and ambient organic aerosols with high-resolution time-of-flight aerosol mass spectrometry, *Environ. Sci. Technol.*, 42, 4478-4485, 2008.
- 10 Canagaratna, M. R., Jimenez, J. L., Kroll, J. H., Chen, Q., Kessler, S. H., Massoli, P., Hildebrandt Ruiz, L., Fortner, E., Williams, L. R., Wilson, K. R., Surratt, J. D., Donahue, N. M., Jayne, J. T., and Worsnop, D. R.: Elemental ratio measurements of organic compounds using aerosol mass spectrometry: characterization, improved calibration, and implications, *Atmos. Chem. Phys.*, 15, 253-272, 10.5194/acp-15-253-2015, 2015.