

Response to comments of Referee 2.

Comments from referee are in blue and response from co-authors is in black.

Major comments.

Quantification of PON from biomass burning using a CToF-AMS: The m/z 46:30 ratio is used for the quantification of PON, which is based on a method done by Farmer et al 2010 that used an HR-AMS and did not include any biomass burning emissions. The large fraction of OA from biomass burning certainly will produce a large CH<sub>2</sub>O<sup>+</sup> contribution and will make the quantification of PON very different compared to the Farmer et al paper. On page 7 line 250 the authors say that the m/z 30 interference is likely small, but this might be very different in biomass burning and needs to be shown or given a reference. In addition it is written on page 6 line 206 that the interference of CH<sub>2</sub>O<sup>+</sup> is discussed in section 3.4.1, but no such section exists in the paper. So it is not clear, how the authors deal with the m/z 30 interference and how large the uncertainty or error estimate on the quantification of PON is. In addition in the later section, where the primary versus secondary PON is discussed, it is certainly possible that the m/z 30 interference is different as the composition changes during the later part of the night, when the authors claim that they observed secondary PON. A section needs to be added, where the interference is clearly explained and the effect needs to be quantified. This should result in an uncertainty range for the m/z 30:46 ratio and error estimate for PON. All of this should be added to the instrumentation section, where there needs to be a description of the AMS added as well that includes a discussion on the calibration for NH<sub>4</sub>NO<sub>3</sub> and, if available, for PON compounds. Here it should be made clear what m/z 30:46 ratio NH<sub>4</sub>NO<sub>3</sub> has in this particular instrument? The resulting error estimate needs to be taken into account for the following discussions.

Section 2.2.2 in methods has been edited as follows:

#### 2.2.2 Particulate Organic Oxides of Nitrogen (PON)

Concentrations of PON were calculated following the method proposed by Farmer et al. (2010) and the considerations used by Kiendler-Scharr et al. (2016). This method has been previously used in studies looking at aerosols from biomass burning (Tiitta et al., 2016;Zhu et al., 2016;Florou et al., 2017). Equation 5 calculates the PON fraction ( $X_{\text{PON}}$ ), using the signals at m/z 30 and m/z 46 to calculate m/z ratios 46:30 from AMS measurements ( $R_{\text{meas}}$ ), from ammonium nitrate calibrations ( $R_{\text{cal}}$ ), and from organic nitrogen ( $R_{\text{ON}}$ ) to quantify PON concentrations.

$$X_{\text{PON}} = \frac{(R_{\text{meas}} - R_{\text{cal}})(1 + R_{\text{ON}})}{(R_{\text{ON}} - R_{\text{cal}})(1 + R_{\text{meas}})} \quad (5)$$

Where ratios from ammonium nitrate calibrations  $R_{\text{cal}} = 0.5$ ;  $R_{\text{meas}} =$  m/z 46:30 ratio from measurements; m/z 46:30 ratio from ON  $R_{\text{ON}} = 0.1$ . Following Kostenidou et al. (2015) consideration,  $R_{\text{ON}} = 0.1$  was calculated as the minimum m/z 46:30 ratio observed.  $R_{\text{ON}}$  value of 0.1 has been used in previous studies (Kiendler-Scharr et al., 2016;Tiitta et al., 2016).

$$\text{PON} = X_{\text{PON}} * \text{NO}_3^- \quad (6)$$

Finally, equation 6 calculates PON concentrations [ $\mu\text{g}\cdot\text{m}^{-3}$ ] where  $\text{NO}_3^-$  is the total nitrate measured by the cToF-AMS. The method proposed by Farmer et al. (2010) is based on HR-ToF-AMS measurements where m/z 30 represents  $\text{NO}^+$  ion and m/z 46  $\text{NO}_2^+$  ion while the cToF-AMS gives unit mass resolution mass spectra information, hence, there is the possibility to have interference of  $\text{CH}_2\text{O}^+$  ion at m/z 30. However, when analysing mass spectra from previous laboratory and ambient studies using HR-ToF-AMS to investigate biomass burning emissions, we can confirm that the signal of  $\text{CH}_2\text{O}^+$  at m/z 30 is low compared to signals at m/z's 29 and 31, while in this study m/z 30 is the main signal (Fig. 5.c). Hence, in this study an interference of  $\text{CH}_2\text{O}^+$  at m/z 30 is unlikely and if there were any interference of  $\text{CH}_2\text{O}^+$  it would be negligible. Table S1 in

supplement shows m/z 30/29 and 30/31 from previous laboratory and ambient studies investigating biomass burning emissions.

