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Characteristics and degradation of organic aerosols from cooking sources based on hourly observations of organic molecular markers in urban environments

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CONTENTS

Section S1. Source analysis using PMF.

Table S2 lists the input data ($PM_{2.5}$ and its components) in the PMF modeling. The preferential input species for PMF are those with high abundance and source specific (Norris et al., 2014). Generally, organic markers with lower volatility and lower reactivity were selected. Figure S5 shows the individual source profiles of the 10 factors resolved in the PMF (a) and time series of individual factor contributions (b). Figure S6 shows the diurnal variation in individual source factors resolved by PMF. Table S3 shows the summary of error estimation diagnostics from bootstrap (BS), displacement (DISP), and bootstrap combined with displacement (BS–DISP) for the PMF base run. Generally, BS and DISP results indicated robust PMF solutions. However, BS–DISP results showed higher uncertainties which may be due to the limited sample size in the study. It should be noted that secondary nitrate and secondary sulfate showed the lowest BS mappings and a high chance of mixing with the vehicle exhaust, industry emission and coal combustion factors. Here, we only briefly present the identification of each source factor.

A total of 10 factors are identified. Among them, seven are primary sources, they are industrial emission, biomass burning, vehicle exhaust, coal combustion, dust, cooking and fire working. Three secondary sources, namely, secondary nitrate, secondary sulfate and SOA factor (Li et al., 2020; Wang et al., 2017).

Secondary nitrate factor is identified by high contributions of nitrate and ammonium. The secondary sulfate factor is characterized by high loadings of sulfate and ammonium. The SOA factor is characterized by high loadings of an anthropogenic SOA tracer (phthalic acid), isoprene SOA tracer (2-methylglyceric acid) and α-pinene SOA tracers (3-hydroxyglutaric acid, pinic acid and cis-pinonic acid) (Wang et al., 2017). The profile of industrial emission contains high loadings of Cr, Zn, Fe and Mn (Men et al., 2019; Pant and Harrison, 2013). Industry activities related to steel production, plating, and metallurgy often emit a large amount of these metallic elements. Biomass burning is identified by high loadings of levoglucosan and mannosan (Feng et al., 2013; Wang et al., 2019). The seventh factor contains a high abundance of n-alkanes and hopanes, and is identified to be vehicle exhaust (Pant and Harrison, 2013; Wang et al., 2017). Coal combustion is identified by high loadings of Se, As and Pb (Chen et al., 2013; Wang et al., 2017), and the dust factor is distinguished by crustal elements (ions) Ca, Si, and Ti. The cooking factor is distinguished by fatty acids (oleic acid, palmitic acid and stearic acid) (Li et al., 2020). The fire working factor is identified by high loadings of flammable metals such as Mg, Cu and Ba, etc.

Figure S1. Time series of $PM_{2.5}$ and its components and organic molecular tracers.

PAHs, polycyclic aromatic hydrocarbons; DCAs, dicarboxylic acids; FAs, fatty acids; ARAs, aromatic acids; SOA-T, secondary organic aerosol tracers; crustal=2.20×[Al]+2.49×[Si]+1.63×[Ca]+2.42×[Fe]+1.94×[Ti] (Huang et al., 2014).

