

1 **Supplementary Material**

2

3 **Elemental Ratio Measurements of Organic Compounds**
4 **using Aerosol Mass Spectrometry: Characterization,**
5 **Improved Calibration, and Implications**

6

7 **Canagaratna, M.R.¹, Jimenez, J. L.², Kroll, J. H.^{3,4}, Chen, Q.³, Kessler, S. H.⁴**
8 **, Massoli, P.¹ Hildebrandt Ruiz, L.⁵, Fortner, E.¹, Williams, L. R.¹, Wilson, K.**
9 **R.⁶, Surratt, J. D.⁷, Donahue, N. M.⁸, Jayne, J.T.¹, and Worsnop, D.R.¹**

10

11 [1]{Aerodyne Research, Inc. Billerica, MA, USA }

12 [2]{Department of Chemistry and Biochemistry, and Cooperative Institute for Research
13 in the Environmental Sciences (CIRES), University of Colorado, Boulder, CO, USA }

14 [3]{Department of Civil and Environmental Engineering, Massachusetts Institute of
15 Technology, Cambridge, MA, USA }

16 [4]{Department of Chemical Engineering, Massachusetts Institute of Technology,
17 Cambridge, MA, USA }

18 [5]{McKetta Department of Chemical Engineering, and Center for Energy and
19 Environmental Resources, The University of Texas at Austin, Austin, TX, USA }

20 [6]{Lawrence Berkeley National Lab, Berkeley, CA, USA }

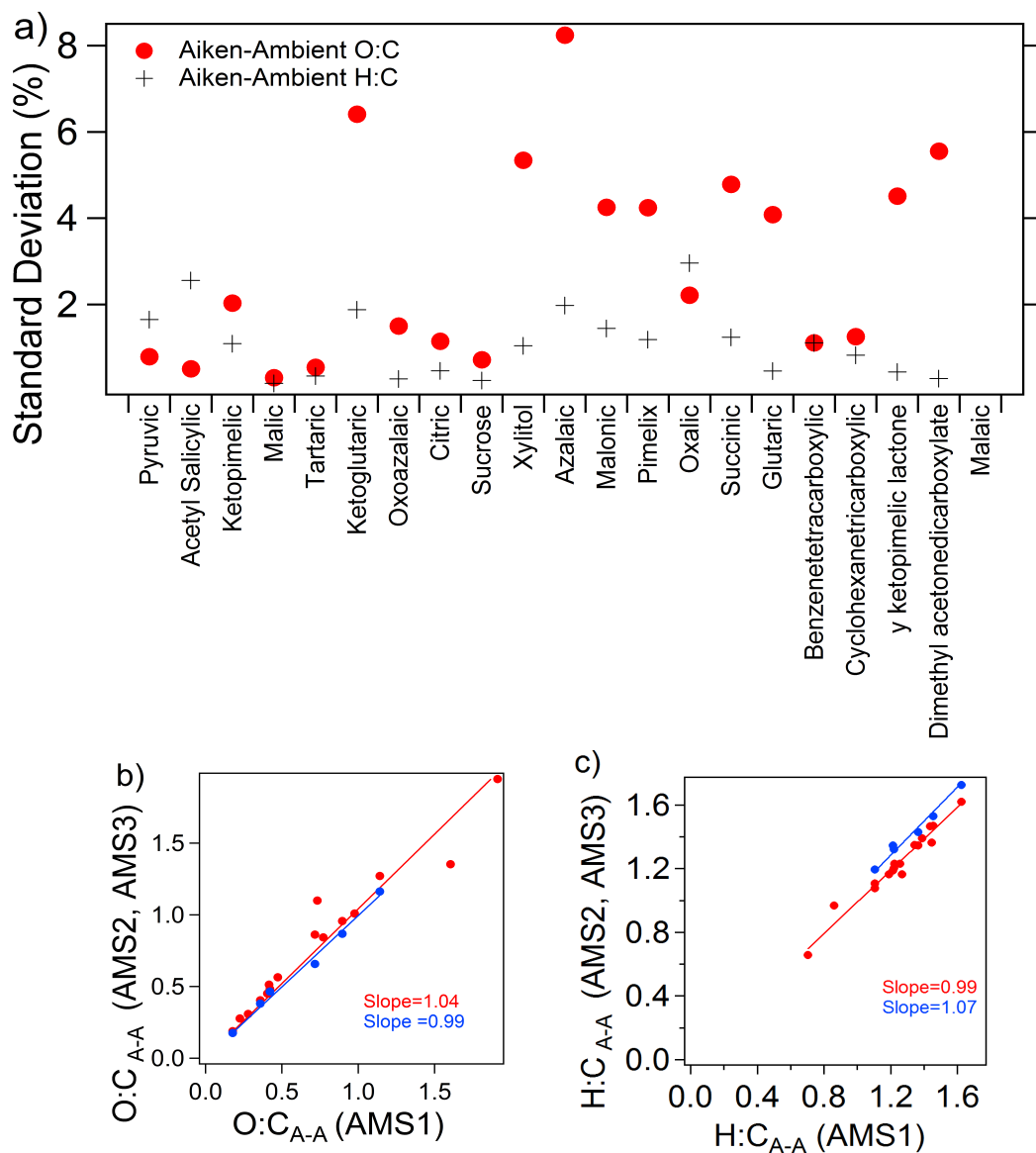
21 [7]{Department of Environmental Science and Engineering, University of North
22 Carolina, Chapel Hill, NC, USA }

23 [8]{Center for Atmospheric Particle Studies, Carnegie Mellon University, Pittsburgh,
24 PA, USA }