Another possible interference would be the presence of mineral nitrates at m/z 30 (e.g. KNO<sub>3</sub> and NaNO<sub>3</sub>). However, mineral nitrate salts tend to be large particles (Allan et al., 2006;Chakraborty et al., 2016) and also have low vaporisation efficiency (Drewnick et al., 2015), which makes it unlikely to be measured by the AMS in large quantities.

Table S1. CH<sub>2</sub>O<sup>+</sup> signals at m/z 29, 30 and 31 from HR-ToF-AMS data of previous studies. Comparison of m/z ratios 30/29 and 30/31 with values found in this study.

	Reference	30/29	30/31	m/z 29	m/z 30	m/z 31	Notes
ambient	This study	4.38	35.00	0.08	0.35	0.01	sPON_ME2
		1.42	8.50	0.06	0.09	0.01	pPON_ME2
	(Aiken et al., 2010)	0.16	0.32	0.05	0.008	0.025	pine burn
		0.20	0.45	0.045	0.009	0.02	BBOA Mex
	(Collier et al., 2016)	0.25	0.56	4	1	1.8	Ground plume
		0.20	0.60	3	0.6	1	Ground plume
		0.23	0.67	3.5	0.8	1.2	aircraft plume
		0.25	1.25	4	1	0.8	aircraft plume
	(Zhou et al., 2017)	0.18	0.88	8	1.4	1.6	no bb
		0.32	0.95	6	1.9	2	bb inf
0.30		0.90	6	1.8	2	bb plm	
Laboratory-based	(He et al., 2010)	0.25	0.75	0.06	0.015	0.02	Fir (diluted/cooled)
		0.21	0.68	0.07	0.015	0.022	pine burn
		0.20	0.56	0.05	0.01	0.018	Willow
		0.30	0.90	0.06	0.018	0.02	Wattle
		0.30	0.90	0.06	0.018	0.02	SugaCaneLeave
		0.30	0.08	0.05	0.015	0.2	Rice Straw
	(Heringa et al., 2011)	0.25	0.67	4	1	1.5	poa
		0.25	0.50	4	1	2	5h aging
	(Ortega et al., 2013)	0.15	0.50	13	2	4	start (oak)
		0.20	0.50	50	10	20	aged (oak)
		0.04	0.05	250	10	220	start (pine)
		0.07	0.10	270	20	200	aged (pine)
	(Corbin et al., 2015b)	0.20	0.80	4	0.8	1	start
			0.83		0.05	0.06	flaming
	(Corbin et al., 2015a)		0.50		0.01	0.02	Filtered and Oxid
			0.50		0.01	0.02	Oxidized
		0.25	0.50	0.04	0.01	0.02	Primary
	(Bruns et al., 2015)	0.43	6.00	0.07	0.03	0.005	OH and UV exp.
		0.34	1.00	0.065	0.022	0.022	OH and UV exp.
		0.40	1.00	0.045	0.018	0.018	OH and UV exp.
0.34		1.00	0.065	0.022	0.022	OH and UV exp.	
0.40		1.00	0.045	0.018	0.018	OH and UV exp.	
0.23		1.00	0.048	0.011	0.011	OH and UV exp.	
0.20		1.00	0.04	0.008	0.008	OH and UV exp.	
0.25		1.00	0.048	0.012	0.012	OH and UV exp.	

These paragraphs have been added to describe Table S1 in the supplement.

Table S1 shows CH<sub>2</sub>O<sup>+</sup> signals at m/z's 29, 30, and 31 from HR-ToF-AMS studies. It is possible to observe the low CH<sub>2</sub>O<sup>+</sup> contribution to m/z 30 with 30/29 ratios between 0.01-0.40. The high values of 0.4 – 6 were observed when exposing aerosols to OH and UV. We can also see that 30/31 30/29 ratios do not show variations during and after biomass burning events or during fresh and aged emissions (Ortega et al., 2013;Corbin et al., 2015a;Corbin et al., 2015b), suggesting there is not substantial CH<sub>2</sub>O<sup>+</sup> variability over the biomass burning process.

In this study, a large contribution of m/z 30 signal to the mass spectra was observed with both sPON and pPON with 30/29 ratios (4.38 and 1.42 respectively) and 30/31 ratios (35.0 and 8.5 respectively) higher than unity. Showing that a CH<sub>2</sub>O<sup>+</sup> interference at m/z30 would be unlikely.

For biomass burning the fragmentation tables need to be modified, which the authors do later in the paper. It does not make sense to me to run PMF on not-corrected data as was done in Section 3.3, when you know you are using incorrect data.