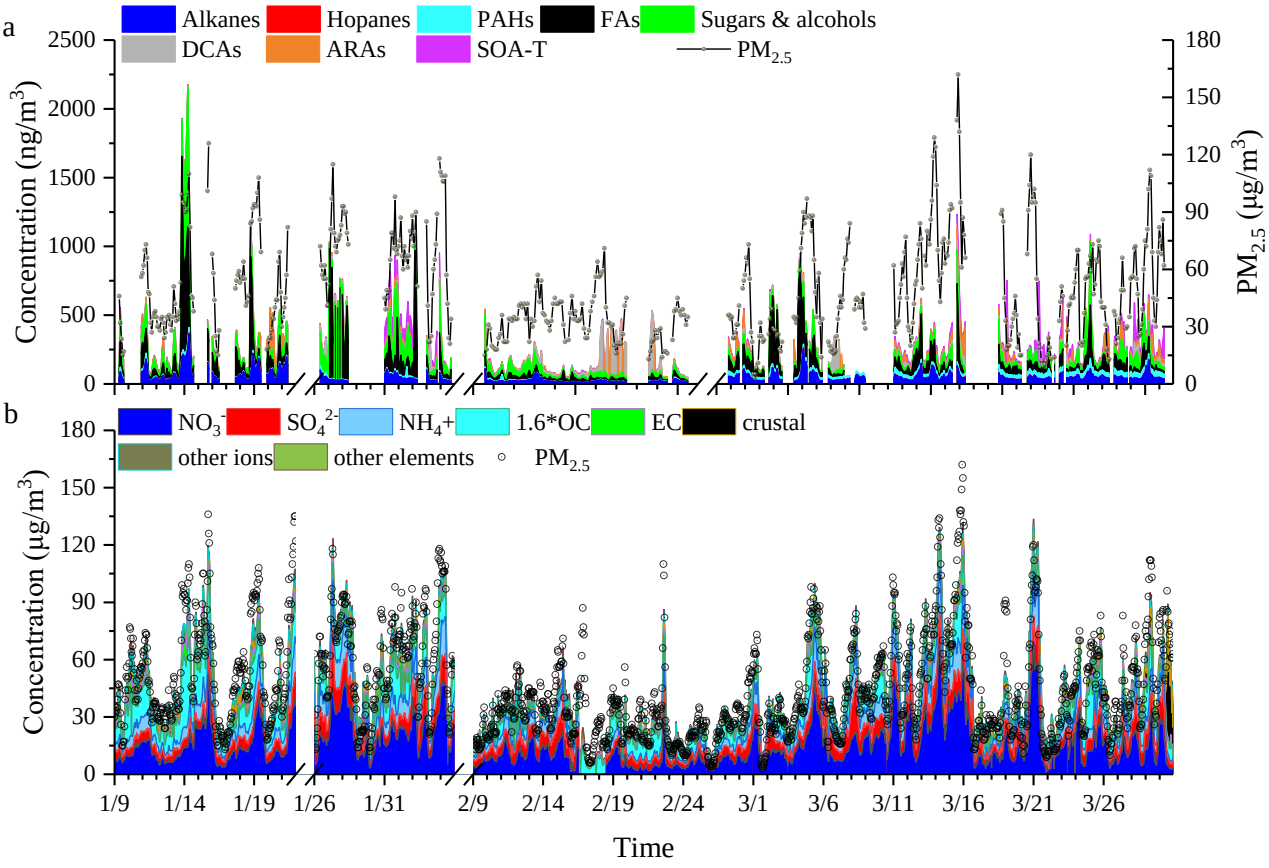

Figure S2. The variation of the total spatial variance.

We choose the most appropriate clustering case based on the change in total spatial variance (TSV). The point raised down by TSV were selected as the optimal number of clusters, and the optimal solution of four clusters was finally extracted in this study (He et al., 2020).

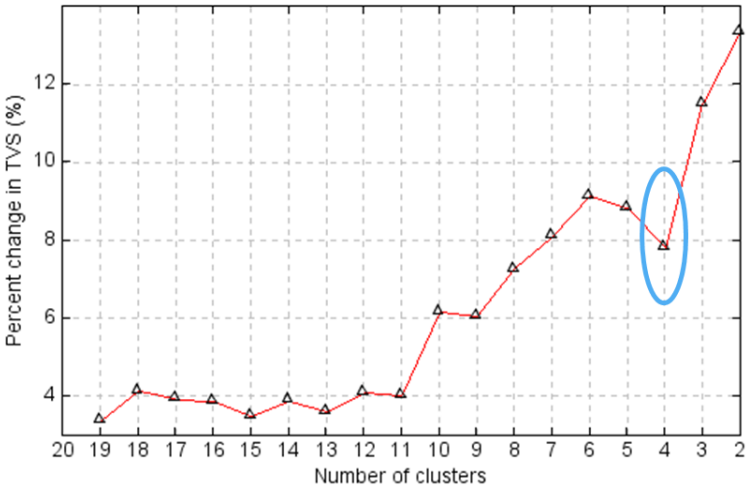

Figure S3. Day-to-day fitting of oleic acid normalized by palmitic acid.

