Supplemental Information for Pre-monsoon Submicron Aerosol Composition and Source Contribution in the Kathmandu Valley, Nepal by Werden et al.

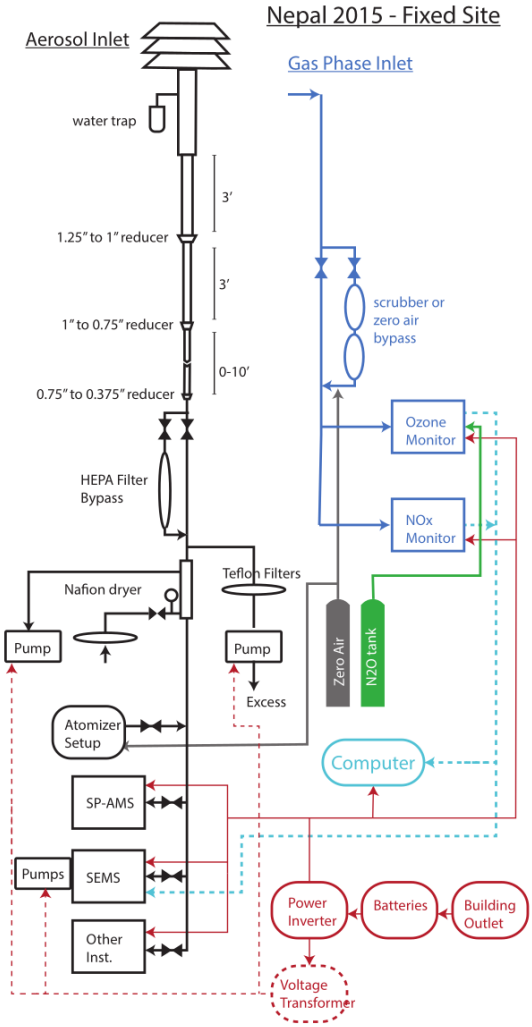

Figure SI1: NAMaSTE inlet setup for particle and gas phase measurements from Bode Thimi, Nepal, April 2015.

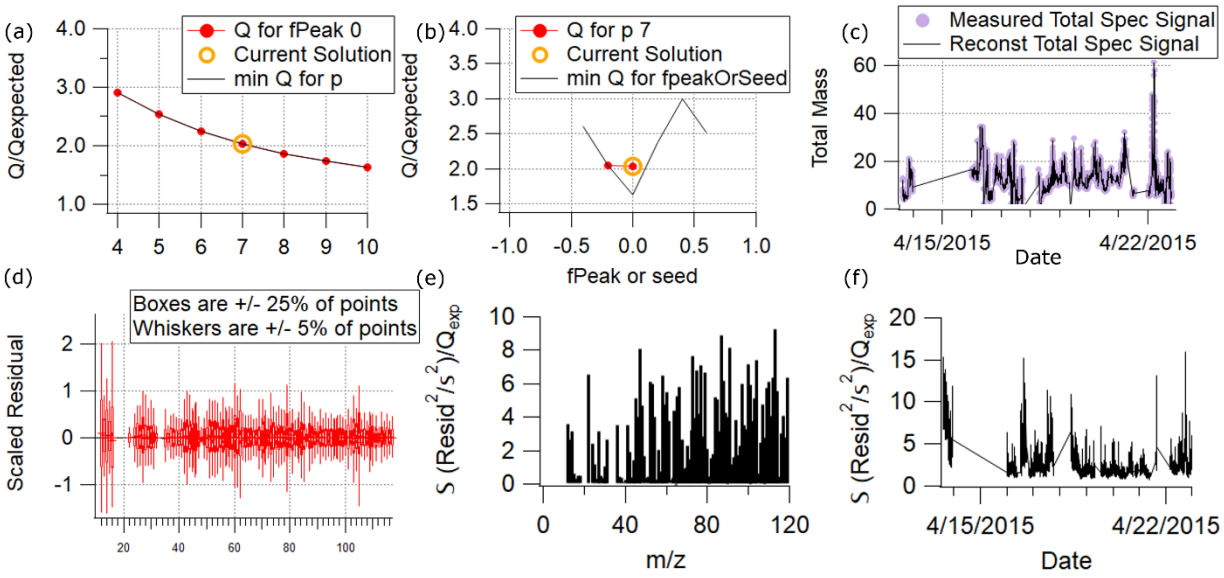

Figure SI2: AMS-PMF heuristics of (a) Q/Q_{exp} for each solution size, (b) Q/Q_{exp} to each FPEAK within the selected solution, (c) time series of total mass, (d) scaled residuals for each m/z for the solution, (e) Residuals for each m/z for the PMF solution, (f) Residual time series for the PMF solution, for NAMaSTE1 in the Kathmandu Valley, April 2015.

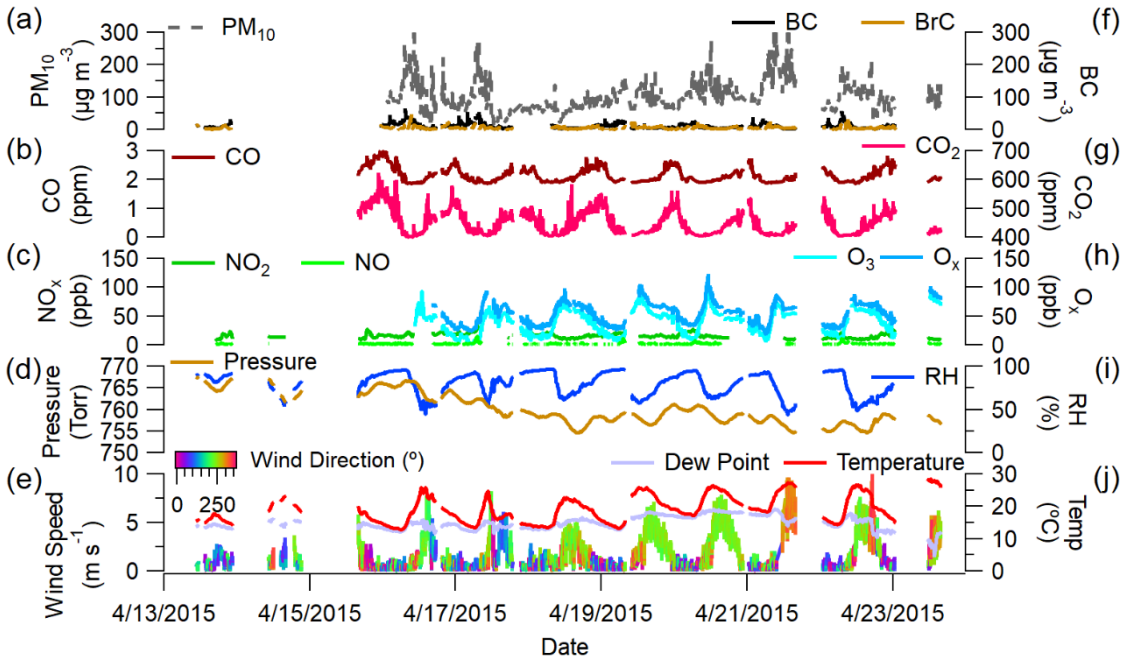

Figure SI3: Optical particulate PM_{10} (a), black and brown carbon (f), gas-phase CO (b), NO and NO_2 (c), CO_2 (g), O_x and O_3 (h), and meteorological measurements of pressure (d), wind speed colored by direction (e), relative humidity (j), and temperature and dew point (j), measurements available coincident with AMS measurements for NAMaSTE1 in the Kathmandu Valley, Nepal, April 2015.