25 Correspondence to: M. R. Canagaratna (mrcana@aerodyne.com)

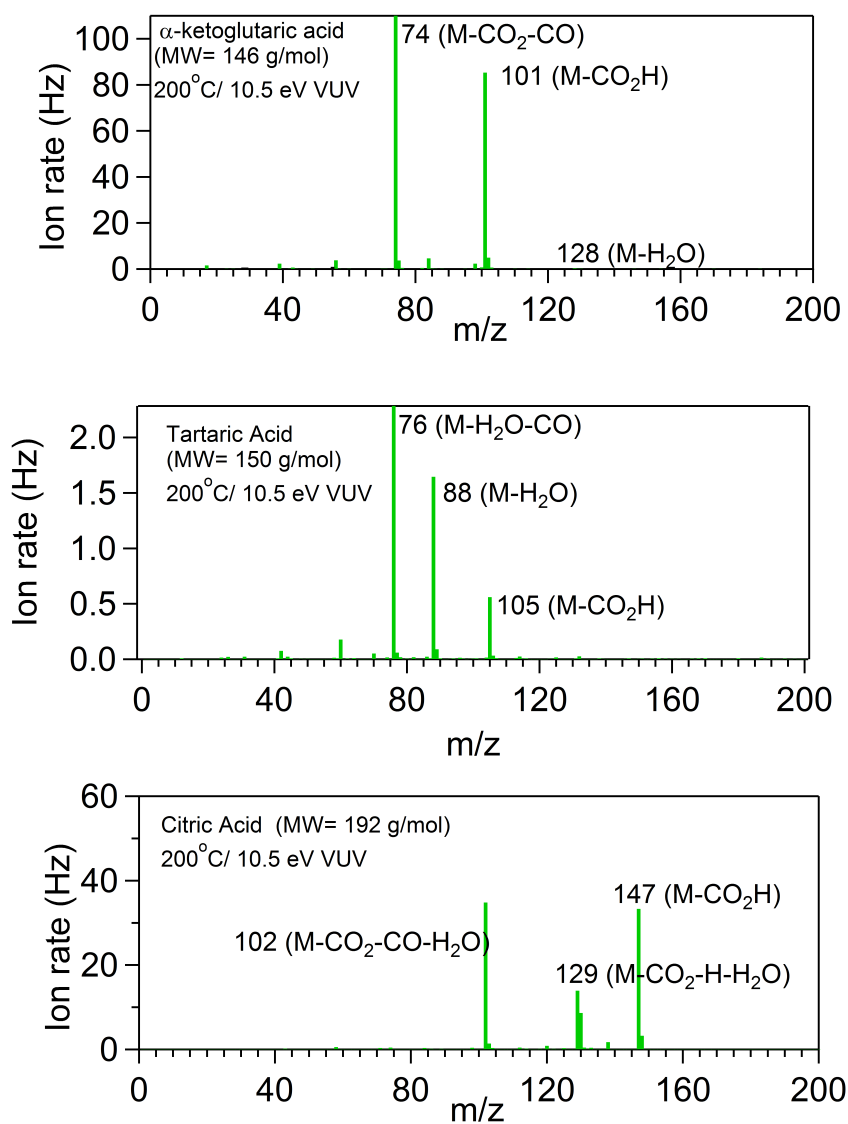
26

27



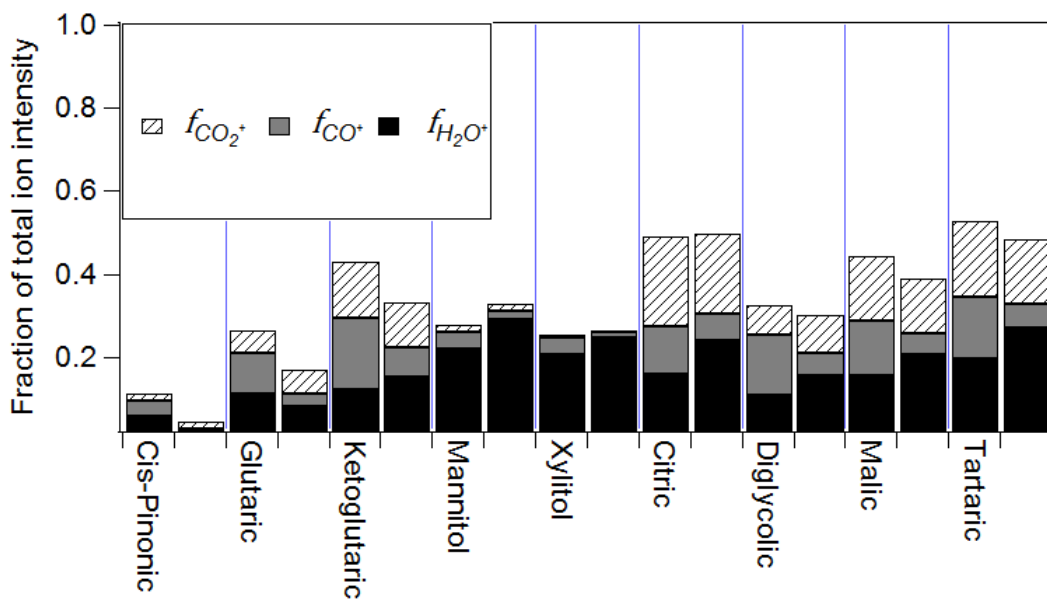
1

2 Figure S1: a) Standard deviations in repeated elemental ratio measurements of several
 3 standards obtained with a single instrument. Standard deviations are shown for O:C and
 4 H:C ratios calculated with the Aiken-Ambient method. b) Scatter plots of Aiken-
 5 Ambient O:C ratios calculated for several standards with three different AMS instrument
 6 (AMS_1, AMS_2, and AMS_3. c) Scatter plots of Aiken-Ambient H:C ratios calculated
 7 for several standards with three different AMS instrument (AMS_1, AMS_2, and
 8 AMS_3).



1

2 Figure S2: VUV-AMS spectra of three different organic standards obtained with
 3 vaporizer set to 200°C and VUV energy of 10.5 eV. Ketoglutaric acid, tartaric acid, and
 4 citric acid correspond to multifunctional organic acid species with carbonyl, hydroxyl,
 5 and polycarboxylic functional groups, respectively.



1

2 Figure S3: Vaporizer temperature dependence of the fractional AMS ion intensity
 3 measured for CO_2^+ , CO^+ , and H_2O^+ for some of the standards measured in this study. For
 4 each standard, fractional ion intensities measured at 600°C (first bar) and 200°C (second
 5 bar) are shown.

