Supplement of

Mass Spectral Characterization of Primary Emissions and Implications in Source Apportionment of Organic Aerosol

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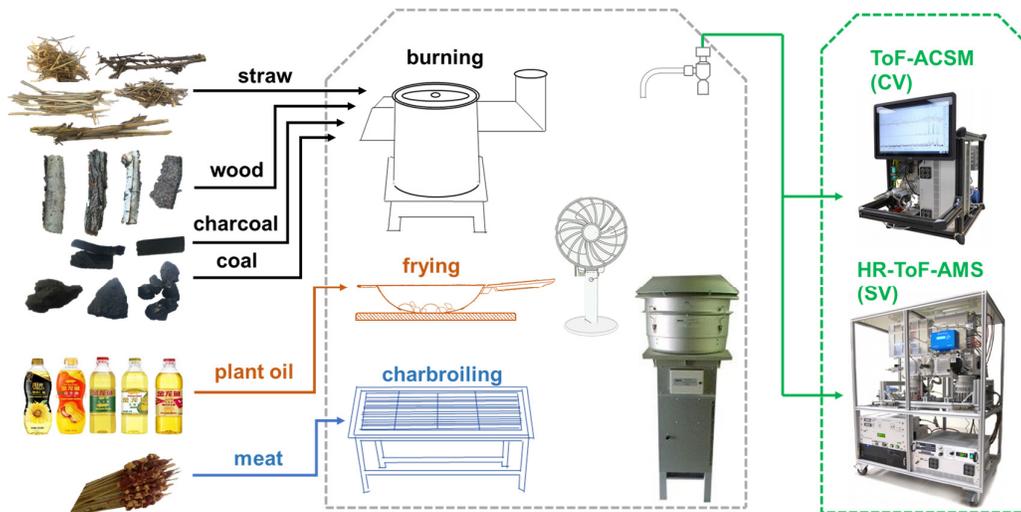
**Figure S1. Schematic of cooking and burning experiments.**
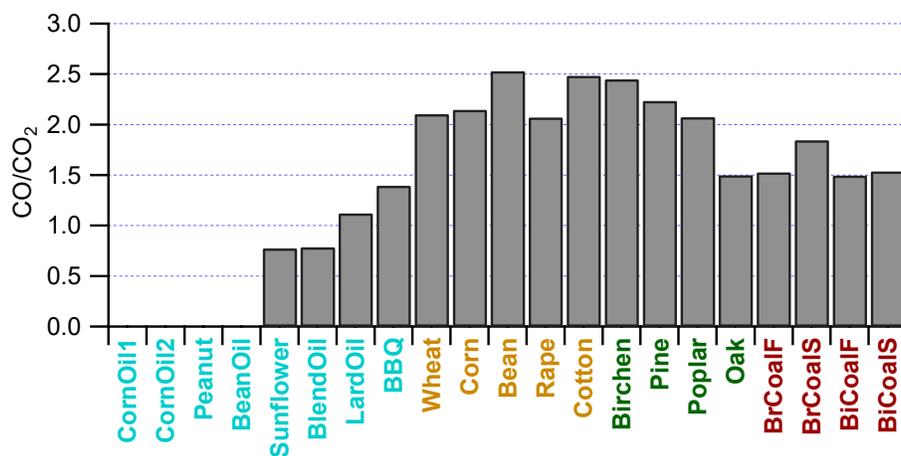

Figure S2. The ratio of measured CO^+/CO_2^+ for WSOA from 17 cooking and burning experiments.