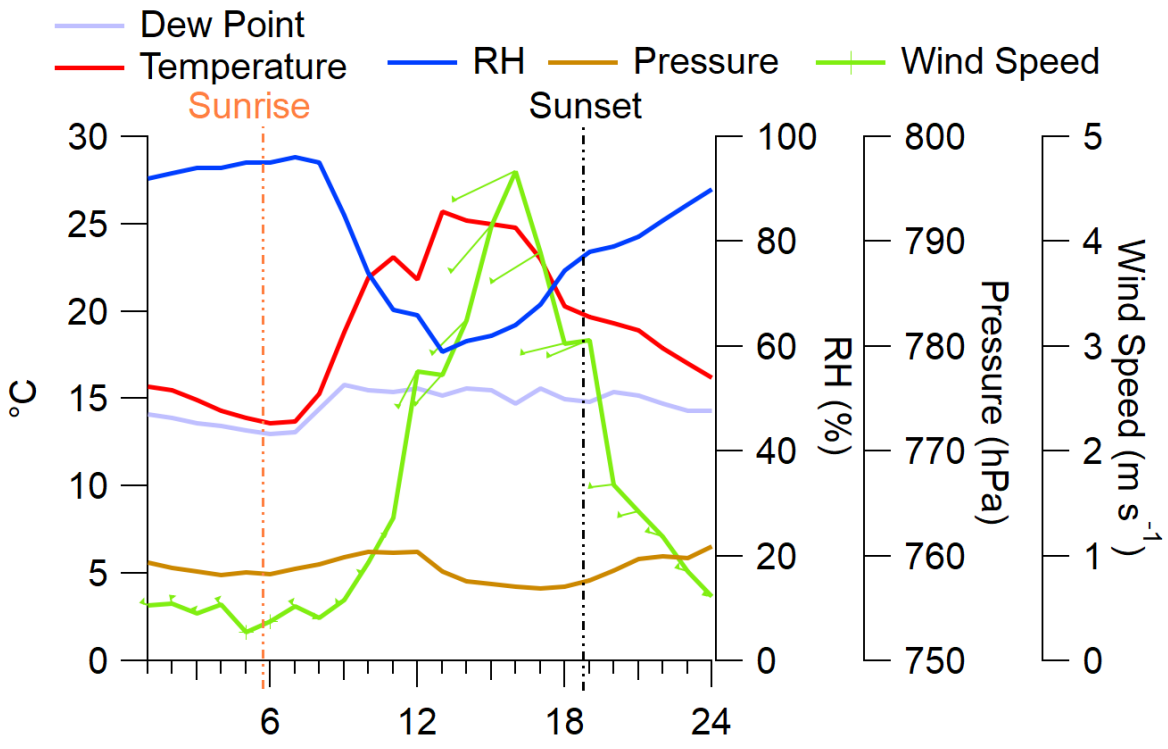

Figure SI4: Weather metric diurnals for NAMaSTE1 in April 2015 at Bode in Kathmandu Valley, Nepal.

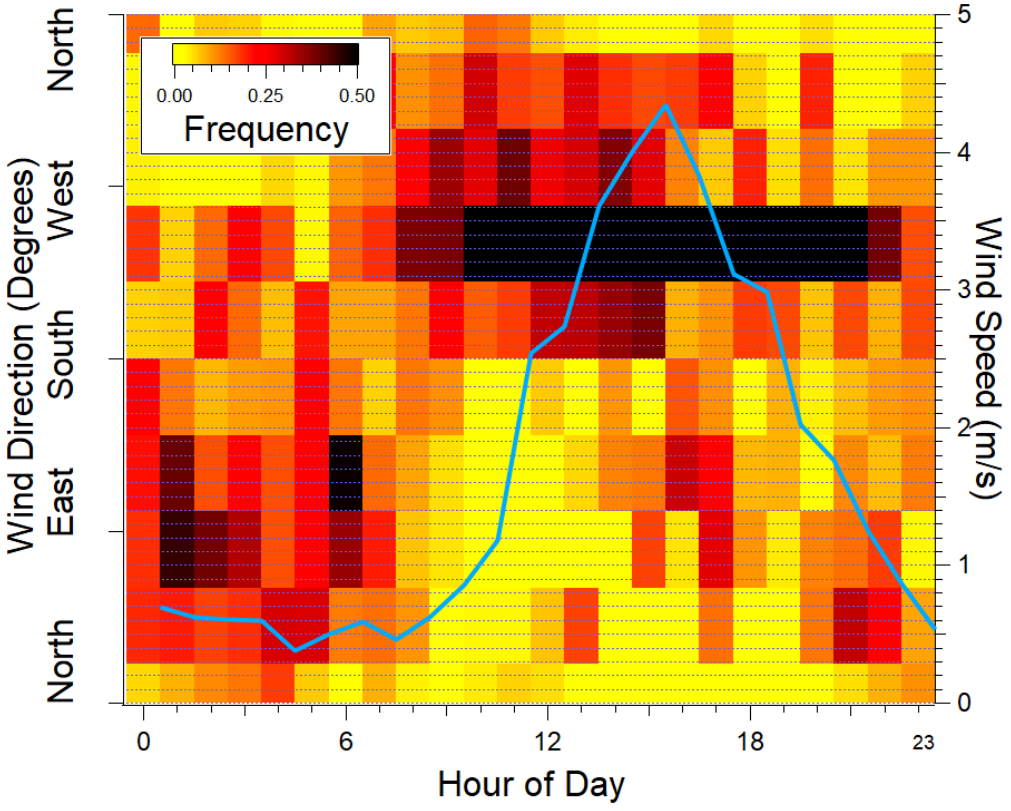

Figure SI5: Wind Diurnal for April 2015, Bode, Madhyapur, Kathmandu Valley, Nepal. Wind direction binned by frequency of occurrence over 5 minutes (degrees), Wind Speed mean ($m\ s^{-1}$).