6

Multifunctional, Esters
Polyacids, Alcohols, Diacids

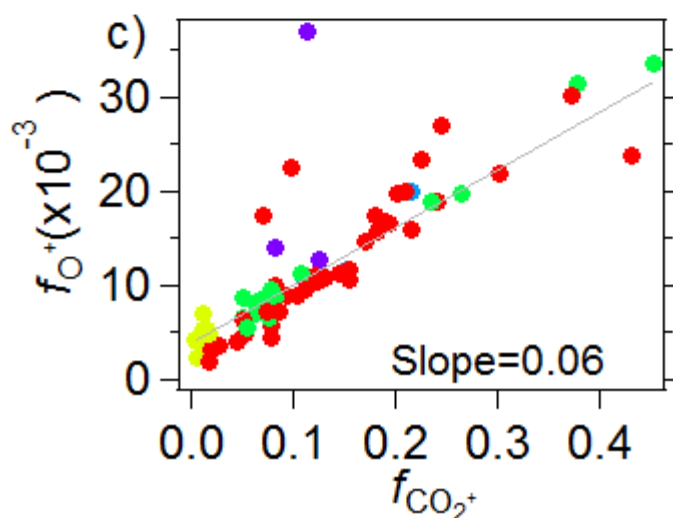
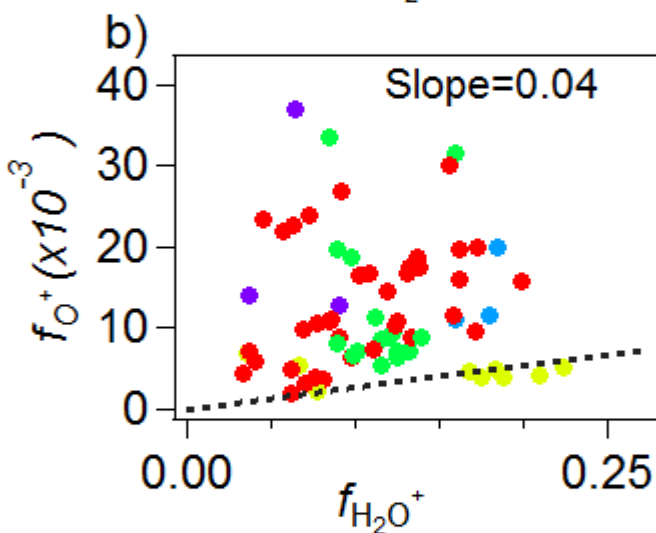
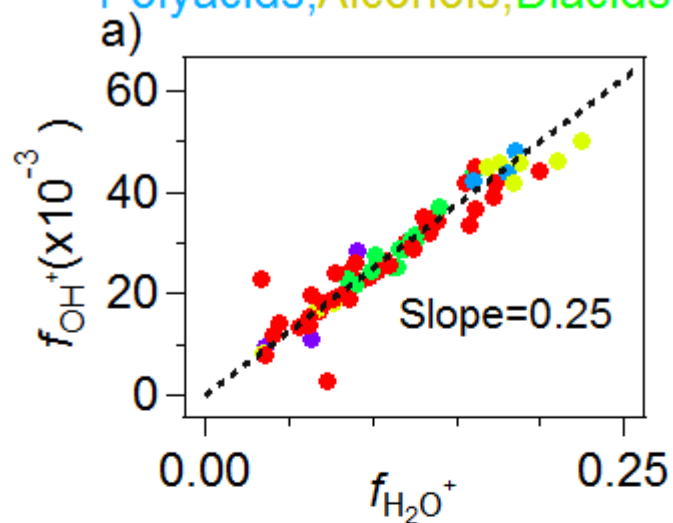
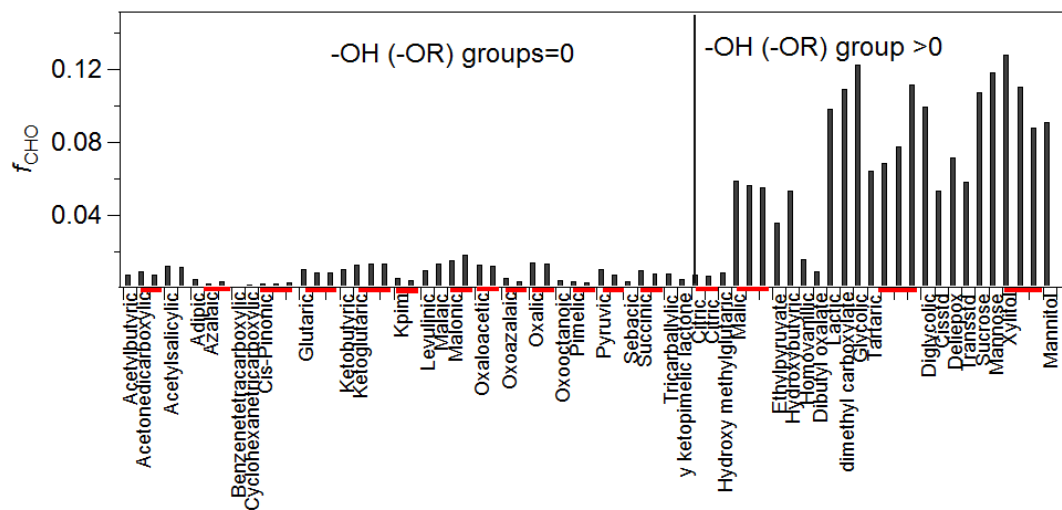
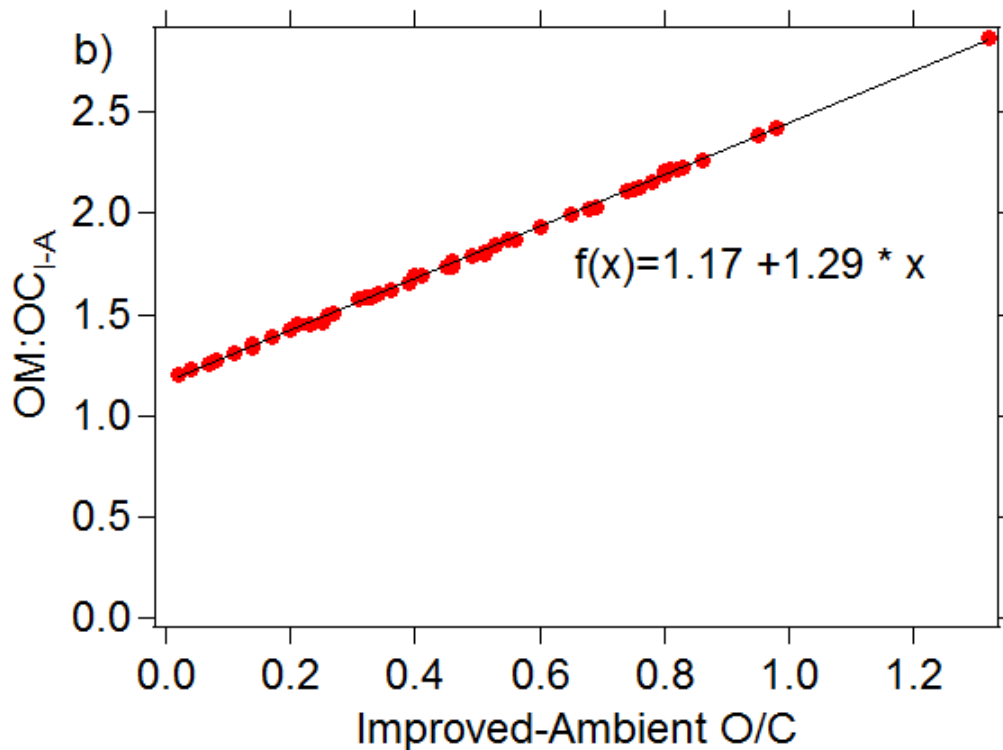
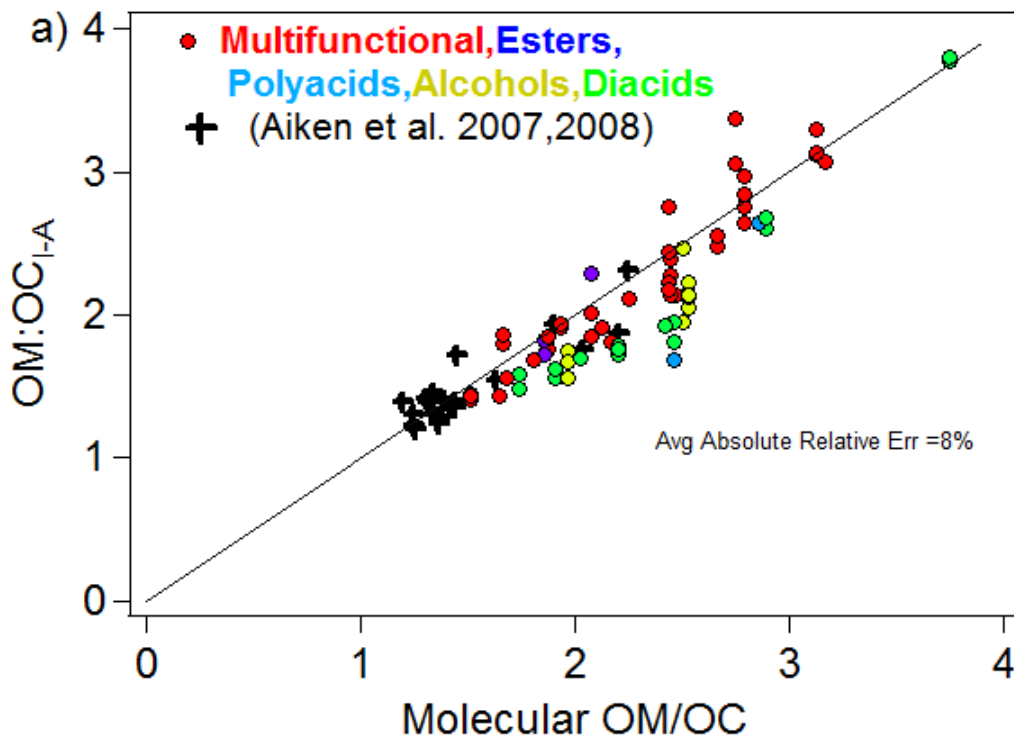


