

Supplementary Materials for

Influence of biomass burning from Southeast Asia at a high-altitude mountain receptor site in China

Jing Zheng^a, Min Hu^{a,*}, Zhaoheng Gong^{a,1}, Dongjie Shang^a, Zhuofei Du^a, Yanhong Qin^a, Jingyao Fang^a, Mengren Li^a, Jianfei Peng^a, Jie Li^b, Yuqia Zhang^b, Fangting Gu^a, Yusheng Wu^a, Song Guo^a

^aState Key Joint Laboratory of Environmental Simulation and Pollution Control, College of Environmental Sciences and Engineering, Peking University, Beijing, China

^bState Key Laboratory of Atmospheric Boundary Layer Physics and Atmospheric Chemistry (LAPC), Nansen-Zhu International Research Center (NZC), Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China

* Correspondence to: minhu@pku.edu.cn

¹ Now at John A. Paulson School of Engineering and Applied Sciences, Harvard University, Cambridge, Massachusetts, 02138, United States

S.1 Instruments

Table S1 Overview of main instruments used during the campaign.

Parameter	Phase	Instrument	Manufacturer
NR-PM ₁ composition	Particle	HR-ToF AMS	Aerodyne Research Inc, Billerica, MA, USA
BC	Particle	Aethalometer, type AE31	Magee Scientific, Berkeley, CA, USA
Aerosol number size distribution	Particle	SMPS (3081-DMA and 3775-CPC),	TSI Inc., Shoreview, MN, USA
VOCs concentration	Gas	GC-MS/FID	Self-made instrument

S.2 Comparisons between AMS and other instruments

The sum of mass concentrations measured by the AMS (sulfate + nitrate + ammonium + OA) and BC was compared to mass concentrations converted from volume concentrations measured by the SMPS by multiplying an estimated composition-dependent density (Middlebrook et al., 2012). Given the decrease of the transmission efficiency of AMS at large size, the size range of the SMPS for integration is taken from 15 to 600 nm when doing the inter-comparison (Hu et al., 2013). The scatter plot of AMS

24 plus BC vs. PM₁ concentrations from SMPS showed a strong correlation ($R^2 = 0.95$) with a slope of 1.1
25 (Fig. S1).

26 **S.3 PMF diagnostics and evaluation**

27 PMF analysis was performed on the high resolution spectral matrix of organics provided by AMS.
28 The data was analyzed according to the method recommend by Ulbrich et al. (2009). Factor numbers
29 from 1 to 12 were tested to see if the solutions could successfully explained the variations of organic
30 time series by several meaningful factors.

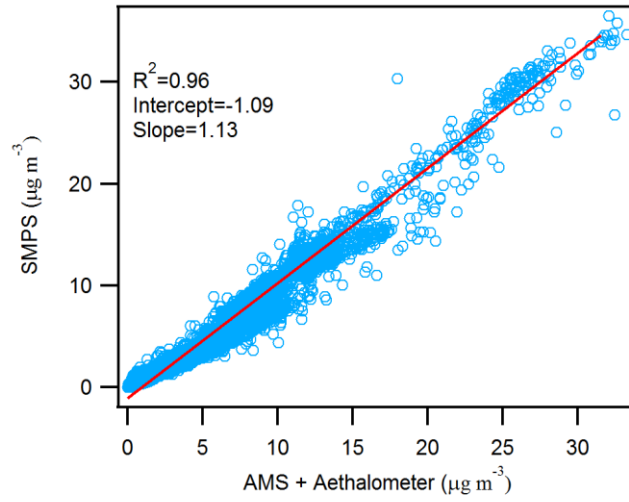
31 One factor or two factors would result in large residuals at both time series and key m/z values, with
32 high Q/Q_{exp} values. A 3-factor solution has a low Q/Q_{exp} values of 1.1, and further increasing the factor
33 number only results in minor decreases in Q/Q_{exp} values. The 3-factor solution has two similar OOA
34 factors. The time series of one OOA factor presents noisy background, shown as fac1 in grey color in
35 Fig. S2(b). The 4-factor solution could clearly identify two factors, and can be assigned as BBOA and
36 OOA-BB. However the time series of the first factors was noisy as Fig. S3(b). The similarity in the
37 spectra of factor 1 and factor 2 indicates that these two factors were essentially a split of one factor. When
38 factor number goes beyond 4, splits of factors also happen, as shown in the example of 5-factor solution
39 in Fig. S4(a).