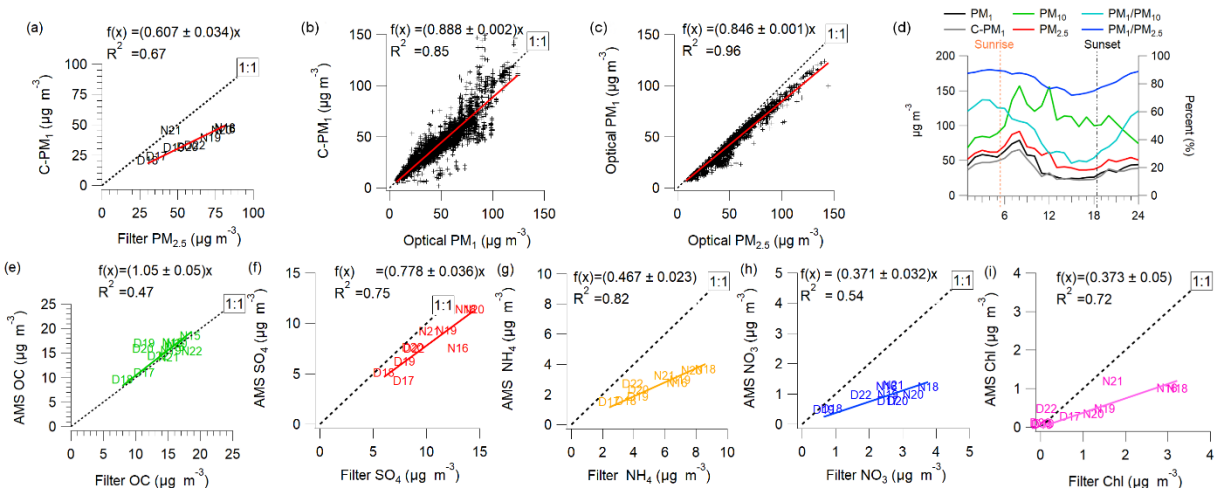

Figure SI6: Comparison of different co-located PM measurement methods from Bode in the Kathmandu Valley during NAMaSTE1 in April 2015. (a) C-PM_1 and filter based $PM_{2.5}$, (b) C-PM_1 and optical PM_1, (c) optical PM_1 and $PM_{2.5}$, (d) diurnal fraction of PM sizes and size fractions. Comparison of AMS OC and OMM-CMB OC sources (e) OC, (f) sulfate, (g) ammonium, (h) nitrate, (i) chloride.

Table SI1: Meteorological Conditions at Bode in Madhyapur Thimi, Kathmandu Valley, Nepal, April 2015.

	Average	σ	Min	Max
Temperature (° C)	19.2	3.5	12.9	28.6
Pressure (hPa)	760	3	755	767
Relative Humidity (%)	80	14	44	100
Wind Speed (m s^{-1})	1.71	1.77	0	10.23
Dew Point (° C)	15.0	2.1	4.4	19.3

Table SI2: Diurnal averages of PM_1 chemical species for NAMaSTE1, April 2015, Bode, Kathmandu Valley, Nepal.

Diurnal Hour	C-PM_1 ($\mu g\ m^{-3}$)	BC_{880nm} ($\mu g\ m^{-3}$)	BrC ($\mu g\ m^{-3}$)	Org ($\mu g\ m^{-3}$)	SO_4^{2-} ($\mu g\ m^{-3}$)	NH_4^+ ($\mu g\ m^{-3}$)	Cl^- ($\mu g\ m^{-3}$)	NO_3^- ($\mu g\ m^{-3}$)	Wind Speed ($m\ s^{-1}$)
1	36.8	12.6	1.9	15.5	7.3	2.6	0.7	1.4	0.6
2	44.9	14.8	-	15.4	10.0	3.4	0.9	1.4	0.6
3	49.6	17.0	-	14.7	11.6	4.3	1.9	1.5	0.6
4	46.0	15.5	0.4	14.3	10.8	3.8	1.3	1.4	0.6
5	46.4	16.6	0.5	14.9	10.6	3.7	1.2	1.4	0.4
6	53.0	17.5	-	15.1	11.7	4.1	1.5	1.5	0.5
7	62.3	21.0	1.3	16.5	12.4	4.4	1.9	1.7	0.6
8	75.8	24.0	0.5	20.5	14.1	5.6	3.0	2.2	0.5
9	64.6	16.9	4.4	23.4	13.2	5.2	2.4	2.6	0.6
10	52.8	14.3	6.3	24.2	11.0	4.3	1.5	2.6	0.9
11	28.0	9.5	2.7	23.3	6.0	2.1	0.2	1.0	1.1
12	33.3	7.6	2.2	15.4	6.3	2.1	0.2	1.0	2.1
13	25.0	5.0	1.8	15.6	4.8	1.7	0.1	0.9	2.7
14	26.2	5.2	1.8	13.7	5.2	1.8	0.2	0.9	3.6
15	23.5	4.9	1.4	13.0	5.5	1.8	0.2	0.5	3.8
16	20.3	3.8	1.3	10.3	5.1	1.6	0.1	0.4	4.1
17	21.0	4.6	1.4	9.6	5.1	1.6	0.1	0.4	3.7
18	20.7	4.3	1.6	9.3	4.7	1.4	0.1	0.4	2.9
19	24.7	5.8	2.6	10.2	4.7	1.6	0.2	0.6	2.7
20	37.4	8.0	4.4	13.3	5.2	1.9	0.4	1.2	1.7
21	34.8	7.3	3.8	20.9	5.5	1.9	0.4	1.0	1.5
22	35.9	9.3	2.7	17.4	6.3	2.2	0.4	1.1	1.1
23	37.1	9.9	2.4	16.5	7.2	2.5	0.6	1.1	0.8
24	35.2	10.4	2.4	15.1	7.2	2.3	0.4	1.0	0.5

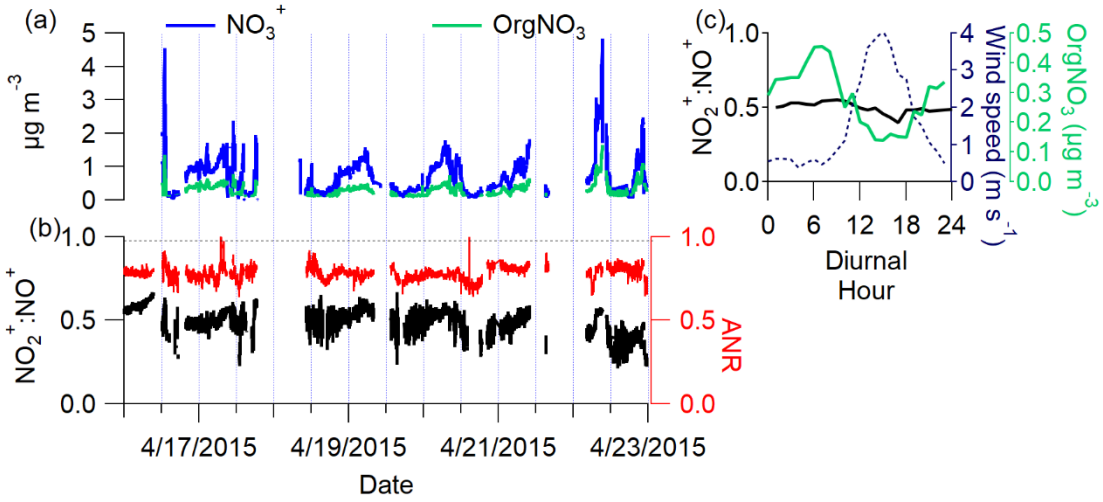

Figure SI7: Time series of a) organic nitrate, nitrate, and the ratio of the two, b) particulate NO^+ to NO_2^+ and ANR, and diurnal pattern c) of NO_2^+:NO^+ Wind speed, and $OrgNO_3$ from NAMaSTE1 in April 2015, in the Kathmandu Valley, Nepal.