OM/OC=1.44; O/C=0.18; H/C=2.01; N/C=0.029

$C_xH_y^+$ $C_xH_yO_1^+$ $C_xH_yO_2^+$
$C_xH_yN_p^+$ $C_xH_yO_zN_p^+$

% of the total signal
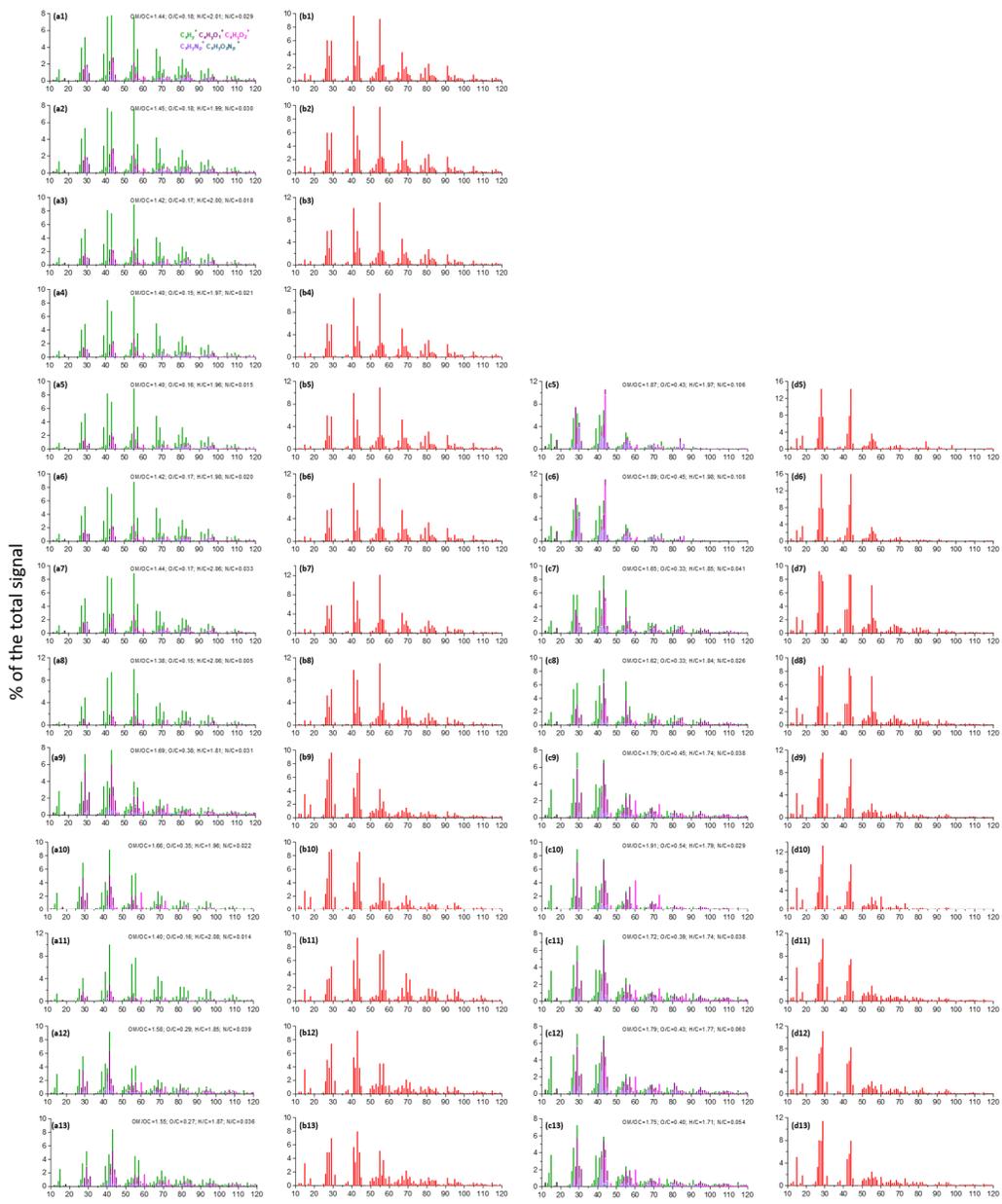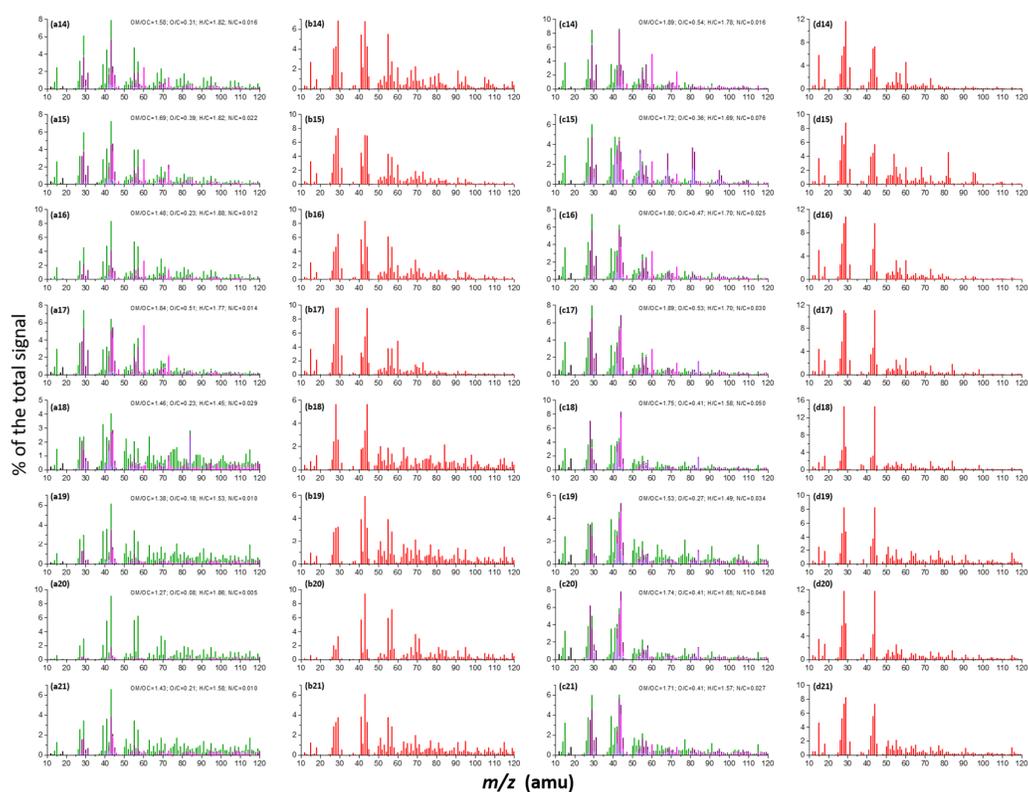
Figure S3. The mass spectral profiles of OA measured by (a) SV-AMS, (b) CV-ACSM and WSOA measured by (c) SV-AMS and (d) CV-ACSM from (1) stir-fried garlic with corn oil, (2) stir-fried celery with corn oil, (3) peanut oil, (4) bean oil, (5) sunflower oil, (6) blend oil, (7) lard oil and (8) barbecue (9) wheat, (10) corn, (11) bean, (12) rape, (13) cotton, (14) birchen, (15) pine tree, (16) poplar, (17) Chinese oak, (18) flaming combustion of brown coal, (19) smoldering combustion of brown coal, (20) flaming combustion of bituminous coal and (21) smoldering combustion of bituminous coal.
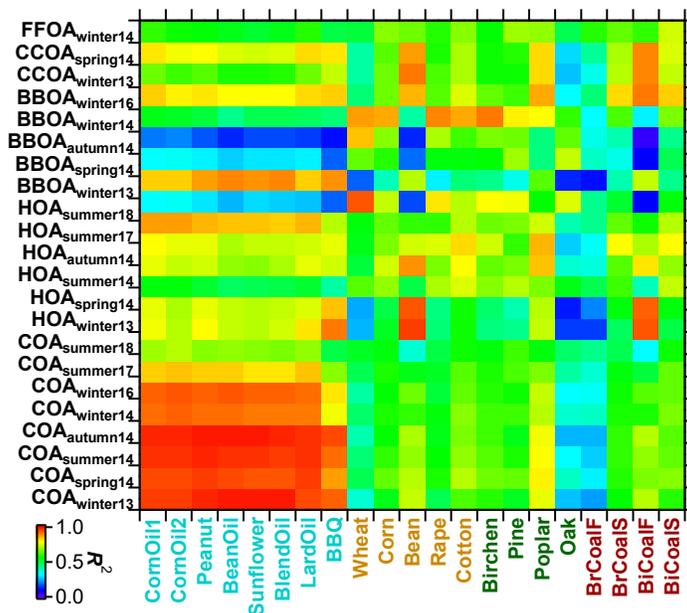
Figure S4. Mass spectral correlations of primary emissions (including cooking, crop straw burning, wood burning and coal combustion) in this study with the previous PMF-resolved OA factors in Beijing (Sun et al., 2016;Xu et al., 2017;Xu et al., 2019).