We agree on showing both solutions in the main manuscript is confusing. The PMF solution without modifying the fragmentation table has been moved to the appendix. Part of this paper is to explore different ways to run ME-2 and evaluate its performance under different conditions, hence we consider important to show this solution on the appendix.

The section on the FragPanel modification is very specific to AMS users and all the three bullet points cannot be understood by anybody else without explaining all the abbreviations and acronyms. Especially sentences like on page 7 line 238: time series of PON:mz30 were calculated with the equation  $\text{PON:mz30} = \text{PON}/\text{mz30}$ , where  $\text{PON} = \text{m/z } 46:30$ . This makes mathematically no sense. Again all of this need to be included in the instrument section together with the quantification of PON and clearly will increase the already large uncertainty in the PON quantification during the biomass burning event.

The following paragraphs have been added to the end of section 2.2.3 Multilinear engine 2 (ME-2):

PON may exhibit covariance with other types of OA, thus their inclusion in the source apportionment analysis may give a more complete factorisation and highlight their co-emission with other OA types. Therefore, a different experiment was designed by modifying the fragmentation table, through the AMS analysis toolkit 1.56, in order to identify a PON source. The fragmentation table contains the different chemical species measured by the AMS, with each row representing m/z for specific species and where the user can define peaks that exist in each species' partial mass spectrum and their dependency on other peaks (Allan et al., 2004). The following steps were performed to modify the fragmentation table:

- Time series of a new ratio named RON\_30 is calculated by  $\text{RON}_{30} = \text{PON}/\text{mz30}$ , where PON is the time series calculated in section 2.2.2 and mz30 is the time series of the signal at m/z=30 measured by the AMS.
- Using the AMS analysis toolkit; the fragmentation table is modified, in the column frag\_Organic at the m/z 30, by multiplying  $\text{RON}_{30} * 30$ . See figure S4 in supplement for a screenshot of the fragmentation table.
- PMF inputs are generated to be used in SoFi software.

Figure S4 has been added to the supplement to show how fragmentation table has been modified.

mz	frag_air	frag_CO2	frag_O16	frag_water	frag_RH	frag_organic	frag_PAH	frag
15	0.00368*frag_air					15,-frag_NH4[15]		frag
16	frag_O16[16],frag		0.39*frag_air[14]	0.04*frag_water	0.04*frag_RH[18]	0.04*frag_organic		
17	0.000391*frag_O			0.25*frag_water	0.25*frag_RH[18]	0.25*frag_organic		
18	0.002*frag_O16			18,-frag_air[18]-f	0.01*frag_air[28]	0.225*frag_organic		
19	frag_RH[19]			0.000691*frag_w	0.000691*frag_R	0.000691*frag_organic		
20	20,-frag_organic			0.002*frag_water	0.002*frag_RH[11]	0.002*frag_organic		
21								
22								
23								
24						24,-frag_sulphate		
25							25	
26							26	
27							27	frag
28	28					frag_organic[44]		
29	0.0064*frag_air[2]					29,-frag_air[29]		frag
30	0.0000136*frag_					RON_30*30		
31						31,-frag_nitrate[3]		
32	32,-frag_sulphate							
33	0.000763*frag_ai							
34	0.00402*frag_air							
35								
36	0.00338*frag_air							
37						37,-frag_chloride		

Figure S4: Modifying fragmentation table to add PON to PMF analysis.

The description of PMF and the ability of PMF to resolve the biomass burning event:

In my opinion, PMF is pushed way too far in this manuscript given the quality of the data. It is well known that PMF has difficulties to resolve large individual peaks and this becomes very clear in this paper as well.

As mentioned to Referee 1, we agree that, during bonfire night, LV-OOA, COA and HOA may be mixed with BBOA concentrations. We mentioned in section 4.1 that this would be the case. Conclusions will be modified mentioning that even when using the methodology of first analysing the period before and after bonfire night and then analyse the bonfire night period, it was not possible to completely separate the OA sources. However, we consider that, while BBOA concentrations would be mixed with other OA sources implying a decrease on BBOA concentrations, the actual BBOA trend remains and BBOA factor is considered to be representative of biomass burning OA emissions. This is supported by the good correlation BBOA shows with  $b_{abs\_470wb}$   $r^2=0.880$ , a marker of emissions from biomass burning. Thus we consider BBOA time series to be accurate enough to determine primary and secondary PON concentrations.

The following paragraph has been added to the end of section 4.1 OA source apportionment:

Here is shown the importance of performing OA source apportionment using different approaches in order to identify the best way to deconvolve OA sources. PMF and ME-2 source apportionment tools could not completely deconvolve OA sources during the bfo event. However, due to the high correlation between for  $b_{abs\_470wb}$  and BBOA\_2 ( $r^2 = 0.880$ ) we consider that while BBOA\_2 might not represent the total OA concentrations from the bonfire night event, it does represent the trend of OA emitted from the biomass burning.