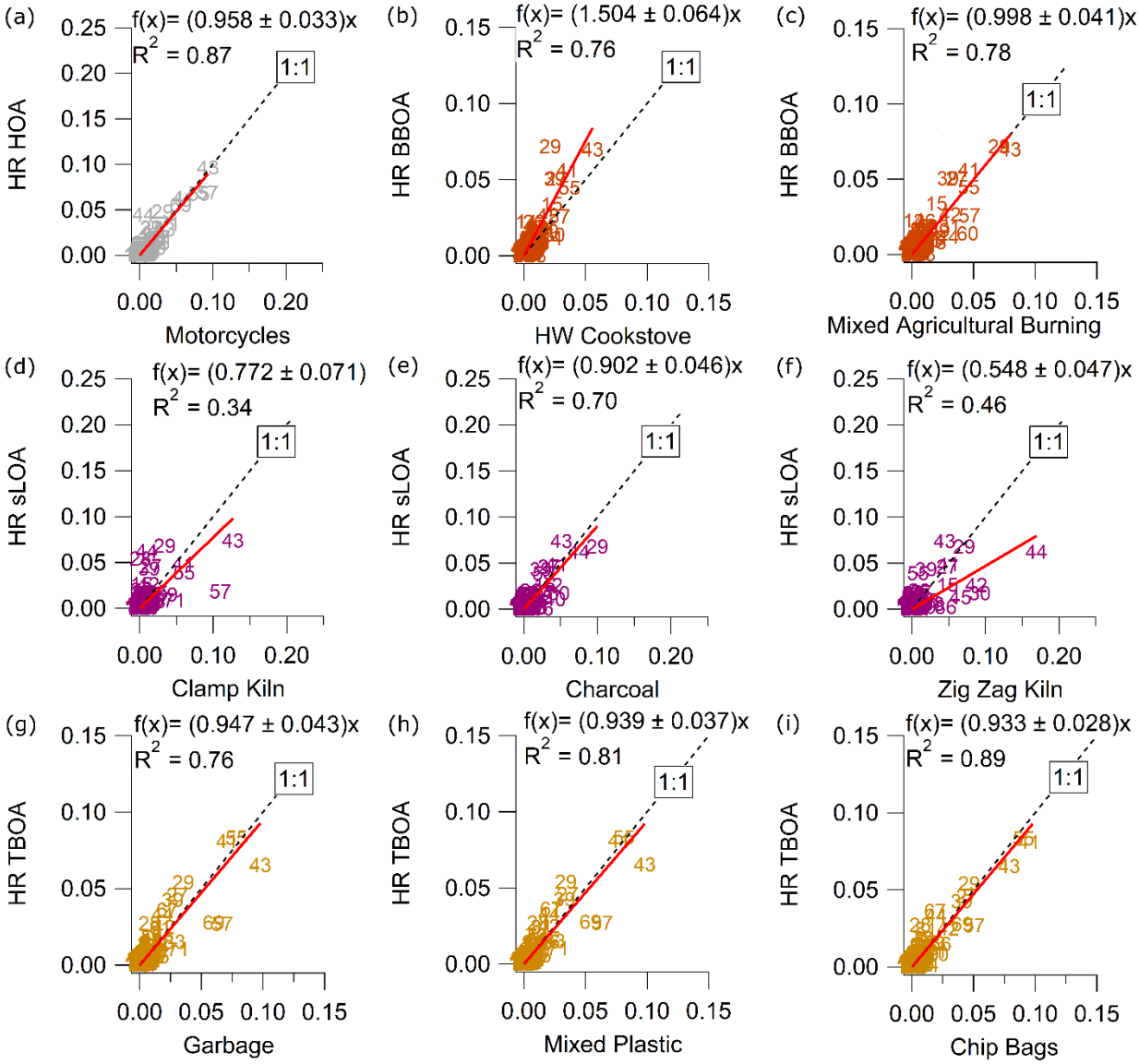

Figure SI8: Comparison of HR-AMS PMF source factors and direct source measurement mass spectra for NAMaSTE1 in Kathmandu, Nepal, 2015. (a) HR HOA compared to motorcycle emissions, (b) BBOA compared to hardwood cookstoves emissions, (c) BBOA compared to mixed agricultural burning emissions, (d) sLOA compared to clamp style brick kilns, (e) sLOA compared to Charcoal, (f) sLOA compared to zig-zag style brick kilns emissions, (g) TBOA compared to garbage burning emissions, (h) TBOA compared to mixed plastic burning, (i) TBOA compared to burning chip bag emissions.

Table SI3: OA Factor daily averages from NAMaSTE1, April 2015, Bode, Madhyapur, Kathmandu Valley, Nepal.

Diurnal Hour	HOA ($\mu g\ m^{-3}$)	BBOA ($\mu g\ m^{-3}$)	TBOA ($\mu g\ m^{-3}$)	sLOA ($\mu g\ m^{-3}$)	OOA1 ($\mu g\ m^{-3}$)	OOA2 ($\mu g\ m^{-3}$)	OOA3 ($\mu g\ m^{-3}$)
0	2.2	2.5	1.0	0.2	2.2	3.7	2.1
1	1.3	2.1	0.7	0.5	3.9	3.5	1.9
2	1.0	2.3	0.5	1.0	3.9	3.4	1.5
3	1.6	2.5	0.7	1.3	3.7	3.0	1.6
4	2.0	2.7	1.0	1.2	2.1	2.3	1.8
5	2.3	3.4	1.1	2.1	2.0	2.3	1.7
6	4.2	4.4	1.9	2.7	3.6	2.2	1.7
7	3.7	4.2	1.7	2.9	3.1	1.7	2.0
8	3.6	3.8	1.8	2.0	3.1	2.5	3.0
9	4.1	3.5	2.1	0.0	7.0	2.9	4.4
10	1.1	1.2	1.3	0.0	3.1	3.1	2.8
11	1.3	1.5	1.9	0.0	3.4	3.0	3.5
12	1.0	0.9	1.2	0.0	2.5	3.2	2.5
13	1.0	1.2	1.1	0.0	2.8	3.2	1.8
14	1.1	0.9	0.8	0.0	3.4	3.2	1.0
15	0.7	0.7	0.6	0.0	3.1	3.0	0.6
16	0.9	1.0	0.6	0.1	3.4	2.6	0.7
17	1.1	1.3	0.7	0.0	4.3	2.3	0.6
18	2.4	2.3	1.5	0.0	4.0	2.4	1.1
19	4.6	2.8	5.9	0.1	1.7	2.3	1.7
20	2.9	2.7	3.6	0.1	2.3	3.0	1.6
21	2.2	2.7	1.7	0.1	4.1	3.7	1.7
22	2.2	2.9	1.1	0.3	3.6	3.8	1.5
23	2.2	2.7	1.0	0.3	2.9	3.7	1.8