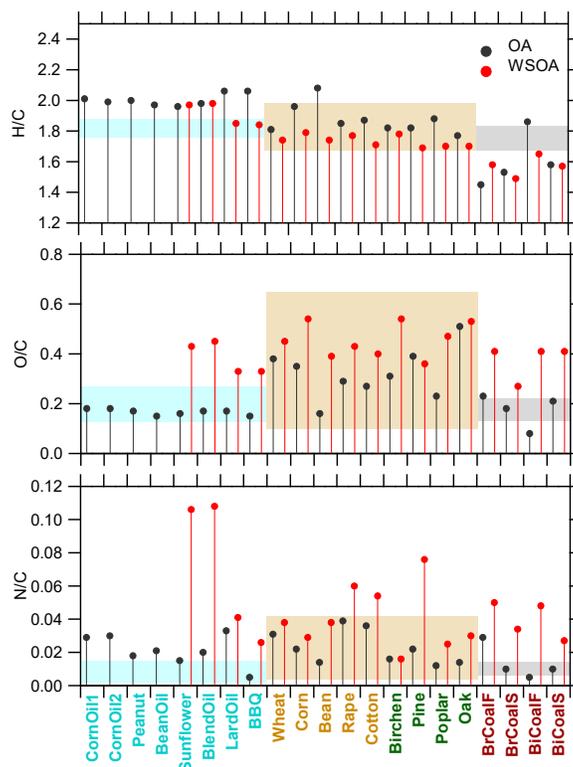
Figure S5. Comparison of H/C, O/C and N/C ratios between OA and WSOA measured by SV-AMS for different primary emissions. The shaded areas indicate the range of elemental ratios that were determined from previous AMS studies in Beijing (Sun et al., 2016;Xu et al., 2017;Xu et al., 2019).
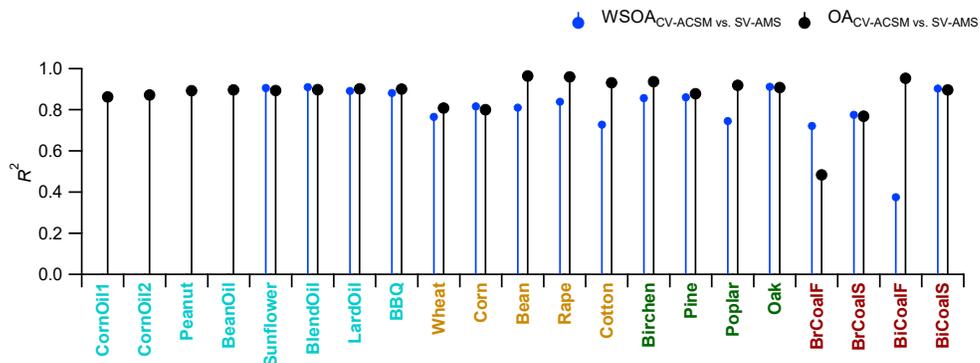
Figure S6. The correlation coefficients between OA and WSOA measured by CV-ACSM and SV-AMS.