Figure S4: Scatter plots of key ions observed in the AMS spectra of laboratory standards. Panel a shows OH^+ vs. H_2O^+ , panel b shows O^+ vs. H_2O^+ , and panel c shows O^+ vs. CO_2^+ . The dashed line denotes the default relationships assumed when analyzing AMS data with the Aiken-Ambient method.

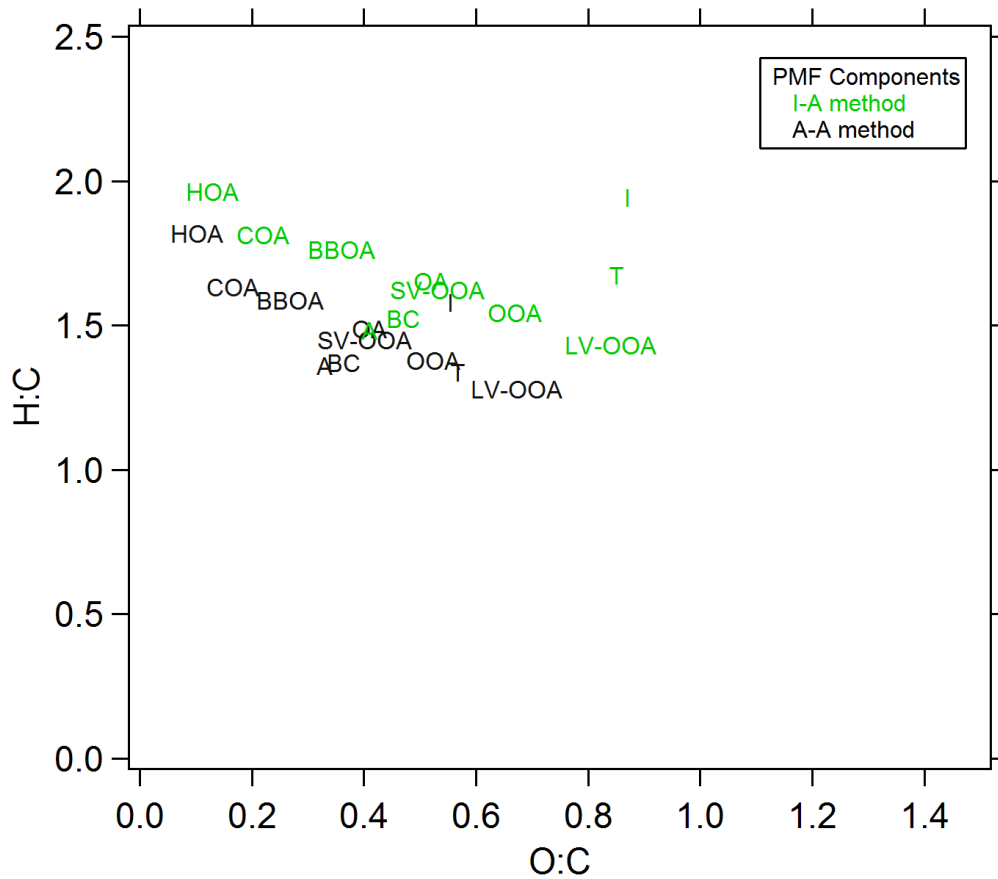


1

2 Figure S5: Dependence of the fractional CHO^+ ion intensity on functional composition of
 3 OA standards. The standards are separated into two groups according to those that
 4 contain at least one -OH or -OR functional group and those that don't contain any of
 5 those functional groups.