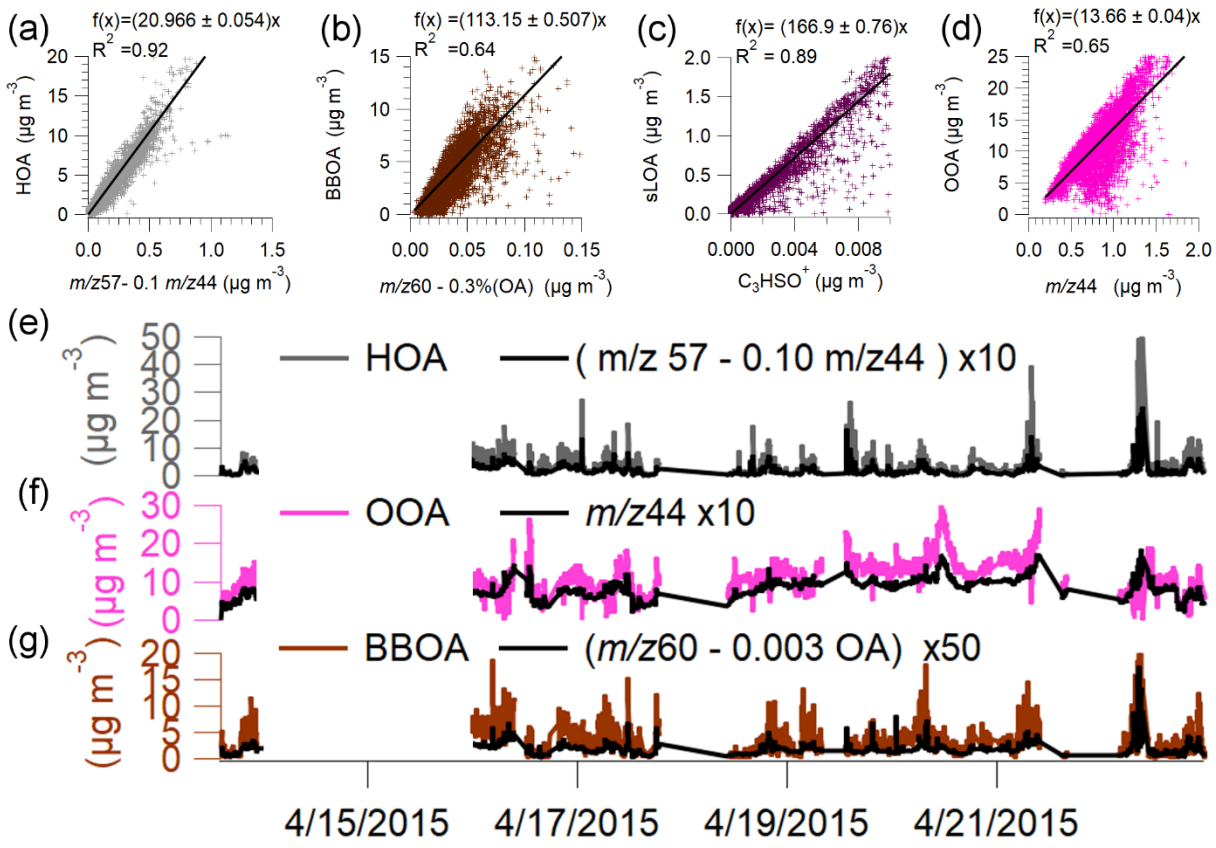

Figure SI9: AMS-PMF source factors and tracer m/z from UMR measurements: (a) HOA vs. m/z 57 OOA corrected (b) OOA vs. m/z 44; (c) BBOA vs. m/z 60 – 0.3% of OA; (d) TBOA vs. m/z 166. (e) LSOA vs. C_3HSO (f) Time series of OOA, BBOA, and HOA estimates in UMR compared to full PMF analysis of the HR data for NAMaSTE1, in April 2015 at Bode Madhyapur Thimi, Kathmandu Valley, Nepal.

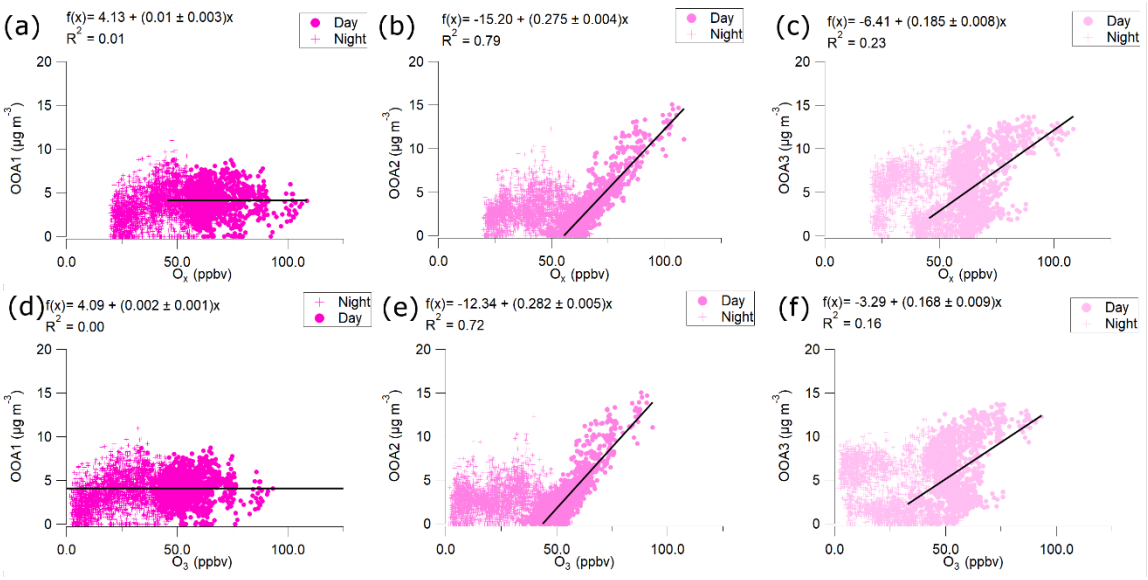

Figure SI10: Odd oxygen and ozone compared to oxygenated organic aerosols for daytime periods of NAMaSTE1, in Kathmandu Valley, Nepal, April 2015. Linear regression of daytime OOA1 and O_x (a), OOA2 and O_x (b), OOA3 and O_x (c), OOA1 and O_3 (d), OOA2 and O_3 (e), OOA3 and O_3 (f).