First of all this paper is clearly tailored to the AMS community, but it should at least be somewhat understandable to anybody else, especially when some of the main findings are related to the absorption of PON. None of the factors that are used such as HOA, COA or LVOOA are explained anywhere or even a reference given. What are those factors, how are they characterized, how do they relate to any of the other measured tracers and how do the ones determined in this manuscript compare to the AMS data base?

We have added a more understandable description of the OA sources with their respective references, The following paragraph has been edited in the section 3.3 OA source apportionment:

Two steps were involved in Test2\_ON: in step a, PMF/ME-2 were run for the event before and after the bonfire night (named as not bonfire event, nbf). In Step b, mass spectra from the solution identified in step a were used as TP, to analyse the bonfire-only (bfo) event. Finally, both solutions (nbf and bfo) were merged for further analysis. Different OA sources were identified in Test2\_ON (Fig. 5), five sources were identified during nb event: biomass burning OA (BBOA), hydrocarbon-like OA (HOA), cooking OA (COA), secondary particulate organic oxides of nitrogen (sPON\_ME2) and low volatility OA (LVOOA). These sources are identified by characteristic peaks at their mass spectrum; BBOA, which is generated during the combustion of biomass, has a peak at m/z 60, related to levoglucosan (Alfarra et al., 2007); HOA, related to traffic emissions, presents high signals at m/z 55 and m/z 57 typical of aliphatic hydrocarbons (Canagaratna et al., 2004); COA, emitted from food cooking activities, is similar to HOA with a higher m/z 55 and lower m/z 57 (Allan et al., 2010; Slowik et al., 2010; Mohr et al., 2012); LVOOA, identified as a secondary organic aerosol, has a high signal at m/z 44 dominated by the CO<sub>2</sub><sup>+</sup> ion (Ng et al., 2010); sPON\_ME2 has a strong signal at m/z 30 and it has been identified to be secondary as it follows the same trend as LVOOA (Figure 5.a). In the case of the bfo event six different sources were identified: BBOA, HOA, COA, LVOOA and two factors with peaks at m/z30, which is related to PON (Sun et al., 2012). These two PON factors may have different sources; one may be secondary (sPON\_ME2) and the other primary (pPON\_ME2) which has similar trend as BBOA (Fig. 5.b). Further details about pPON\_ME2 and sPON\_ME2 nature will be explored in section 4.2.

The next issue is that PMF was done in many different ways in this manuscript, many tests were performed and a lot of these tests were subsequently discarded. So why do you describe all the tests that have not worked. As it is written, this is very confusing and really hard to follow. Furthermore, two different PMF tests were actually used in the manuscript and they are very clearly different and the results that fit the story the best were used for no apparent reason. Even the number of BBOA factors changes between the two tests.

One of the objectives of this paper is to explore different ways to perform source apportionment, hence we consider important to mention the different tests perform. However, we agreed that mentioning both solutions in the main text is confusing. Hence, we have modified the manuscript by only explaining in the main text the optimal solution (Test2\_ON) and moving the other solution to the appendix.

It is very clear that PMF, even in the way as done here with separating the biomass burning event from the rest of the time series, cannot resolve the single event. In Figure 6 the combined increase of LVOOA, COA, and HOA is about twice as large as the combined BBOA\_2, sPON\_ME and pPON\_ME signals. One might argue that during bonfire night activities such as cooking and traffic might increased as well, but certainly not to such large extents. Especially the LVOOA signal, which is larger than the BBOOA signal, has to be from biomass burning as well. So it seems that the interferences in the biomass burning event are larger than the BBOA signal itself.

Given this large uncertainty and interferences on the PMF results, it seems clearly a step too far to try to separate sPON from pPON with two different methods that have large uncertainties and are not even fully consistent with each other. The I-CIMS measures some primary and secondary ON tracers, some of which are specific to biomass burning such as nitroaromatics, why have those measurements not been used to correlate with the sPON signal? It is not clear from the text on page 9, what compounds from the I-CIMS have actually been used, except some of the inorganic tracers.

This is the correct table, which is in the supplement:

Table S4: R<sup>2</sup> values between OA factors and CIMS measurements.