- 1 Figure S6: a) Scatter plot between OM/OC values calculated with Improved-Ambient
- 2 method and the known OM/OC values for standard molecules. b) Scatter plot between
- 3 OM/OC values and O:C values calculated with the Improved-Ambient method for
- 4 standard molecules. The black line shows a linear fit through the data.



1

2

3 Figure S7: a) Van Krevelen plots of ambient PMF components (HOA, COA, BBOA, SV-
 4 OOA, LV-OOA, OOA) and chamber SOA (α -pinene(A), toluene (T) and isoprene (I))
 5 obtained when the O:C and H:C values are calculated with the A-A and I-A methods.

1 Table S1. Improved-Ambient (I-A) results for previously reported ambient OA components.

Ambient PMF components	Reference	O:C _{I-A}	Change (%)	H:C _{I-A}	Change (%)	OM:OC _{I-A}	Change (%)	$\overline{OS}_c(I-A)$	Absolute Change
HOA	(Aiken et al., 2009)	0.21	31	2.03	10	1.45	6	-1.61	-0.09
	(DeCarlo et al., 2010)	0.07	24	1.92	7	1.26	2	-1.77	-0.10
	(Docherty et al., 2011)	0.02	26	2.10	7	1.21	2	-2.05	-0.13
	(Ge et al., 2012)	0.11	27	1.95	8	1.33	3	-1.72	-0.10
	(Gong et al., 2012)	0.11	26	1.94	8	1.34	3	-1.71	-0.09
	(He et al., 2011)	0.14	25	1.83	8	1.35	4	-1.55	-0.07
	(Wang et al., 2010)	0.14	28	1.88	9	1.34	4	-1.60	-0.09
	(Huang et al., 2012)	0.20	28	1.93	9	1.43	5	-1.52	-0.07
	(Huang et al., 2013) (Winter)	0.14	29	2.02	9	1.38	4	-1.74	-0.11
	(Huang et al., 2013) (Summer)	0.17	29	1.93	9	1.40	5	-1.60	-0.09
	(Mohr et al., 2012)	0.04	26	2.10	7	1.23	2	-2.03	-0.13
	(Saarikoski et al., 2012)	0.26	24	1.84	8	1.50	5	-1.32	-0.03
	(Setyan et al., 2012)	0.11	34	1.99	11	1.31	4	-1.77	-0.14
(Sun et al., 2011)	0.08	26	1.96	7	1.26	3	-1.81	-0.10	
BBOA	(Aiken et al., 2009)	0.40	34	1.88	11	1.69	10	-1.08	0.01
	(DeCarlo et al., 2010)	0.55	31	1.60	12	1.88	11	-0.49	0.09
	(Ge et al., 2012)	0.46	40	1.78	14	1.79	12	-0.86	0.04
	(Gong et al., 2012)	0.25	31	1.55	10	1.50	6	-1.05	-0.02
	(He et al., 2011)	0.45	42	1.69	15	1.81	12	-0.79	0.04
	(Huang et al., 2011)	0.34	32	1.79	10	1.60	8	-1.10	0.00
	(Huang et al., 2013) (Winter)	0.36	35	1.70	12	1.66	9	-0.97	0.00
	(Mohr et al., 2012)	0.31	30	1.94	10	1.58	8	-1.31	-0.02
	(Saarikoski et al., 2012)	0.33	44	1.77	16	1.59	11	-1.11	-0.04
COA	(Ge et al., 2012)	0.14	27	1.85	8	1.35	4	-1.57	-0.07
	(Wang et al., 2010)	0.14	28	1.88	9	1.34	4	-1.60	-0.09
	(Mohr et al., 2012)	0.27	31	1.73	10	1.51	7	-1.18	-0.03
	(Sun et al., 2011)	0.23	26	1.71	8	1.44	5	-1.26	-0.04
OOA	(Aiken et al., 2009) (OOA)	0.80	33	1.67	14	2.20	15	-0.07	0.20
	(DeCarlo et al., 2010) (SVOOA)	0.83	29	1.46	13	2.23	13	0.20	0.21
	(DeCarlo et al., 2010) (LVOOA)	1.32	29	1.29	16	2.87	17	1.34	0.42
	(Docherty et al., 2011) (SV-OOA)	0.32	40	1.88	14	1.59	10	-1.23	-0.04
	(Docherty et al., 2011) (LVOOA)	0.86	20	1.40	10	2.26	10	0.32	0.16
	(Ge et al., 2012) (OOA)	0.55	31	1.60	12	1.88	11	-0.50	0.09
	(Gong et al., 2012) (SV-OOA)	0.46	25	1.46	10	1.75	8	-0.53	0.06
	(Gong et al., 2012) (LV-OOA)	0.68	24	1.43	10	2.06	10	-0.06	0.14
	(He et al., 2011) (SV-OOA)	0.60	32	1.64	13	1.95	12	-0.45	0.10
	(He et al., 2011) (LV-OOA)	0.76	29	1.43	14	2.17	12	0.09	0.17
	(Wang et al., 2010) (OOA1)	0.56	17	1.48	7	1.87	7	-0.35	0.07
	(Wang et al., 2010) (OOA2)	0.65	38	1.54	16	1.99	15	-0.24	0.15
	(Huang et al., 2011) (SV-OOA)	0.49	27	1.63	10	1.79	9	-0.64	0.06
	(Huang et al., 2011) (LV-OOA)	0.80	26	1.45	11	2.19	12	0.16	0.18
	(Huang et al., 2012) (SV-OOA)	0.45	30	1.65	12	1.74	10	-0.74	0.04
	(Huang et al., 2012) (LV-OOA)	0.81	25	1.66	11	2.22	11	-0.04	0.15
	(Huang et al., 2013) (Winter; OOA)	0.75	28	1.45	12	2.16	12	0.06	0.17
	(Huang et al., 2013) (Summer; OOA)	0.53	28	1.63	11	1.86	10	-0.58	0.07
	(Mohr et al., 2012) (SV-OOA)	0.41	29	1.75	11	1.70	9	-0.92	0.02
	(Mohr et al., 2012) (LV-OOA)	0.98	31	1.35	14	2.42	16	0.62	0.30
	(Saarikoski et al., 2012) (OOAa)	0.95	20	1.46	10	2.39	10	0.44	0.19
	(Saarikoski et al., 2012) (OOAb)	0.80	28	1.58	12	2.20	13	0.03	0.18
	(Saarikoski et al., 2012) (OOAc)	0.69	21	1.36	9	2.03	9	0.01	0.12
	(Setyan et al., 2012) (LO-OOA)	0.51	21	1.46	8	1.80	7	-0.45	0.06
(Setyan et al., 2012) (MO-OOA)	0.74	37	1.52	15	2.11	15	-0.04	0.20	
(Sun et al., 2011) (SVOOA)	0.51	33	1.58	13	1.81	11	-0.56	0.08	
(Sun et al., 2011) (LVOOA)	0.78	24	1.43	11	2.16	11	0.14	0.17	