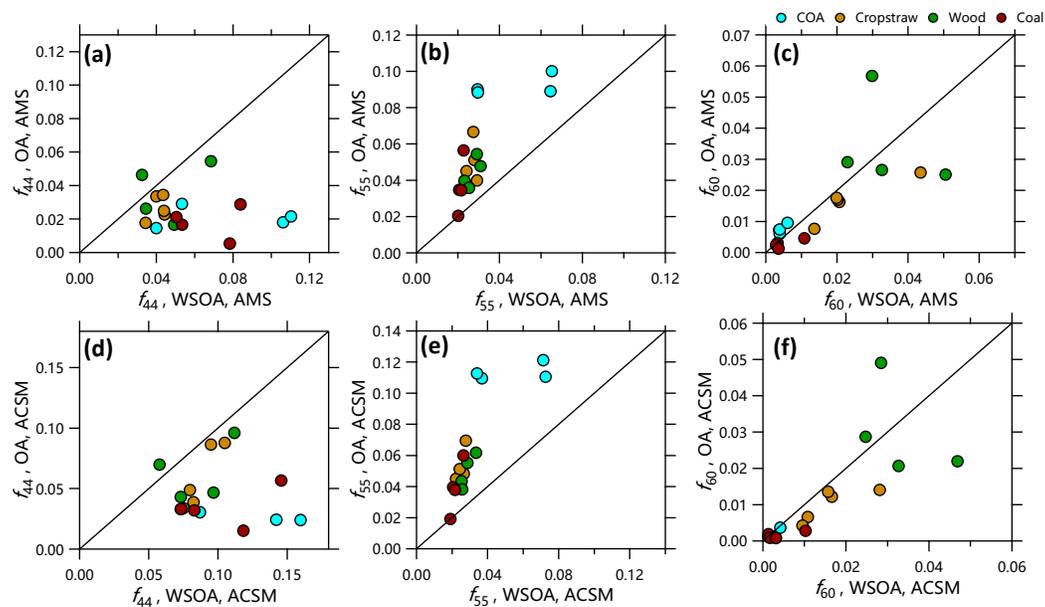
Figure S7. Relationship between OA and WSOA of f_{44}, f_{55} and f_{60} measured by SV-AMS and CV-ACSM.
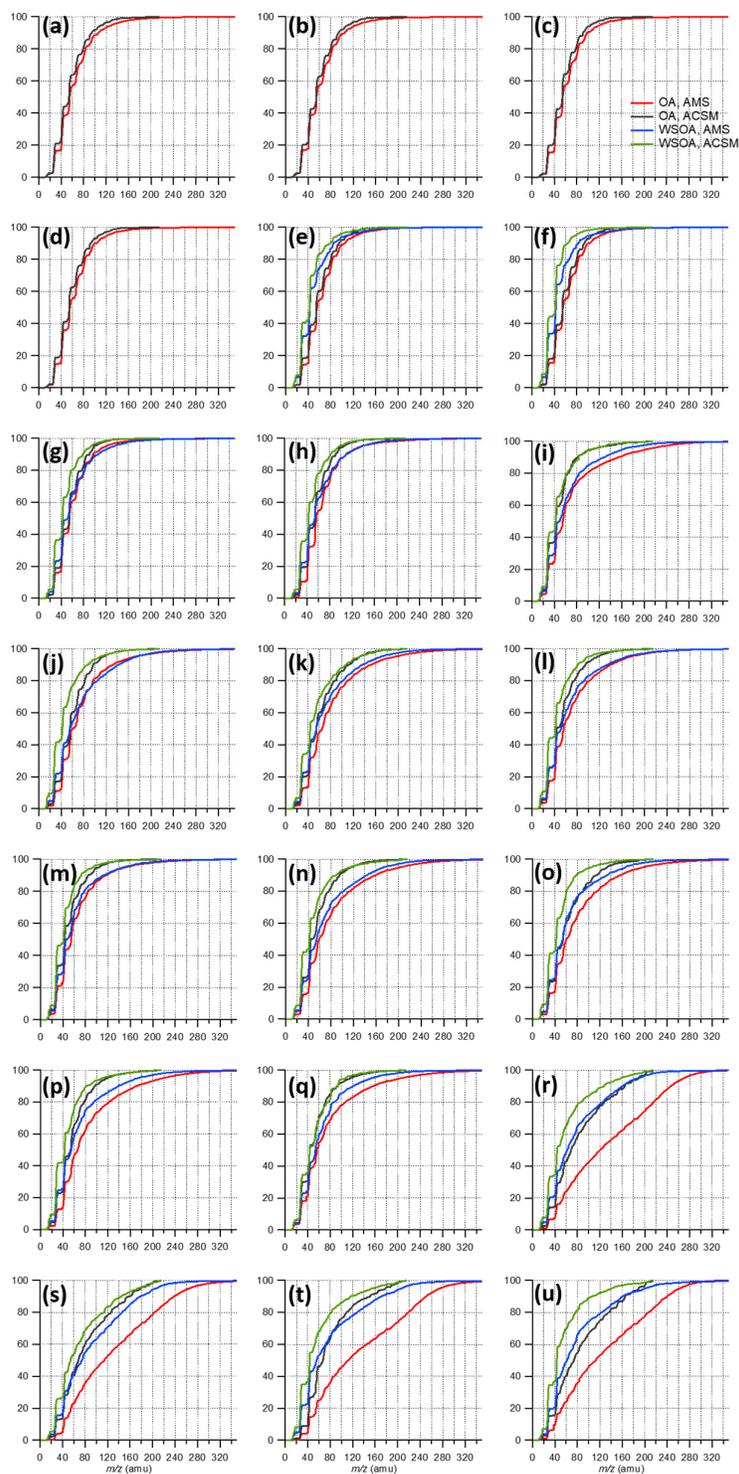
Figure S8. Cumulative mass fraction of mass spectral profiles of OA from (a) stir-fried garlic with corn oil, (b) stir-fried celery with corn oil, (c) peanut oil, (d) bean oil, (e) sunflower oil, (f) blend oil, (g) lard oil and (h) barbecue (i) wheat, (j) corn, (k) bean, (l) rape, (m) cotton, (n) birchen, (o) pine tree, (p) poplar, (q) Chinese oak, (r) flaming combustion of brown coal, (s) smoldering combustion of