Formula	Name	BBOA					COA				sPON				LVOOA				pPON
		ALL	HSC	LC	bfo	WL	ALL	LC	bfo	WL	ALL	LC	bfo	WL	ALL	LC	bfo	WL	bfo
C4H6O2	methacrylic acid	0.89			0.92	0.53	0.64		0.77	0.48					0.78		0.82		0.52
C3H4O2	Acid_Acrylic	0.85			0.90	0.65	0.62		0.70	0.43			0.48	0.79		0.88			
H2COH2O	methylhydroperoxide	0.78			0.90		0.54		0.69					0.66		0.85			
C6H6O	Phenol	0.89			0.89		0.59		0.73					0.75		0.73		0.57	
C7H6O2	Benzoic acid	0.89		0.57	0.89	0.86	0.65		0.83	0.45		0.71		0.73	0.67	0.72	0.64	0.58	0.57
C2H5NO	Methylformamide	0.88			0.89	0.47	0.61		0.79					0.65		0.67	0.56	0.65	
C2H3NO	Methyl isocyanate	0.89	0.49	0.44	0.89	0.71	0.55		0.66				0.50	0.85		0.88			
C5H10O2	Pentanoic acid	0.77			0.87		0.60		0.76					0.54		0.66			
HNO2	nitrous acid	0.81			0.86	0.66	0.59		0.84				0.57	0.61		0.66		0.70	
CH2O2	formic acid	0.52			0.86				0.62					0.58		0.88			
C3H7NO	Dimethylformamide	0.80			0.85		0.59		0.76					0.56		0.63	0.60	0.63	
C3H6O2	propionic acid	0.87		0.67	0.85	0.72	0.53	0.45	0.62			0.41		0.67	0.78		0.78	0.63	
C2H5N3O2	C2H5N3O2				0.83				0.77							0.59			
CHNO	isocyanic acid	0.86		0.64	0.83		0.56		0.68			0.81		0.84	0.80	0.86		0.47	
C4H6O4	succinic acid				0.83				0.71							0.60			
C6H6O3	trihydroxybenzene	0.83	0.48	0.72	0.82	0.85	0.62		0.79	0.42		0.75	0.71	0.59	0.82	0.54	0.59	0.49	
C4H8O2	butyric acid				0.80				0.58							0.76			
C2H2NO3	C2H2NO3	0.61			0.79		0.48		0.56			0.49		0.63		0.90			
HO2H2O	HO2H2O	0.53			0.77				0.63							0.70			
CHN	Hydrogen cyanide	0.80		0.66	0.76	0.84	0.57	0.36	0.70			0.60		0.74	0.62	0.69	0.61	0.54	0.77
C6H6O2	Catechol	0.73			0.73		0.44		0.56					0.63		0.62			
C7H8O	Cresol	0.79			0.72		0.50		0.59					0.59		0.51		0.65	
C3H4O4	Malonic acid				0.69				0.50							0.52	0.54		
C7H8O2	guaiaicol	0.63			0.62	0.78			0.45	0.43			0.62	0.58		0.57			
C2H4O3	Glycolic Acid				0.62		0.42		0.63										
CNO	anion isocyanate	0.66		0.61	0.61		0.48		0.50			0.81		0.74	0.76	0.74			
C3H7NO2	L-Alanine				0.54				0.64									0.65	
*NO		0.40			0.63				0.59							0.58		0.46	
*NO2					0.45	0.51			0.41			0.50				0.54			
*Nox					0.60	0.47			0.57							0.59			
*CO		0.79	0.55		0.81	0.67	0.64		0.80	0.42			0.48	0.58		0.56		0.78	
*SO2					0.63				0.57							0.52		0.72	
CINO3	Chlorine nitrate			0.45							0.45	0.69	0.53		0.66				
CINO2	nitryl chloride			0.47								0.74	0.52		0.67				
Cl2	Chlorine												0.51					0.44	
C6H5NO3	nitrophenol		0.41															0.55	

ALL = all dataset, LC = low concentrations, bfo = bonfire night, WL = winter-like.

The following paragraph has been added at the end of the section 4.3 OA factors and CIMS correlations, which supports the primary and secondary nature of PON:

during the bfo event, pPON\_ME2 showed high  $r^2$  values with carbon monoxide (0.78) as well as hydrogen cyanide (0.77), Methylformamide (0.65) and Dimethylformamide (0.63) which are typical primary pollutants related to combustion processes [(Borduas et al., 2015) and references therein]. sPON\_ME2 showed low correlations with CINO<sub>2</sub> (0.52) and CINO<sub>3</sub> (0.53). High  $r^2$  values were also observed during LC episode between CINO<sub>2</sub> - CINO<sub>3</sub> and LVOOA (0.67 - 0.66) and sPON (0.74 - 0.69) proving their secondary origin. Cl<sub>2</sub>, which has been previously identified to be related to both primary and secondary sources (Faxon et al., 2015), shows low correlations with pPON\_ME2 (0.44) during bfo event and sPON\_ME2 (0.55) during LC event.