1

2 Table S2. Improved-Ambient (I-A) results for total OA from previously reported ambient
 3 field campaigns.

Reference	O:C _{I-A}	Change (%)	H:C _{I-A}	Change (%)	OM:OC _{I-A}	Change (%)	\overline{OS}_c (I-A)	Absolute Change
(Aiken et al., 2009)	0.53	32	1.82	12	1.86	11	-0.77	0.06
(Docherty et al., 2011)	0.44	27	1.71	10	1.73	9	-0.82	0.03
(Chen et al., 2009 and 2014)	0.60	34	1.65	14	1.94	13	-0.44	0.11
(Ge et al., 2012)	0.35	30	1.75	10	1.63	8	-1.05	0.00
(Gong et al., 2012)	0.50	26	1.63	9	1.87	9	-0.62	0.07
(He et al., 2011)	0.39	31	1.83	12	1.71	9	-1.04	-0.01
(Wang et al., 2010)	0.41	26	1.63	9	1.69	8	-0.80	0.03
(Huang et al., 2011)	0.60	27	1.64	11	1.94	11	-0.44	0.10
(Huang et al., 2012)	0.40	28	1.92	11	1.69	8	-1.13	-0.02
(Huang et al., 2013) (Winter)	0.43	30	1.73	11	1.75	9	-0.87	0.03
(Huang et al., 2013) (Summer)	0.36	28	1.94	10	1.67	8	-1.22	-0.02
(Martin et al., 2008)	0.69	26	1.40	11	2.04	11	-0.01	0.15
(Mohr et al., 2012)	0.41	30	1.77	11	1.70	9	-0.94	0.01
(Ovadnevaite et al., 2011)	0.70	17	1.34	8	2.05	8	0.06	0.11
(Poulain et al., 2011) (Summer)	0.52	17	1.51	7	1.83	6	-0.47	0.05
(Poulain et al., 2011) (Autumn)	0.54	14	1.48	7	1.84	6	-0.40	0.04
(Poulain et al., 2011) (Winter)	0.53	16	1.48	7	1.83	6	-0.41	0.05
(Robinson et al., 2011)	0.71	45	1.62	20	2.08	18	-0.20	0.17
(Saarikoski et al., 2012)	0.59	26	1.64	10	1.92	10	-0.46	0.09
(Setyan et al., 2012)	0.56	28	1.53	11	1.88	10	-0.40	0.10
(Sun et al., 2011)	0.46	28	1.65	11	1.75	9	-0.73	0.04

4

1 Table S3. Comparison of different versions of the organic fragmentation waves that can
 2 be used for AMS analysis

3

4

Frag_organic		
m/z	Default AMS Frag. Table Allan et al., (2004)	Hildebrandt Ruiz et al., (2014) Correction
1		Hwave *frag_organic [18]
16	0.04*frag_organic [18]	0.04*frag_organic [18]
17	0.25*frag_organic [18]	0.25*frag_organic [18]
18	1*frag_organic [44]	1*frag_organic [44]

5

6

7

8

9

10

11

12

13

14

15

16

17

1 **Calculation of H⁺/H₂O⁺ for Organic Frag Wave in AMS fragmentation table.**

2 The current treatment of water fragmentation does not account for the H-atoms which
3 were bound to HO⁺ and O⁺ before fragmentation. The neglected mass from H-atoms is
4 negligible when calculating organic aerosol mass concentrations. However, the neglected
5 H⁺ signal does affect oxidation state ($\overline{OS}_c \sim 2 \times O:C - H:C$) calculations from current H:C
6 and O:C AMS values. In particular, the \overline{OS}_c values are not invariant with respect to
7 hydration/dehydration processes as they should be; the oxidation state decreases with
8 dehydration because the prescribed H/O ratio of water in the AMS analysis is less than 2.
9 Here we calculate H⁺/H₂O⁺ that needs to be added to the standard organic fragmentation
10 wave to obtain an H/O ratio of 2 in the total signal of H₂O determined by AMS data
11 analysis. The addition of H⁺ changes the organic H:C ratio calculated in elemental
12 analysis of the organic aerosol (OA) and therefore the oxidation state (\overline{OS}_c) estimated
13 from O:C and H:C ratios.

14 The ratio of H⁺/H₂O⁺ needed to add to the updated fragmentation table to keep \overline{OS}_c
15 constant upon (de-) hydration can be calculated as follows:

16

17 For any given time point, let:

18 $x = H^+/H_2O^+$

19 $z =$ initial mass of H₂O⁺, $y =$ factor by which H₂O changes,

20 $f_{OH} = OH^+/H_2O^+ = 0.25$ and $f_O = O^+/H_2O^+ = 0.04$

21 Accounting for the contribution of ¹⁸O:

22 $f'_{OH} = 1.00205499 * f_{OH}$ and $f'_O = 1.00205499 * f_O$

23 $mw_i =$ molecular weights

24 $f_{cal}^{OC}, f_{cal}^{HC}$ = calibration factors for O:C and H:C

25 The Aiken-Ambient and Aiken-Explicit values are 0.75 and 0.91, respectively

26 The Improved-Ambient values are (See Equations 8 and 9) :

27 $0.75 * (1.26 - 0.623 * f_{CO_2} + 2.28 * f_{CHO})$ for O/C

1 0.91* (1.07+1.07*f_{CHO}) for H:C

2 NOTE: f_{CO2} and f_{CHO} are calculated using the default organic fragmentation wave
3 that does not include the H⁺ fragment since inclusion of the H⁺ fragment does not
4 significantly affect the calculated organic mass.