brown coal, (t) flaming combustion of bituminous coal and (u) smoldering combustion of bituminous coal.
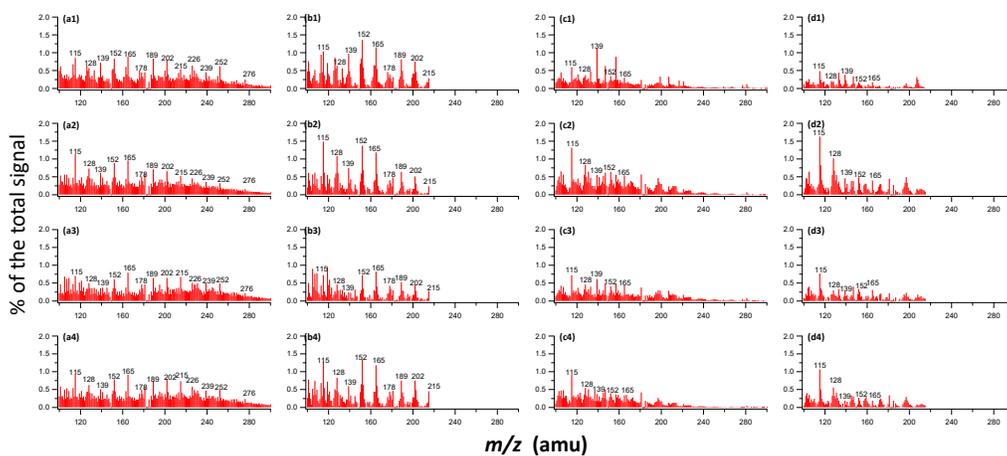
Figure S9. Unit mass resolution spectra (*m/z* 100–350) of OA measured by (a) SV-AMS, (b) CV-ACSM and WSOA measured by (c) SV-AMS and (d) CV-ACSM from (1) flaming combustion of brown coal, (2) smoldering combustion of brown coal, (3) flaming combustion of bituminous coal and (4) smoldering combustion of bituminous coal.

Table S1. A summary of elemental ratios and $f_{44}, f_{43}, f_{60}, f_{73}, f_{55}, f_{57}$ of OA and WSOA measured by SV-AMS and CV-ACSM.