#### Minor Comments:

There are a large number of minor issues mostly about missing Tables, wrong numbering of Sections and typos in axis labels and such, so I only point out the two most obvious ones.

We are sorry for not updating the numbers and labelling in the last version of the manuscript before submitting it to ACPD. A full update of numbering to tables and figures has been performed.

- I mentioned that before, but all the references to other sections are wrong in the manuscript. Most importantly there are references to sections that don't even exist such as Section 3.4.1, in which supposedly the interference of m/z 30 is discussed. –

The interference of m/z 30 is being discussed in section 2.2.2

- Another glaring omission is Table 1 mentioned on page 9 line 325. This Table could be the most important evidence to support the separation of sPON from pPON, but is unfortunately missing.

This table is in supplement as Table S4.

## References

- Aiken, A. C., De Foy, B., Wiedinmyer, C., Decarlo, P. F., Ulbrich, I. M., Wehrli, M. N., Szidat, S., Prevot, A. S. H., Noda, J., Wacker, L., Volkamer, R., Fortner, E., Wang, J., Laskin, A., Shutthanandan, V., Zheng, J., Zhang, R., Paredes-Miranda, G., Arnott, W. P., Molina, L. T., Sosa, G., Querol, X., and Jimenez, J. L.: Mexico city aerosol analysis during milagro using high resolution aerosol mass spectrometry at the urban supersite (t0)-part 2: Analysis of the biomass burning contribution and the non-fossil carbon fraction, *Atmos Chem Phys*, 10, 5315-5341, 10.5194/acp-10-5315-2010, 2010.
- Alfarra, M. R., Prevot, A. S. H., Szidat, S., Sandradewi, J., Weimer, S., Lanz, V. A., Schreiber, D., Mohr, M., and Baltensperger, U.: Identification of the mass spectral signature of organic aerosols from wood burning emissions, *Environmental Science & Technology*, 41, 5770-5777, Doi 10.1021/Es062289b, 2007.
- Allan, J. D., Delia, A. E., Coe, H., Bower, K. N., Alfarra, M. R., Jimenez, J. L., Middlebrook, A. M., Drewnick, F., Onasch, T. B., Canagaratna, M. R., Jayne, J. T., and Worsnop, D. R.: A generalised method for the extraction of chemically resolved mass spectra from aerodyne aerosol mass spectrometer data, *J Aerosol Sci*, 35, 909-922, DOI 10.1016/j.jaerosci.2004.02.007, 2004.
- Allan, J. D., Alfarra, M. R., Bower, K. N., Coe, H., Jayne, J. T., Worsnop, D. R., Aalto, P. P., Kulmala, M., Hyötyläinen, T., Cavalli, F., and Laaksonen, A.: Size and composition measurements of background aerosol and new particle growth in a finnish forest during quest 2 using an aerodyne aerosol mass spectrometer, *Atmos. Chem. Phys.*, 6, 315-327, 10.5194/acp-6-315-2006, 2006.
- Allan, J. D., Williams, P. I., Morgan, W. T., Martin, C. L., Flynn, M. J., Lee, J., Nemitz, E., Phillips, G. J., Gallagher, M. W., and Coe, H.: Contributions from transport, solid fuel burning and cooking to primary organic aerosols in two uk cities, *Atmos Chem Phys*, 10, 647-668, 2010.
- Borduas, N., da Silva, G., Murphy, J. G., and Abbatt, J. P. D.: Experimental and theoretical understanding of the gas phase oxidation of atmospheric amides with oh radicals: Kinetics, products, and mechanisms, *The Journal of Physical Chemistry A*, 119, 4298-4308, 10.1021/jp503759f, 2015.
- Bruns, E. A., Krapf, M., Orasche, J., Huang, Y., Zimmermann, R., Drinovec, L., Močnik, G., El-Haddad, I., Slowik, J. G., Dommen, J., Baltensperger, U., and Prévôt, A. S. H.: Characterization of primary and secondary wood combustion products generated under different burner loads, *Atmos. Chem. Phys.*, 15, 2825-2841, 10.5194/acp-15-2825-2015, 2015.
- Canagaratna, M. R., Jayne, J. T., Ghertner, D. A., Herndon, S., Shi, Q., Jimenez, J. L., Silva, P. J., Williams, P., Lanni, T., Drewnick, F., Demerjian, K. L., Kolb, C. E., and Worsnop, D. R.: Chase studies of particulate emissions from in-use new york city vehicles, *Aerosol Science and Technology*, 38, 555-573, 10.1080/02786820490465504, 2004.
- Chakraborty, A., Gupta, T., and Tripathi, S. N.: Chemical composition and characteristics of ambient aerosols and rainwater residues during indian summer monsoon: Insight from aerosol mass spectrometry, *Atmos Environ*, 136, 144-155, 10.1016/j.atmosenv.2016.04.024, 2016.