5 Then:

6
$$\text{moles of O} = z \times \left(\frac{f'_O}{mw_O} + \frac{f'_{OH}}{mw_{OH}} + \frac{1}{mw_{H_2O}} \right)$$

7
$$\text{moles of H} = z \times \left(\frac{f'_{OH}}{mw_{OH}} + \frac{2}{mw_{H_2O}} + \frac{x}{mw_H} \right)$$

8 To simplify the equations, let $\frac{f'_O}{mw_O} + \frac{f'_{OH}}{mw_{OH}} + \frac{1}{mw_{H_2O}} = a$ and $\frac{f'_{OH}}{mw_{OH}} + \frac{2}{mw_{H_2O}} = b$

9 Then:

10
$$\text{moles of O} = z \times a \quad \text{and} \quad \text{moles of H} = z \times \left(b + \frac{x}{mw_H} \right)$$

11 Keeping oxidation state constant when H₂O is changed by y:

12
$$\frac{2}{f_{cal}^{OC}} \times z a y - \frac{1}{f_{cal}^{HC}} z y \times \left(b + \frac{x}{mw_H} \right) = \frac{2}{f_{cal}^{OC}} \times z a - \frac{1}{f_{cal}^{HC}} z \times \left(b + \frac{x}{mw_H} \right)$$

13 Dividing by z and rearranging:

14
$$\frac{2}{f_{cal}^{OC}} \times a (y - 1) = \frac{1}{f_{cal}^{HC}} \times \left(b + \frac{x}{mw_H} \right) (y - 1)$$

15 Dividing by (y-1) and rearranging:

16
$$x = \left(\frac{2f_{cal}^{HC}}{f_{cal}^{OC}} \times a - b \right) \times mw_H$$

17

18 The calculated H⁺/H₂O⁺ ratio from the above equations can be directly

19 incorporated into the AMS analysis frag_organic wave as shown in Table S3. The
20 modified Frag_organic wave refers to HWave, which is a new wave that contains time
21 varying values of the H⁺/H₂O⁺ ratios over the time period being analyzed. For the
22 Aiken-Ambient and Aiken Explicit methods, where the constant Aiken et al. (2008)

1 values are used for f_{cal}^{OC} and f_{cal}^{HC} , the HWave is constant over time at a value of 0.05.

2 For the Improved-Ambient method, the variations in f_{cal}^{OC} and f_{cal}^{HC} introduce a time
3 variation in HWave.

4

5

6

1 **References**

- 2
- 3 Aiken, A. C., Salcedo, D., Cubison, M. J., Huffman, J. A., DeCarlo, P. F., Ulbrich, I. M.,
4 Docherty, K. S., Sueper, D., Kimmel, J. R., Worsnop, D. R., Trimborn, A., Northway,
5 M., Stone, E. A., Schauer, J. J., Volkamer, R. M., Fortner, E., de Foy, B., Wang, J.,
6 Laskin, A., Shutthanandan, V., Zheng, J., Zhang, R., Gaffney, J., Marley, N. A., Paredes-
7 Miranda, G., Arnott, W. P., Molina, L. T., Sosa, G., and Jimenez, J. L.: Mexico City
8 aerosol analysis during MILAGRO using high resolution aerosol mass spectrometry at
9 the urban supersite (T0) - Part 1: Fine particle composition and organic source
10 apportionment, *Atmos. Chem. Phys.*, 9, 6633-6653, 10.5194/acp-9-6633-2009, 2009.
- 11
- 12 Allan, J. D., Coe, H., Bower, K. N., Alfarra, M. R., Delia, A. E., Jiménez, J. L.,
13 Middlebrook, A. M., Drewnick, F., Onasch, T. B., Canagaratna, M. R., Jayne, J. T., and
14 Worsnop, D. R.: Technical note: Extraction of chemically resolved mass spectra from
15 Aerodyne aerosol mass spectrometer data, *J. Aerosol Sci.*, 35, 909-922, 2004.
- 16
- 17 Chen, Q., Farmer, D. K., Schneider, J., Zorn, S. R., Heald, C. L., Karl, T. G., Guenther,
18 A., Allan, J. D., Robinson, N., Coe, H., Kimmel, J. R., Pauliquevis, T., Borrmann, S.,
19 Poschl, U., Andreae, M. O., Artaxo, P., Jimenez, J. L., and Martin, S. T.: Mass spectral
20 characterization of submicron biogenic organic particles in the Amazon Basin, *Geophys.*
21 *Res. Lett.*, 36, L20806, 10.1029/2009gl039880, 2009.
- 22
- 23 Chen, Q.: Manuscript in Preparation, 2014.
- 24
- 25 DeCarlo, P. F., Ulbrich, I. M., Crouse, J., de Foy, B., Dunlea, E. J., Aiken, A. C.,
26 Knapp, D., Weinheimer, A. J., Campos, T., Wennberg, P. O., and Jimenez, J. L.:
27 Investigation of the sources and processing of organic aerosol over the Central Mexican
28 Plateau from aircraft measurements during MILAGRO, *Atmos. Chem. Phys.*, 10, 5257-
29 5280, 10.5194/acp-10-5257-2010, 2010.
- 30
- 31 Docherty, K. S., Aiken, A. C., Huffman, J. A., Ulbrich, I. M., DeCarlo, P. F., Sueper, D.,
32 Worsnop, D. R., Snyder, D. C., Peltier, R. E., Weber, R. J., Grover, B. D., Eatough, D. J.,
33 Williams, B. J., Goldstein, A. H., Ziemann, P. J., and Jimenez, J. L.: The 2005 Study of
34 Organic Aerosols at Riverside (SOAR-1): instrumental intercomparisons and fine particle
35 composition, *Atmos. Chem. Phys.*, 11, 12387-12420, 10.5194/acp-11-12387-2011, 2011.
- 36
- 37 Ge, X. L., Setyan, A., Sun, Y. L., and Zhang, Q.: Primary and secondary organic aerosols
38 in Fresno, California during wintertime: Results from high resolution aerosol mass
39 spectrometry, *J. Geophys. Res.*, 117, D19301, 10.1029/2012jd018026, 2012.
- 40
- 41 Gong, Z., Lan, Z., Xue, L., Zeng, L., He, L., and Huang, X.: Characterization of
42 submicron aerosols in the urban outflow of the central Pearl River Delta region of China,
43 *Frontiers of Environmental Science & Engineering*, 6, 725-733, 10.1007/s11783-012-
44 0441-8, 2012.
- 45

1 He, L. Y., Huang, X. F., Xue, L., Hu, M., Lin, Y., Zheng, J., Zhang, R. Y., and Zhang, Y.
2 H.: Submicron aerosol analysis and organic source apportionment in an urban atmosphere
3 in Pearl River Delta of China using high-resolution aerosol mass spectrometry, *J.*
4 *Geophys. Res.*, 116, D12304, Doi 10.1029/2010jd014566, 2011.