Table SI4: OA to OC ratios from NAMaSTE1 AMS-PMF factors, April 2015 at Bode in the Kathmandu Valley, Nepal, and other previous studies.

		OA:OC ratios		
Factor	Source	Goetz et al., 2018	Canagaratna et al., 2015	PMF NAMaSTE1
HOA	Traffic	1.30	1.34	1.42
BBOA	Biomass Burning	1.62	1.64	1.68
TBOA	Mixed Plastics Burning	1.42		1.40
sLOA	Clamp Brick Kilns	1.32		1.45
OOA1	SVOOA		2.25	2.33
OOA2	MVOOA			1.71
OOA3	LVOOA		1.84	1.87

Table SI5: OC to BC ratios from previous studies and NAMaSTE1 factors in April 2015 at Bode in the Kathmandu Valley, Nepal.

OC:BC ratios

Factor	Goetz et al., 2018	Jayarathne et al., 2018	Weyant et al., 2014	Andrea and Merlet, 2001	Christian et al., 2010	Zhu et al., 2002	NAMaSTE 1
HOA	-	-	-	-	-	0.23-6.25	0.45
BBOA	3.7	6.44	-	1.8-58	-	-	3.7
TBOA	1	-	-	-	2.3	-	1
sLOA	1-52	-	0.1-0.29	-	0.16	-	0.5

Table SI6: OC source fractional comparison between AMS-PMF PM_1 and CMB-OCC $PM_{2.5}$ analysis from NAMaSTE1 in Bode Thimi, Nepal, April 2015.

OC Source	Daytime (%)	Overnight (%)
$PM_{2.5}$ CMB GAS	15.1	21.9
PM_1 PMF HOA	17.4	20.2
$PM_{2.5}$ CMB BB	16.5	14.2
PM_1 PMF BBOA	15	20.6
$PM_{2.5}$ CMB Trash	17.5	17.1
PM_1 PMF TBOA	14.3	11.5
$PM_{2.5}$ CMB Coal	3.9	5.3
PM_1 PMF sLOA	3.5	9.3
$PM_{2.5}$ CMB SOA + Other	47	41.5
PM_1 PMF Sum OOA	49.8	32.1

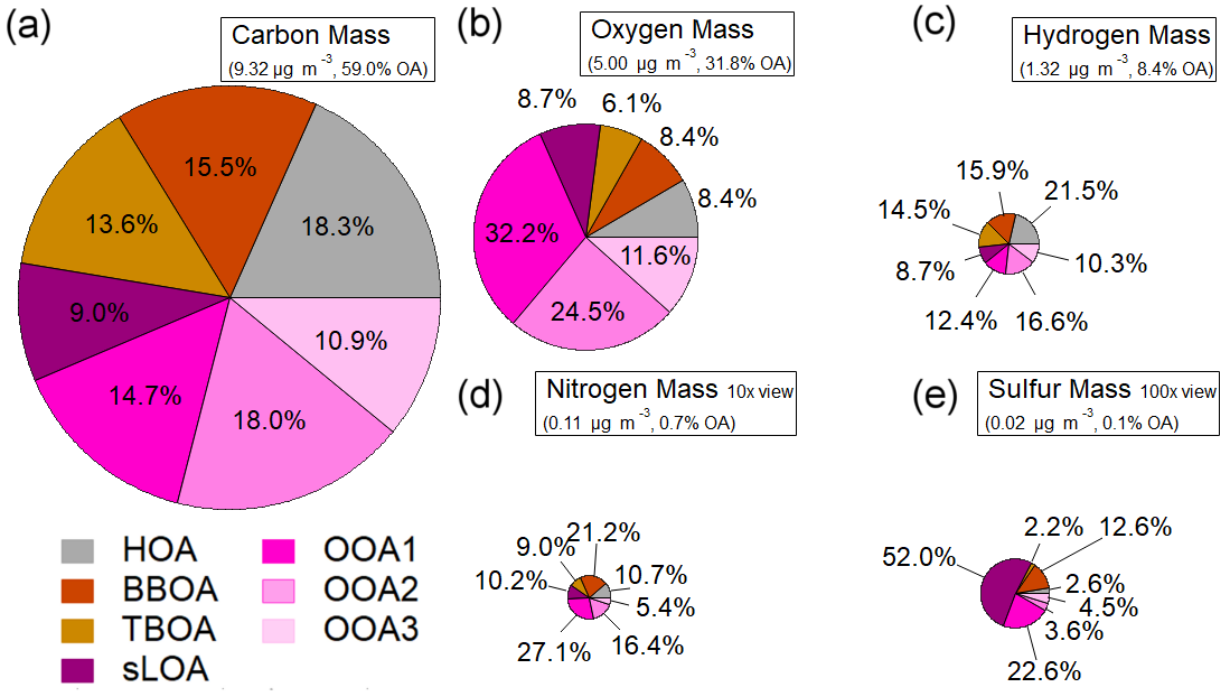

Figure SI11: Average mass and OA source fraction of elemental (a) carbon, (b) oxygen, (c) hydrogen, (d) nitrogen, and (e) sulfur, from each of the AMS-PMF factors for NAMaSTE1, Kathmandu Valley, Nepal April 2015.