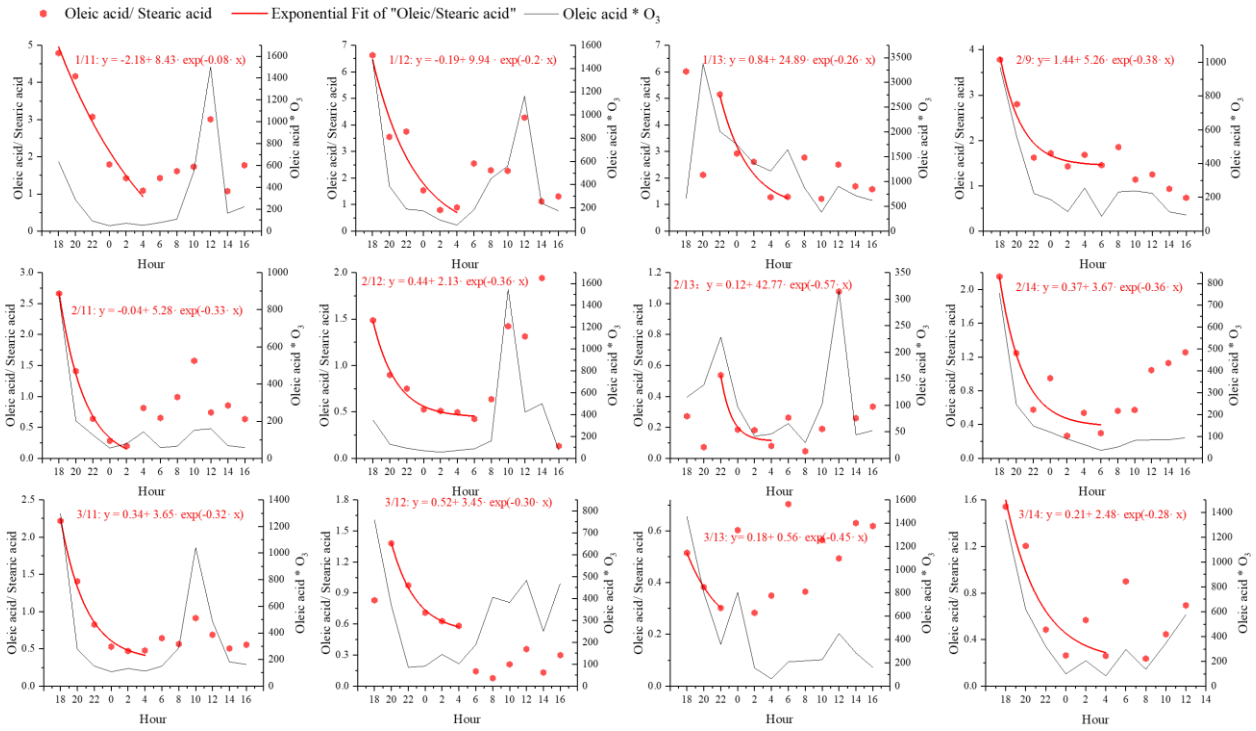

Figure S4. Day-to-day fitting of linoleic acid normalized by palmitic acid.