Collier, S., Zhou, S., Onasch, T. B., Jaffe, D. A., Kleinman, L., Sedlacek, A. J., Briggs, N. L., Hee, J., Fortner, E., Shilling, J. E., Worsnop, D., Yokelson, R. J., Parworth, C., Ge, X., Xu, J., Butterfield, Z., Chand, D., Dubey, M. K., Pekour, M. S., Springston, S., and Zhang, Q.: Regional influence of aerosol emissions from wildfires driven by combustion efficiency: Insights from the bbop campaign, *Environmental Science & Technology*, 50, 8613-8622, 10.1021/acs.est.6b01617, 2016.

Corbin, J. C., Keller, A., Lohmann, U., Burtscher, H., Sierau, B., and Mensah, A. A.: Organic emissions from a wood stove and a pellet stove before and after simulated atmospheric aging, *Aerosol Science and Technology*, 49, 1037-1050, 10.1080/02786826.2015.1079586, 2015a.

Corbin, J. C., Lohmann, U., Sierau, B., Keller, A., Burtscher, H., and Mensah, A. A.: Black carbon surface oxidation and organic composition of beech-wood soot aerosols, *Atmos. Chem. Phys.*, 15, 11885-11907, 10.5194/acp-15-11885-2015, 2015b.

Drewnick, F., Diesch, J. M., Faber, P., and Borrmann, S.: Aerosol mass spectrometry: Particle–vaporizer interactions and their consequences for the measurements, *Atmos. Meas. Tech.*, 8, 3811-3830, 10.5194/amt-8-3811-2015, 2015.

Farmer, D. K., Matsunaga, A., Docherty, K. S., Surratt, J. D., Seinfeld, J. H., Ziemann, P. J., and Jimenez, J. L.: Response of an aerosol mass spectrometer to organonitrates and organosulfates and implications for atmospheric chemistry, *Proceedings of the National Academy of Sciences of the United States of America*, 107, 6670-6675, 10.1073/pnas.0912340107, 2010.

Faxon, C., Bean, J., and Ruiz, L.: Inland concentrations of cl<sub>2</sub> and clno<sub>2</sub> in southeast texas suggest chlorine chemistry significantly contributes to atmospheric reactivity, *Atmosphere*, 6, 1487, 2015.

Florou, K., Papanastasiou, D. K., Pikridas, M., Kaltsonoudis, C., Louvaris, E., Gkatzelis, G. I., Patoulias, D., Mihalopoulos, N., and Pandis, S. N.: The contribution of wood burning and other pollution sources to wintertime organic aerosol levels in two greek cities, *Atmos. Chem. Phys.*, 17, 3145-3163, 10.5194/acp-17-3145-2017, 2017.

He, L. Y., Lin, Y., Huang, X. F., Guo, S., Xue, L., Su, Q., Hu, M., Luan, S. J., and Zhang, Y. H.: Characterization of high-resolution aerosol mass spectra of primary organic aerosol emissions from chinese cooking and biomass burning, *Atmos. Chem. Phys.*, 10, 11535-11543, 10.5194/acp-10-11535-2010, 2010.

Heringa, M. F., DeCarlo, P. F., Chirico, R., Tritscher, T., Dommen, J., Weingartner, E., Richter, R., Wehrle, G., Prévôt, A. S. H., and Baltensperger, U.: Investigations of primary and secondary particulate matter of different wood combustion appliances with a high-resolution time-of-flight aerosol mass spectrometer, *Atmos. Chem. Phys.*, 11, 5945-5957, 10.5194/acp-11-5945-2011, 2011.

Kiendler-Scharr, A., Mensah, A. A., Friese, E., Topping, D., Nemitz, E., Prevot, A. S. H., Äijälä, M., Allan, J., Canonaco, F., Canagaratna, M., Carbone, S., Crippa, M., Dall'Osto, M., Day, D. A., De Carlo, P., Di Marco, C. F., Elbern, H., Eriksson, A., Freney, E., Hao, L., Herrmann, H., Hildebrandt, L., Hillamo, R., Jimenez, J. L., Laaksonen, A., McFiggans, G., Mohr, C., O'Dowd, C., Otjes, R., Ovadnevaite, J., Pandis, S. N., Poulain, L., Schlag, P., Sellegri, K., Swietlicki, E., Tiitta, P., Vermeulen, A., Wahner, A., Worsnop, D., and Wu, H. C.: Ubiquity of organic nitrates from nighttime chemistry in the european submicron aerosol, *Geophys Res Lett*, 43, 7735-7744, 10.1002/2016gl069239, 2016.