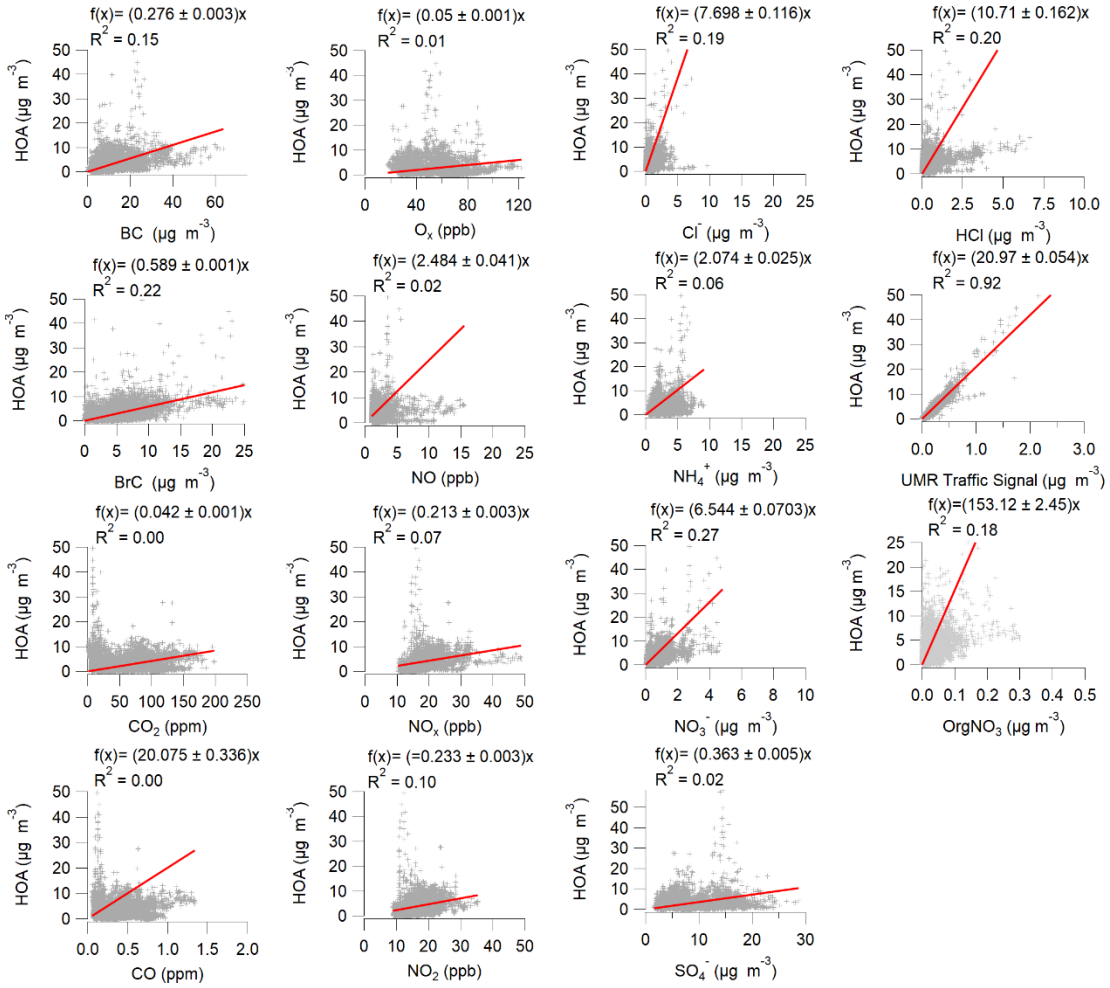

Figure SI12: Comparison of HOA to tracer aerosol and gas-phase species for NAMaSTE1in April 2015 in Kathmandu Valley, Nepal.

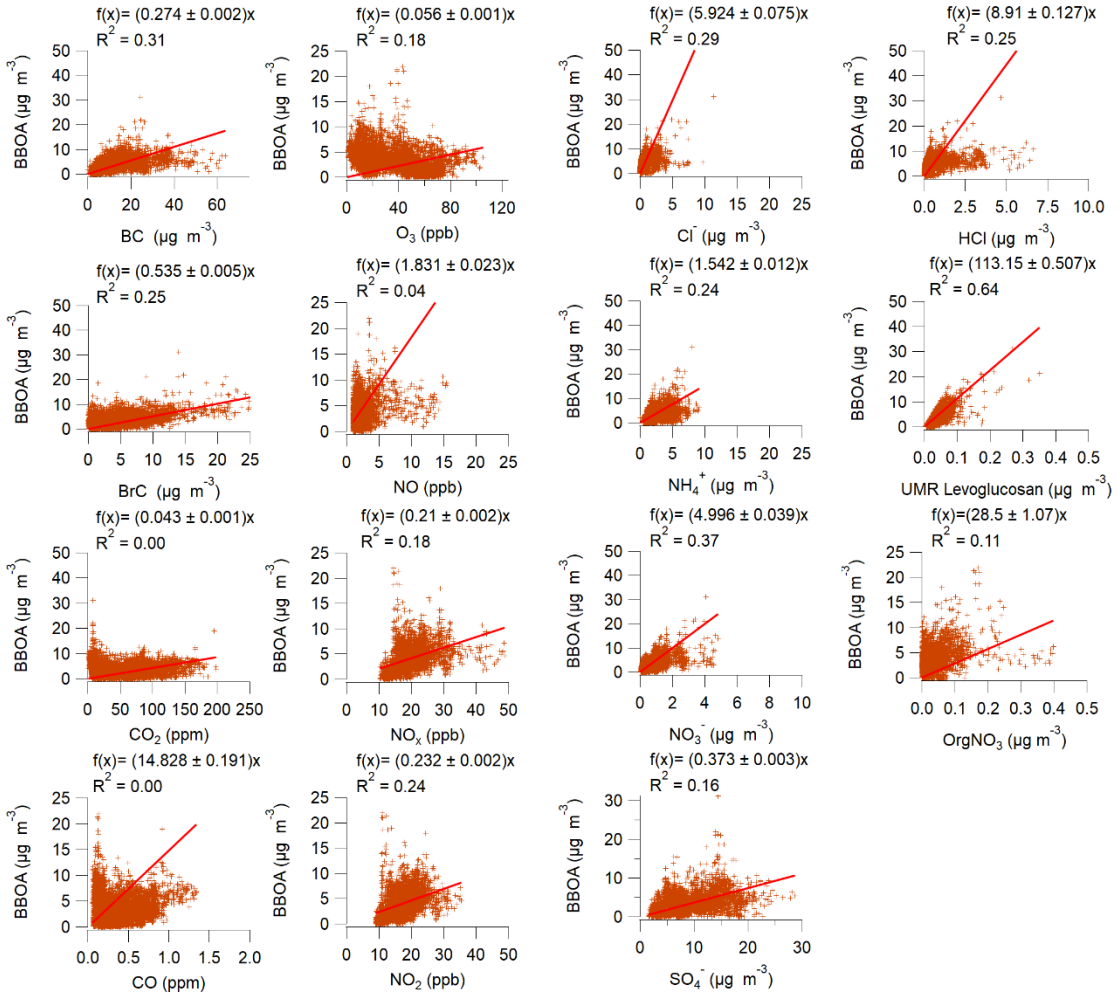

Figure SI13: Comparison of BBOA to tracer aerosol and gas-phase species for NAMaSTE1 in April 2015 in Kathmandu Valley, Nepal.