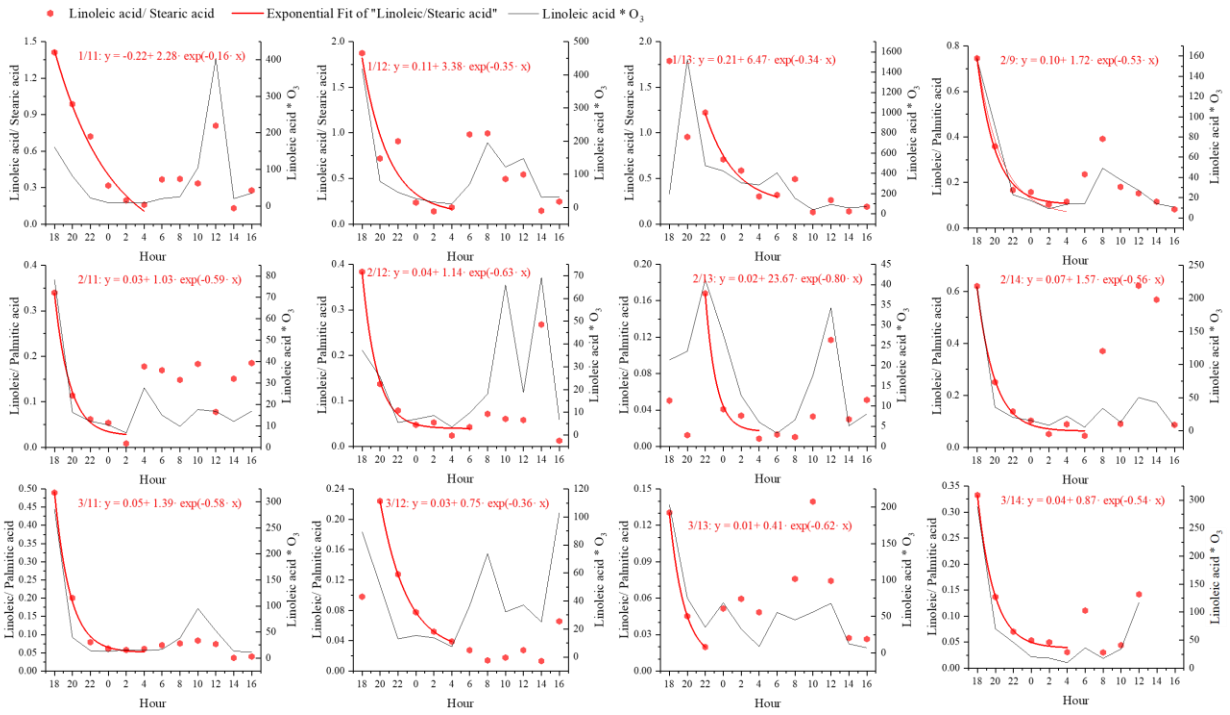

Figure S5. Individual source profiles of the 10 factors resolved in the PMF (a) and time series of individual factor contributions (b).

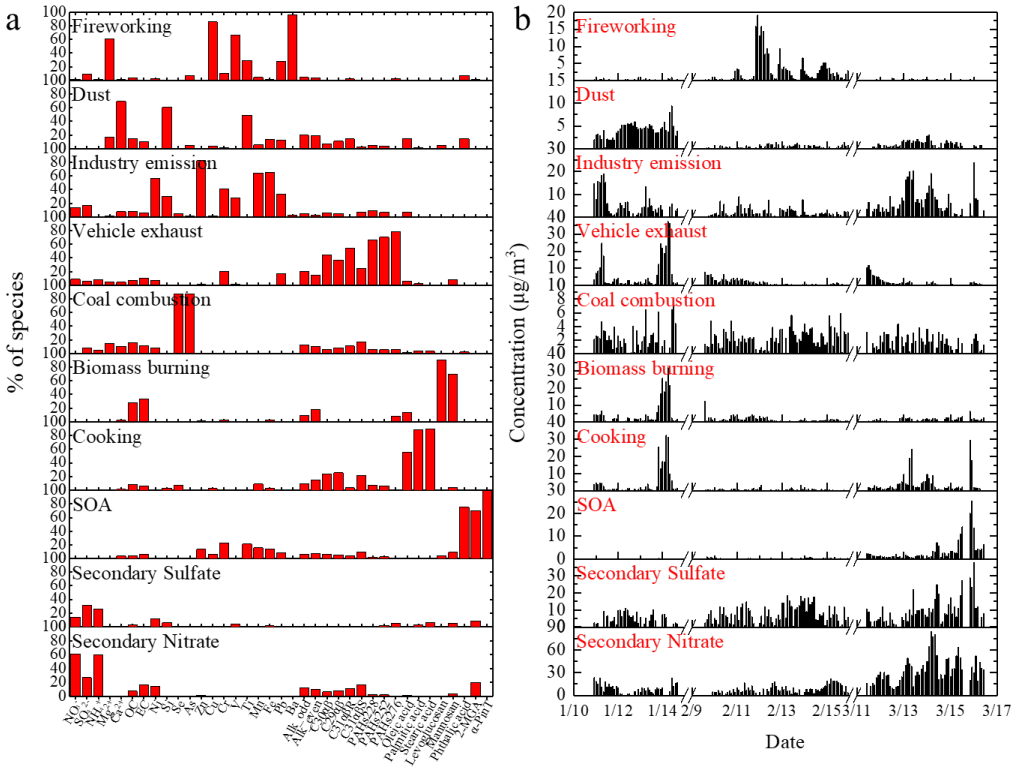

Figure S6. Diurnal variation in individual source factors resolved by PMF.