| Fuels	O/C	H/C	f_{44}	f_{43}	f_{60}	f_{73}	f_{55}	f_{57}	f_{44}	f_{43}	f_{60}	f_{73}	f_{55}	f_{57}
			OA measure by SV-AMS						OA measured by CV-ACSM					
CornOil1	0.18	2.01	2.77	7.78	0.59	0.62	7.59	3.80	3.72	5.99	0.06	0.06	9.24	2.43
CornOil2	0.18	1.99	2.92	7.31	0.57	0.65	7.70	3.41	3.42	5.60	0.06	0.05	9.85	2.16
Peanut	0.17	2.00	2.18	7.65	0.78	0.88	9.00	3.86	3.02	6.03	0.09	0.07	11.13	2.41
BeanOil	0.15	1.97	2.35	6.84	0.57	0.59	9.00	3.54	2.89	5.56	0.09	0.07	11.36	2.17
Sunflower	0.16	1.96	1.80	6.96	0.72	0.77	9.00	3.32	2.42	5.28	0.13	0.09	10.96	2.04
BlendOil	0.17	1.98	2.16	7.01	0.60	0.73	8.84	3.49	2.40	5.57	0.10	0.08	11.28	2.18
LardOil	0.17	2.06	2.91	8.19	0.74	0.78	8.91	4.37	3.04	6.84	0.10	0.09	12.12	2.86
BBQ	0.15	2.06	1.46	9.49	0.95	1.07	10.01	5.70	3.30	8.04	0.37	0.37	11.05	3.96
Wheat	0.38	1.81	3.35	7.75	1.63	1.30	3.99	3.26	8.78	6.69	0.66	0.45	4.27	2.41
Corn	0.35	1.96	3.45	8.95	2.57	1.41	5.11	5.46	8.63	7.08	1.41	0.61	4.82	4.02
Bean	0.16	2.08	1.77	10.03	0.76	0.60	6.67	7.72	3.38	9.36	0.42	0.23	6.95	7.49
Rape	0.29	1.85	2.27	9.23	1.70	1.10	3.83	4.16	3.87	9.33	1.22	0.71	4.49	4.51
Cotton	0.27	1.87	2.49	8.47	1.76	1.12	4.50	3.91	4.89	8.00	1.36	0.70	5.13	3.79
Birchen	0.31	1.82	2.62	7.95	2.51	1.32	4.78	3.17	4.30	6.82	2.20	0.99	5.52	2.78
Pine	0.39	1.82	4.64	7.24	2.91	2.25	3.97	4.00	6.98	7.06	2.87	1.80	4.34	3.88
Poplar	0.23	1.88	1.66	8.34	2.65	1.53	5.44	4.78	4.66	8.40	2.06	0.94	6.18	4.69
Oak	0.51	1.77	5.46	6.45	5.68	2.22	3.58	4.23	9.60	5.54	4.91	1.78	3.82	3.79
BrCoalF	0.23	1.45	2.88	4.08	0.31	1.05	2.04	1.54	5.66	3.39	0.19	0.85	1.91	1.38
BrCoalS	0.18	1.53	1.66	6.20	0.24	0.32	3.47	2.40	3.19	5.94	0.09	0.27	3.96	2.89
BiCoalF	0.08	1.86	0.53	9.15	0.12	0.23	5.65	6.31	1.51	9.47	0.08	0.13	6.00	7.22
BiCoalS	0.21	1.58	2.11	6.63	0.46	0.45	3.45	2.56	3.32	6.15	0.28	0.35	3.78	2.85
			WSOA measure by SV-AMS						WSOA measured by CV-ACSM					
Sunflower	0.43	1.97	10.62	6.90	0.38	0.42	2.94	1.47	14.22	7.85	0.13	0.07	3.68	1.79
BlendOil	0.45	1.98	11.03	7.29	0.39	0.44	2.96	1.56	15.97	8.63	0.19	0.10	3.40	1.79
LardOil	0.33	1.85	5.34	8.60	0.39	0.44	6.46	2.58	8.70	8.77	0.26	0.25	7.13	1.87
BBQ	0.33	1.84	3.99	8.37	0.61	0.76	6.53	2.80	7.32	8.50	0.42	0.42	7.27	1.96
Wheat	0.45	1.74	3.99	6.87	2.07	1.64	2.92	2.77	10.49	5.55	1.08	0.99	2.52	1.39
Corn	0.54	1.79	4.35	7.51	4.35	2.22	2.79	3.45	9.49	5.92	2.81	1.39	2.66	1.90
Bean	0.39	1.74	3.44	7.23	1.37	1.52	2.74	2.03	7.50	6.45	0.95	1.01	2.78	1.33
Rape	0.43	1.77	4.43	6.87	2.02	1.19	2.37	2.04	8.23	5.86	1.66	1.29	2.22	1.36