5
6 Hildebrandt Ruiz, L., et al. : Manuscript in preparation, 2014.

7
8 Huang, X. F., He, L. Y., Hu, M., Canagaratna, M. R., Kroll, J. H., Ng, N. L., Zhang, Y.
9 H., Lin, Y., Xue, L., Sun, T. L., Liu, X. G., Shao, M., Jayne, J. T., and Worsnop, D. R.:
10 Characterization of submicron aerosols at a rural site in Pearl River Delta of China using
11 an Aerodyne High-Resolution Aerosol Mass Spectrometer, *Atmos. Chem. Phys.*, 11,
12 1865-1877, DOI 10.5194/acp-11-1865-2011, 2011.

13
14 Huang, X. F., He, L. Y., Xue, L., Sun, T. L., Zeng, L. W., Gong, Z. H., Hu, M., and Zhu,
15 T.: Highly time-resolved chemical characterization of atmospheric fine particles during
16 2010 Shanghai World Expo, *Atmos. Chem. Phys.*, 12, 4897-4907, DOI 10.5194/acp-12-
17 4897-2012, 2012.

18
19 Huang, X. F., Xue, L., Tian, X. D., Shao, W. W., Sun, T. L., Gong, Z. H., Ju, W. W.,
20 Jiang, B., Hu, M., and He, L. Y.: Highly time-resolved carbonaceous aerosol
21 characterization in Yangtze River Delta of China: Composition, mixing state and
22 secondary formation, *Atmos. Environ.*, 64, 200-207, 10.1016/j.atmosenv.2012.09.059,
23 2013.

24
25 Martin, S. T., Rosenoern, T., Chen, Q., and Collins, D. R.: Phase changes of ambient
26 particles in the Southern Great Plains of Oklahoma, *Geophys. Res. Lett.*, 35, L22801,
27 10.1029/2008gl035650, 2008.

28
29 Mohr, C., DeCarlo, P. F., Heringa, M. F., Chirico, R., Slowik, J. G., Richter, R., Reche,
30 C., Alastuey, A., Querol, X., Seco, R., Penuelas, J., Jimenez, J. L., Crippa, M.,
31 Zimmermann, R., Baltensperger, U., and Prevot, A. S. H.: Identification and
32 quantification of organic aerosol from cooking and other sources in Barcelona using
33 aerosol mass spectrometer data, *Atmos. Chem. Phys.*, 12, 1649-1665, 10.5194/acp-12-
34 1649-2012, 2012.

35
36 Ovadnevaite, J., O'Dowd, C., Dall'Osto, M., Ceburnis, D., Worsnop, D. R., and
37 Berresheim, H.: Detecting high contributions of primary organic matter to marine
38 aerosol: A case study, *Geophys. Res. Lett.*, 38, L02807, 10.1029/2010gl046083, 2011.

39
40 Poulain, L., Spindler, G., Birmili, W., Plass-Dulmer, C., Wiedensohler, A., and
41 Herrmann, H.: Seasonal and diurnal variations of particulate nitrate and organic matter at
42 the IfT research station Melpitz, *Atmos. Chem. Phys.*, 11, 12579-12599, 10.5194/acp-11-
43 12579-2011, 2011.

44
45 Robinson, N. H., Hamilton, J. F., Allan, J. D., Langford, B., Oram, D. E., Chen, Q.,
46 Docherty, K., Farmer, D. K., Jimenez, J. L., Ward, M. W., Hewitt, C. N., Barley, M. H.,

1 Jenkin, M. E., Rickard, A. R., Martin, S. T., McFiggans, G., and Coe, H.: Evidence for a
2 significant proportion of secondary organic aerosol from isoprene above a maritime
3 tropical forest, *Atmos. Chem. Phys.*, 11, 1039-1050, 10.5194/acp-11-1039-2011, 2011.
4

5 Saarikoski, S., Carbone, S., Decesari, S., Giulianelli, L., Angelini, F., Canagaratna, M.,
6 Ng, N. L., Trimborn, A., Facchini, M. C., Fuzzi, S., Hillamo, R., and Worsnop, D.:
7 Chemical characterization of springtime submicrometer aerosol in Po Valley, Italy,
8 *Atmos. Chem. Phys.*, 12, 8401-8421, 10.5194/acp-12-8401-2012, 2012.
9

10 Setyan, A., Zhang, Q., Merkel, M., Knighton, W. B., Sun, Y., Song, C., Shilling, J. E.,
11 Onasch, T. B., Herndon, S. C., Worsnop, D. R., Fast, J. D., Zaveri, R. A., Berg, L. K.,
12 Wiedensohler, A., Flowers, B. A., Dubey, M. K., and Subramanian, R.: Characterization
13 of submicron particles influenced by mixed biogenic and anthropogenic emissions using
14 high-resolution aerosol mass spectrometry: results from CARES, *Atmos. Chem. Phys.*,
15 12, 8131-8156, 10.5194/acp-12-8131-2012, 2012.
16

17 Sun, Y. L., Zhang, Q., Schwab, J. J., Demerjian, K. L., Chen, W. N., Bae, M. S., Hung,
18 H. M., Hogrefe, O., Frank, B., Rattigan, O. V., and Lin, Y. C.: Characterization of the
19 sources and processes of organic and inorganic aerosols in New York city with a high-
20 resolution time-of-flight aerosol mass spectrometer, *Atmos. Chem. Phys.*, 11, 1581-1602,
21 10.5194/acp-11-1581-2011, 2011.
22

23 Wang, X. F., Gao, S., Yang, X., Chen, H., Chen, J. M., Zhuang, G. S., Surratt, J. D.,
24 Chan, M. N., and Seinfeld, J. H.: Evidence for High Molecular Weight Nitrogen-
25 Containing Organic Salts in Urban Aerosols, *Environ. Sci. Technol.*, 44, 4441-4446,
26 10.1021/es1001117, 2010.
27
28