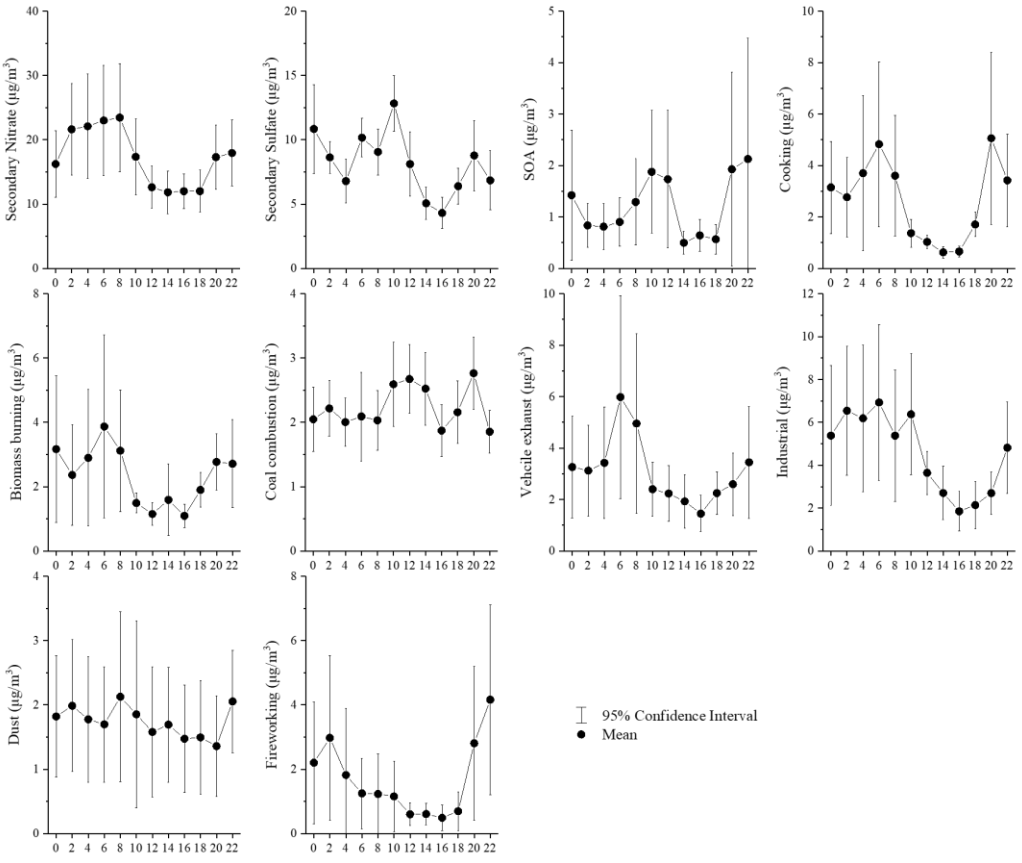

Table S1. Contribution of TFAs to total OC (ng/μg) from different sources.

Sources	Min	Max	Avg	Std	References
Biomass Burning	6.6	25.8	14.5	5.8	(Hays et al., 2002; Schauer et al., 2001; Zhang et al., 2007)
Coal Combustion	3.9	29.9	11.6	9.9	(Zhang et al., 2008)
Vehicle Exhaust	0.32	6.2	2.6	2.1	(Cai et al., 2017)
Cooking	27.7	82.2	55.9	21.4	(Pei et al., 2016; Zhao et al., 2015; Zhao et al., 2007)

Table S2. $PM_{2.5}$ and its components included in the PMF analysis (O_3 and NO_2 are not in PMF input).