40 Based on the analysis above, the 4-factor solution was chosen, with factor 3 identified as OOA-BB,
41 and factor 4 identified as BBOA. Factor 1 and factor 2 were combined together to form a new factor by
42 a mass-weighted averaging of their profiles, and is identified as OOA. The concentration of the combined
43 factor equals to the sum of the concentrations of factor 1 and factor 2.

44 The stability of the solution was further investigated by FPEAK rotational analysis and SEED
45 method. Results showed very little variability at different FPEAK values, with FPEAK = 0 being the
46 lowest point in Fig.S5 (b). Thus FPEAK= 0 is chosen. Seeds were chosen from 0 to 100, and with an
47 interval of 10. Nearly identical results were seen for different seed values, as shown in Fig.S5 (d), proving
48 that the solution of PMF is stable.

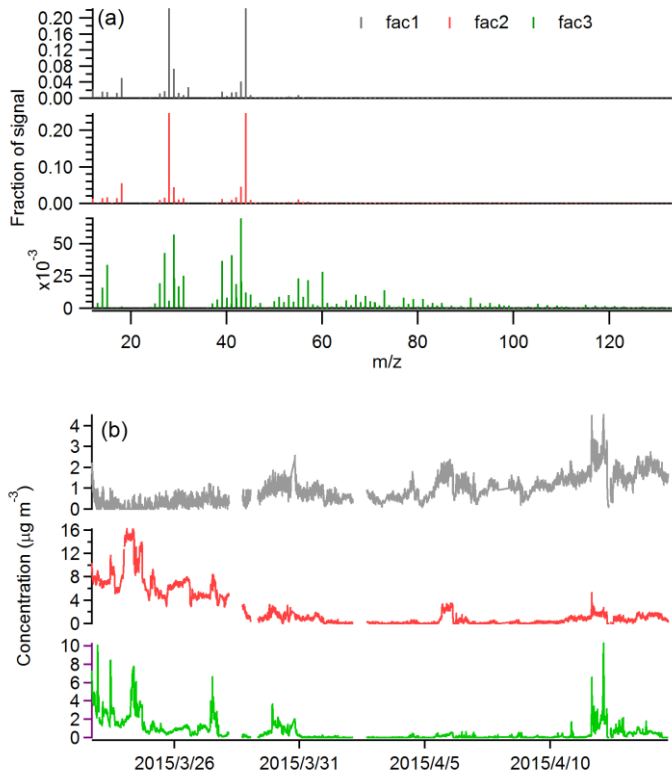
49

50



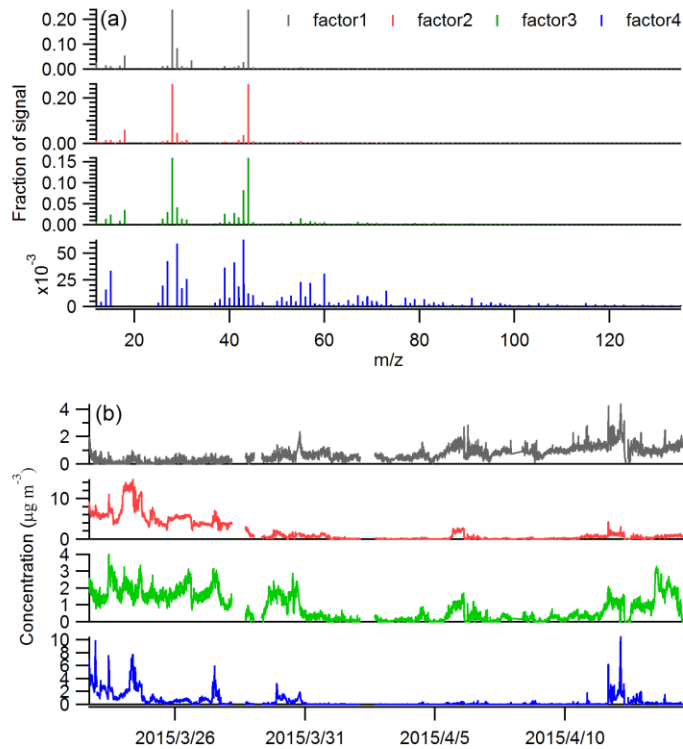
51
52
53
54
55
56

Fig. S1 Comparison of the mass concentration of PM_{10} measured by SMPS and that by AMS plus Aethalometer



57
58
59

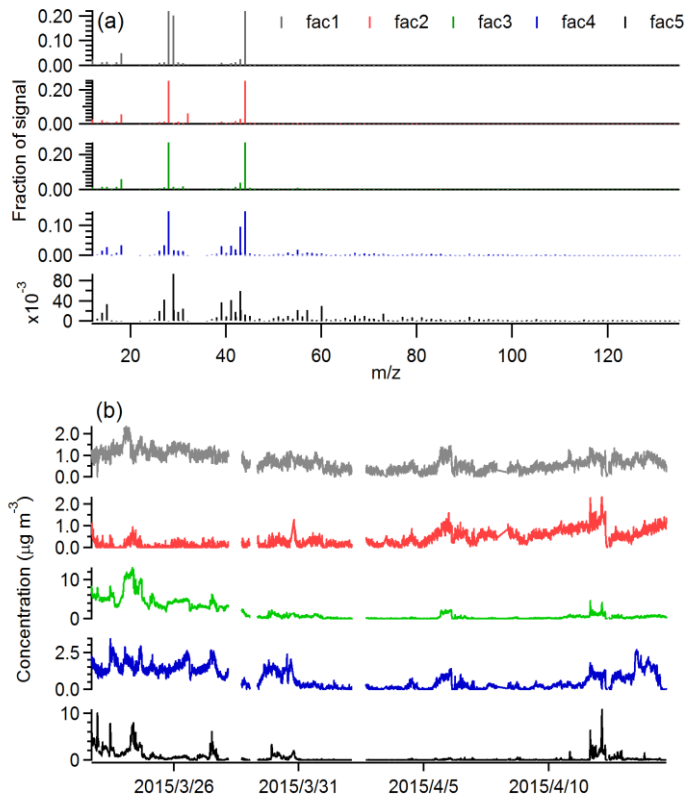
Fig. S2 (a) mass spectra and (b) time series of the 3-factor solution