Kostenidou, E., Florou, K., Kaltsonoudis, C., Tsiflikiotou, M., Vratolis, S., Eleftheriadis, K., and Pandis, S. N.: Sources and chemical characterization of organic aerosol during the summer in the eastern mediterranean, *Atmos. Chem. Phys.*, 15, 11355-11371, 10.5194/acp-15-11355-2015, 2015.

Mohr, C., DeCarlo, P. F., Heringa, M. F., Chirico, R., Slowik, J. G., Richter, R., Reche, C., Alastuey, A., Querol, X., Seco, R., Penuelas, J., Jimenez, J. L., Crippa, M., Zimmermann, R., Baltensperger, U., and Prevot, A. S. H.: Identification and quantification of organic aerosol from cooking and other sources in barcelona using aerosol mass spectrometer data, *Atmos Chem Phys*, 12, 1649-1665, DOI 10.5194/acp-12-1649-2012, 2012.

Ng, N. L., Canagaratna, M. R., Zhang, Q., Jimenez, J. L., Tian, J., Ulbrich, I. M., Kroll, J. H., Docherty, K. S., Chhabra, P. S., Bahreini, R., Murphy, S. M., Seinfeld, J. H., Hildebrandt, L., Donahue, N. M., DeCarlo, P. F., Lanz, V. A., Prevot, A. S. H., Dinar, E., Rudich, Y., and Worsnop, D. R.: Organic aerosol



components observed in northern hemispheric datasets from aerosol mass spectrometry, *Atmos Chem Phys*, 10, 4625-4641, DOI 10.5194/acp-10-4625-2010, 2010.

Ortega, A. M., Day, D. A., Cubison, M. J., Brune, W. H., Bon, D., de Gouw, J. A., and Jimenez, J. L.: Secondary organic aerosol formation and primary organic aerosol oxidation from biomass-burning smoke in a flow reactor during flame-3, *Atmos. Chem. Phys.*, 13, 11551-11571, 10.5194/acp-13-11551-2013, 2013.

Slowik, J. G., Vlasenko, A., McGuire, M., Evans, G. J., and Abbatt, J. P.: Simultaneous factor analysis of organic particle and gas mass spectra: Ams and ptr-ms measurements at an urban site, *Atmos Chem Phys*, 10, 1969-1988, 2010.

Sun, Y. L., Zhang, Q., Schwab, J. J., Yang, T., Ng, N. L., and Demerjian, K. L.: Factor analysis of combined organic and inorganic aerosol mass spectra from high resolution aerosol mass spectrometer measurements, *Atmos Chem Phys*, 12, 8537-8551, 10.5194/acp-12-8537-2012, 2012.

Tiitta, P., Leskinen, A., Hao, L., Yli-Pirilä, P., Kortelainen, M., Grigonyte, J., Tissari, J., Lamberg, H., Hartikainen, A., Kuusalo, K., Kortelainen, A. M., Virtanen, A., Lehtinen, K. E. J., Komppula, M., Pieber, S., Prévôt, A. S. H., Onasch, T. B., Worsnop, D. R., Czech, H., Zimmermann, R., Jokiniemi, J., and Sippula, O.: Transformation of logwood combustion emissions in a smog chamber: Formation of secondary organic aerosol and changes in the primary organic aerosol upon daytime and nighttime aging, *Atmos. Chem. Phys.*, 16, 13251-13269, 10.5194/acp-16-13251-2016, 2016.

Zhou, S., Collier, S., Jaffe, D. A., Briggs, N. L., Hee, J., Sedlacek Iii, A. J., Kleinman, L., Onasch, T. B., and Zhang, Q.: Regional influence of wildfires on aerosol chemistry in the western us and insights into atmospheric aging of biomass burning organic aerosol, *Atmos. Chem. Phys.*, 17, 2477-2493, 10.5194/acp-17-2477-2017, 2017.

Zhu, Q., He, L. Y., Huang, X. F., Cao, L. M., Gong, Z. H., Wang, C., Zhuang, X., and Hu, M.: Atmospheric aerosol compositions and sources at two national background sites in northern and southern china, *Atmos. Chem. Phys.*, 16, 10283-10297, 10.5194/acp-16-10283-2016, 2016.