naming	grouping	unit	concentration
Alk_odd	*n*-C_{25}, *n*-C_{27}, *n*-C_{29}, *n*-C_{31} and *n*-C_{33}	ng/m^3	14.58
Alk_even	*n*-C_{24}, *n*-C_{26}, *n*-C_{28}, *n*-C_{30} and *n*-C_{32}	ng/m^3	18.19
C30αβ	17*α*(H)21*β*(H)-hopane	ng/m^3	0.27
C29αβ	17*α*(H)21*β*(H)-30-norhopane	ng/m^3	0.20
C31αβR	17*α*(H)21*β*(H)-(22*R*)-homohopane	ng/m^3	0.10
C31αβS	17*α*(H)21*β*(H)-(22*S*)-homohopane	ng/m^3	0.23
PAHs228	Benzo[a]anthracene, Chrysene	ng/m^3	0.93
PAHs252	Benzo[b+k]fluoranthene, Benzo[a]pyrene	ng/m^3	1.32
PAHs276	Benzo[g,h,i]perylene, Indeno[1,2,3-cd]pyrene	ng/m^3	1.97
Oleic acid	Oleic acid	ng/m^3	32.15
Palmitic acid	Palmitic acid	ng/m^3	38.77
Stearic acid	Stearic acid	ng/m^3	26.51
Levoglucosan	Levoglucosan	ng/m^3	63.03
Mannosan	Mannosan	ng/m^3	3.82
Phthalic acid	Phthalic acid	ng/m^3	14.72
2-MGA	2-Methylglyceric acid	ng/m^3	2.06
α-PinT	3-Hydroxyglutaric acid, Pinic acid, Cis-pinonic acid	ng/m^3	10.26
NO_3^-		μg/m^3	17.28
SO_4^{2-}		μg/m^3	7.53
NH_4^+		μg/m^3	7.41
Other ions	Mg^{2+}, Ca^{2+}	μg/m^3	0.52
OC		μg/m^3	6.73
EC		μg/m^3	2.20
Crustal elements	Si, Ti, Fe	μg/m^3	0.48
Other elements	Ni, Se, As, Zn, Cu, Cr, V, Mn, Pb, Ba	μg/m^3	1.34
$PM_{2.5}$		μg/m^3	50.07
O_3		μg/m^3	51.53
NO_2		μg/m^3	42.85

Table S3. Summary of error estimation diagnostics from BS, DISP and BS-DISP for PMF.

BS Mapping (R≥0.6)		Secondary Nitrate	Secondary Sulfate	SOA	Cooking	Biomass burning	Coal combustion	Vehicle exhaust	Industry emission	Dust	Fireworking	Unmapped
SN		84	0	0	0	0	0	6	4	5	0	1
SS		0	83	0	0	0	7	0	6	0	0	4
SOA		0	0	98	1	0	0	0	0	0	0	1
Cooking		0	0	0	100	0	0	0	0	0	0	0
BB		0	0	0	0	99	0	0	1	0	0	0
CC		0	0	0	0	0	92	0	4	0	0	4
VE		0	0	0	0	0	0	96	2	0	0	2
In		0	0	0	0	0	0	0	100	0	0	0
Dust		0	0	0	0	0	0	0	0	100	0	0
Fire		0	0	0	0	0	0	0	0	0	100	0
DISP Diagnostics		Error Code: 0				Largest Decrease in Q: 0 (0%)						
Factor Swaps	dQ^{max}=4	0	0	0	0	0	0	0	0	0	0	
	dQ^{max}=8	0	0	0	0	0	0	0	0	0	0	
	dQ^{max}=15	0	0	0	0	0	0	0	0	0	0	
	dQ^{max}=25	0	0	0	0	0	0	0	0	0	0	
BS-DISP Diagnostics		# of runs accepted: 62 out of 101				Largest Decrease in Q: -20.938 (-0.43%)						
# of Decreases in Q: 8			# of Swaps in Best Fit: 21				# of Swaps in DISP: 10					
Factor Swaps	dQ^{max}=0.5	5	8	9	26	15	1	11	8	12	7	
	dQ^{max}=1	5	8	9	26	15	1	12	8	13	7	
	dQ^{max}=2	7	8	10	28	15	1	13	8	17	8	
	dQ^{max}=4	7	10	13	32	16	2	14	9	21	11	

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