Cotton	0.40	1.71	4.39	5.90	1.99	1.03	2.42	1.97	7.97	5.58	1.57	1.31	2.44	1.52
Birchen	0.54	1.78	3.46	8.67	5.05	2.44	3.09	3.58	7.31	6.96	4.69	1.89	2.86	2.68
Pine	0.36	1.69	3.26	4.75	2.29	1.08	2.31	1.93	5.78	4.49	2.48	1.27	2.54	1.56
Poplar	0.47	1.70	4.93	6.28	3.26	1.52	2.91	2.58	9.68	5.29	3.27	1.86	3.35	2.04
Oak	0.53	1.70	6.85	5.58	2.99	1.36	2.53	2.31	11.19	4.66	2.84	1.60	2.56	1.67
BrCoalF	0.41	1.58	8.39	4.59	0.33	0.11	2.01	1.02	14.58	3.22	0.13	1.93	1.91	0.78
BrCoalS	0.27	1.49	5.35	4.62	0.29	0.12	2.06	0.86	8.30	3.80	0.16	1.23	2.06	0.64
BiCoalF	0.41	1.65	7.83	5.89	0.36	0.17	2.27	1.11	11.84	4.38	0.31	1.40	2.64	0.84
BiCoalS	0.41	1.57	5.04	6.05	1.09	0.79	2.16	1.47	7.34	5.54	1.03	1.20	2.17	1.24

Note: CornOil1= stir-fried garlic with corn oil; CornOil2= stir-fried celery with corn oil; Peanut= stir-fried celery with peanut oil; Sunflower= stir-fried celery with sunflower oil; BeanOil= stir-fried celery with bean oil; BlendOil= stir-fried celery with blend oil; LardOil= stir-fried celery with lard oil; BBQ= barbecue; Wheat= dry wheat stalk burning; Corn= dry corn stalk burning; Bean= dry bean stalk burning; Rape= dry rape stalk burning; Cotton= dry cotton stalk burning; Birchen= dry birchen burning; Pine= dry pine tree burning; Poplar= dry poplar burning; Oak= dry Chinese oak burning; BrCoalF= brown coal combustion under flaming conditions; BrCoalS= brown coal combustion under smoldering conditions; BiCoalF= bituminous coal combustion under flaming conditions; BiCoalS= bituminous coal combustion under smoldering conditions.

References

Sun, Y., Du, W., Fu, P., Wang, Q., Li, J., Ge, X., Zhang, Q., Zhu, C., Ren, L., Xu, W., Zhao, J., Han, T., Worsnop, D. R., and Wang, Z.: Primary and secondary aerosols in Beijing in winter: sources, variations and processes, Atmos. Chem. Phys., 16, 8309-8329, 10.5194/acp-16-8309-2016, 2016.

Xu, W., Han, T., Du, W., Wang, Q., Chen, C., Zhao, J., Zhang, Y., Li, J., Fu, P., Wang, Z., Worsnop, D. R., and Sun, Y.: Effects of Aqueous-Phase and Photochemical Processing on Secondary Organic Aerosol Formation and Evolution in Beijing, China, Environ. Sci. Technol., 51, 762-770, 10.1021/acs.est.6b04498, 2017.

Xu, W., Sun, Y., Wang, Q., Zhao, J., Wang, J., Ge, X., Xie, C., Zhou, W., Du, W., Li, J., Fu, P., Wang, Z., Worsnop, D. R., and Coe, H.: Changes in Aerosol Chemistry From 2014 to 2016 in Winter in Beijing: Insights From High-Resolution Aerosol Mass Spectrometry, Journal of Geophysical Research: Atmospheres, 124, 1132-1147, doi:10.1029/2018JD029245, 2019.