60

61

Fig. S3 (a) mass spectra and (b) time series of the 4-factor solution

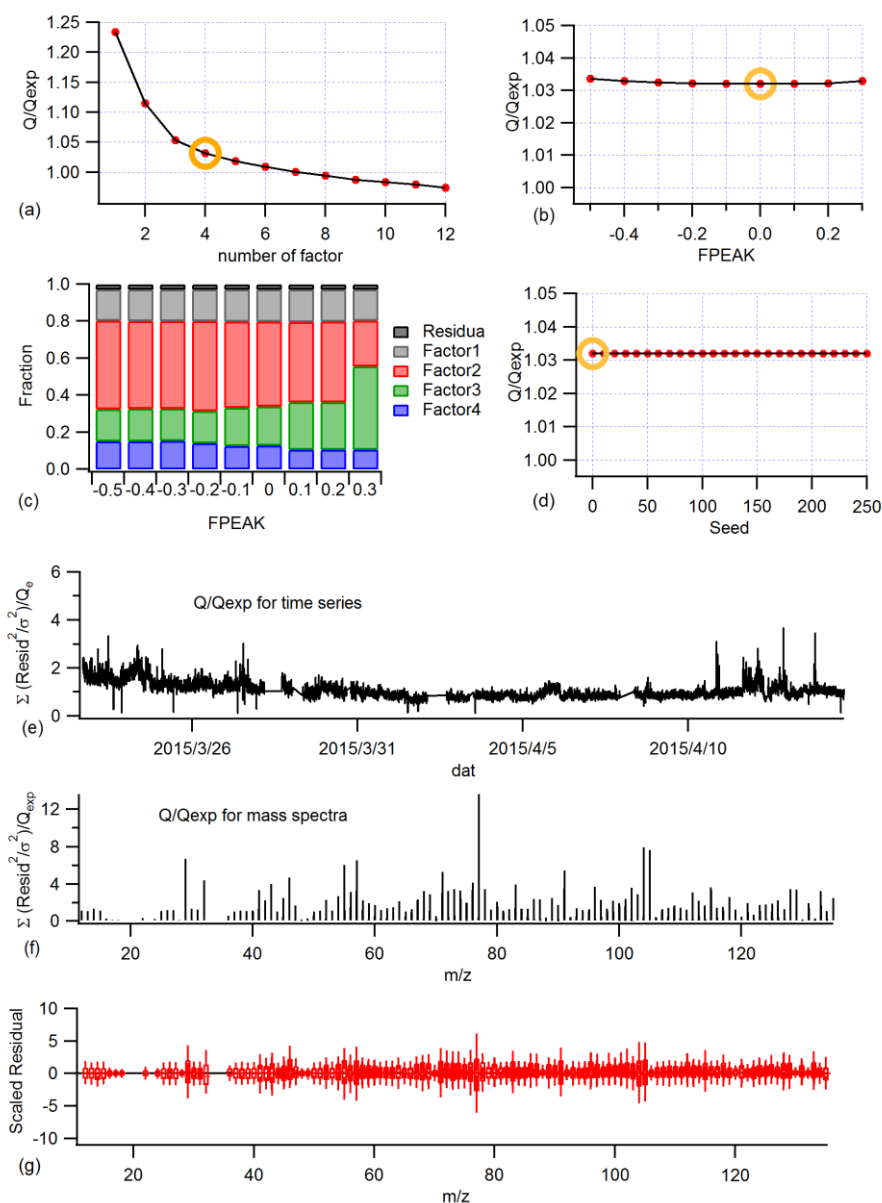


62

63

64

Fig. S4 (a) mass spectra and (b) time series of the 5-factor solution



65

66 Fig. S5 diagnostic plot of PMS solution. Panel (a) the Q/Q_{exp} values as a function of factor number.

67 (b) the Q/Q_{exp} values as a function of FPEAK values of 4 factor solution. (c) relative contribution of

68 four OA factors of different FPEAK value (d) the Q/Q_{exp} values as a function of seed values of 4

69 factor solution. (e) time series of the Q/Q_{exp} values (f) the Q/Q_{exp} values of different m/z (g) the box-

70 whisker plot for the scaled residual for the mass spectra.

71

72 Reference

73 Hu, W. W., Hu, M., Yuan, B., Jimenez, J. L., Tang, Q., Peng, J. F., Hu, W., Shao, M., Wang, M., Zeng, L.
 74 M., Wu, Y. S., Gong, Z. H., Huang, X. F., and He, L. Y.: Insights on organic aerosol aging and the
 75 influence of coal combustion at a regional receptor site of central eastern China, *Atmos. Chem. Phys.*,
 76 13, 10095-10112, doi: 10.5194/acp-13-10095-2013, 2013.

77 Middlebrook, A. M., Bahreini, R., Jimenez, J. L., and Canagaratna, M. R.: Evaluation of Composition-
78 Dependent Collection Efficiencies for the Aerodyne Aerosol Mass Spectrometer using Field Data,
79 *Aerosol Sci. Technol.*, 46, 258-271, doi: 10.1080/02786826.2011.620041, 2012.
80 Ulbrich, I. M., Canagaratna, M. R., Zhang, Q., Worsnop, D. R., and Jimenez, J. L.: Interpretation of
81 organic components from Positive Matrix Factorization of aerosol mass spectrometric data, *Atmos.*
82 *Chem. Phys.*, 9, 2891-2918, doi: 10.5194/acp-9-2891-2009, 2009.

83

84

85

86