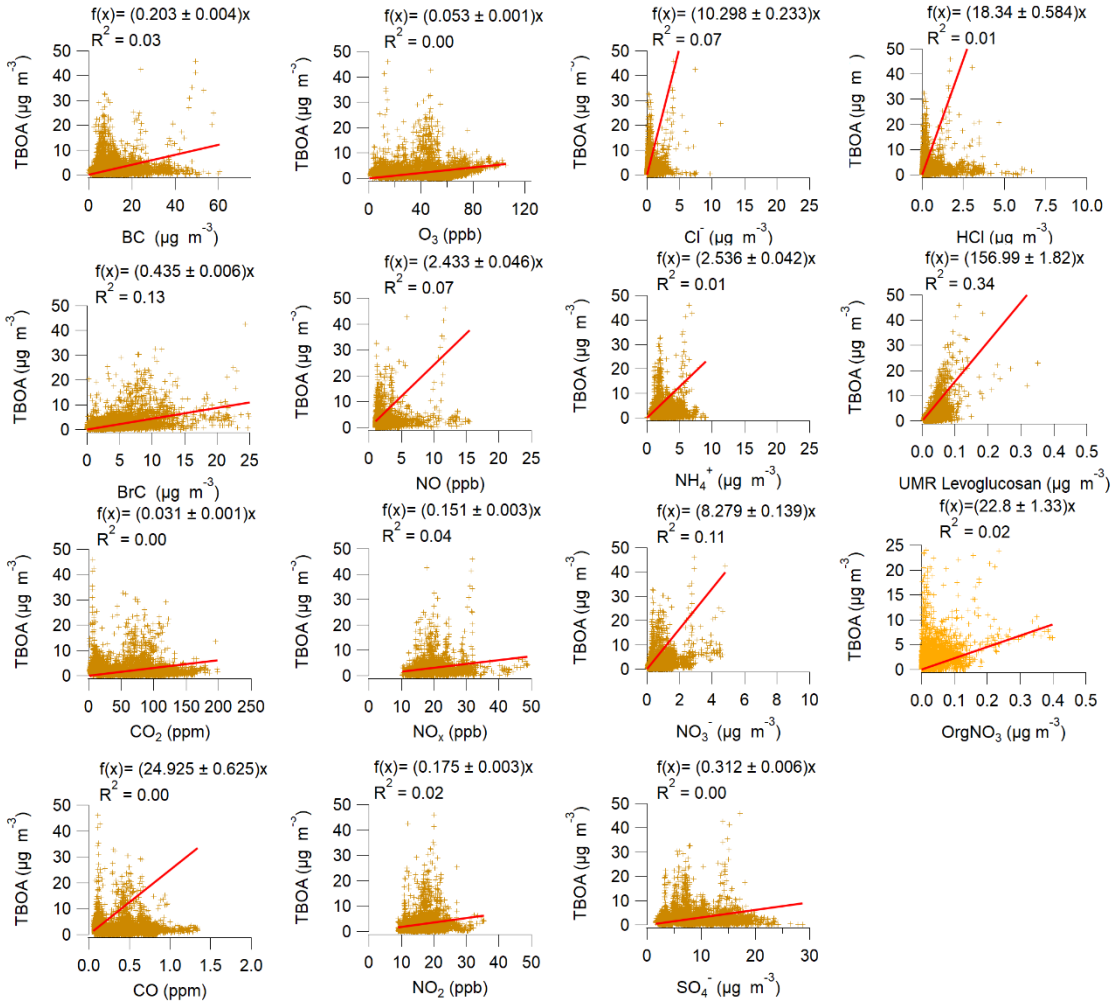

Figure SI14: Comparison of TBOA to tracer aerosol and gas-phase species, for NAMaSTE1 in April 2015, Kathmandu, Nepal.

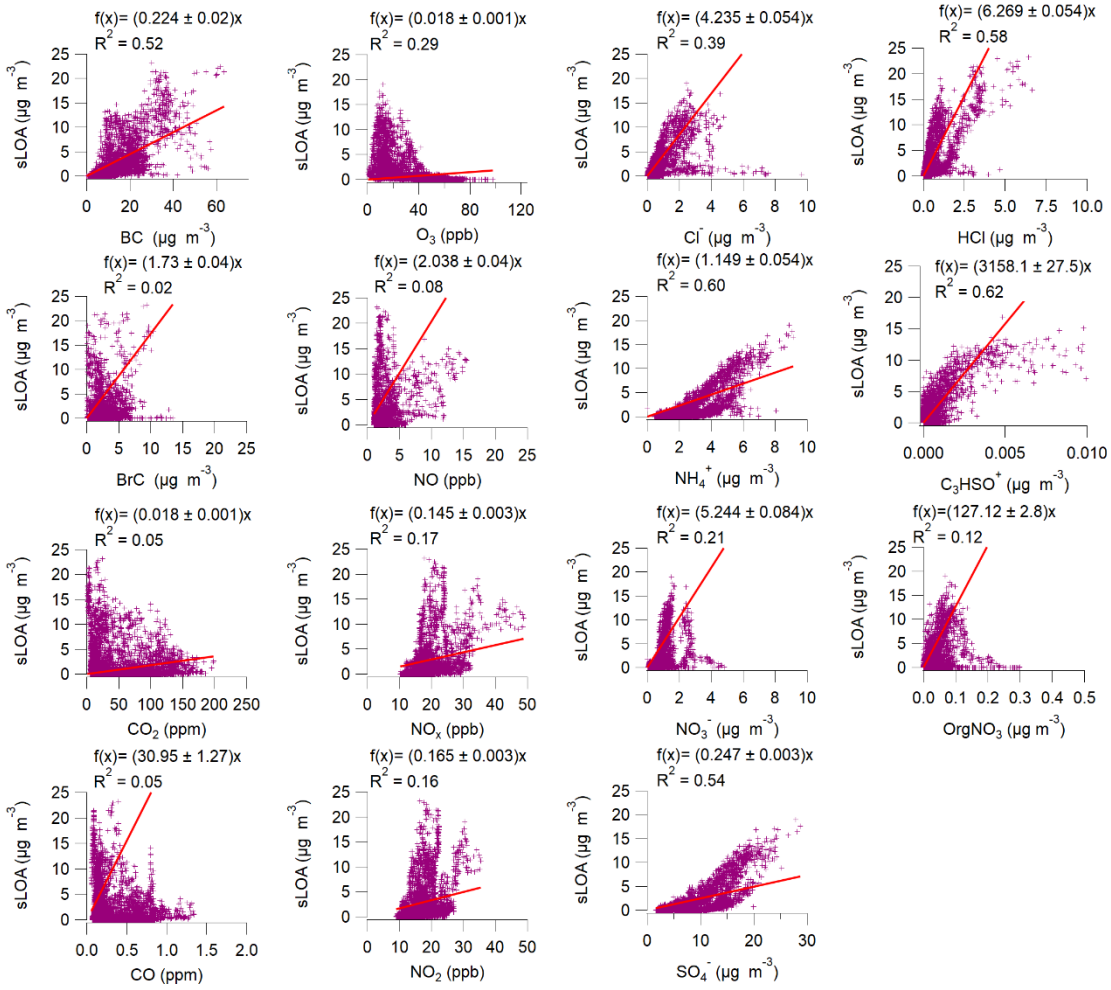

Figure SI15: Comparison of sLOA to tracer aerosol and gas-phase species for NAMaSTE1in April 2015 in Kathmandu Valley, Nepal.

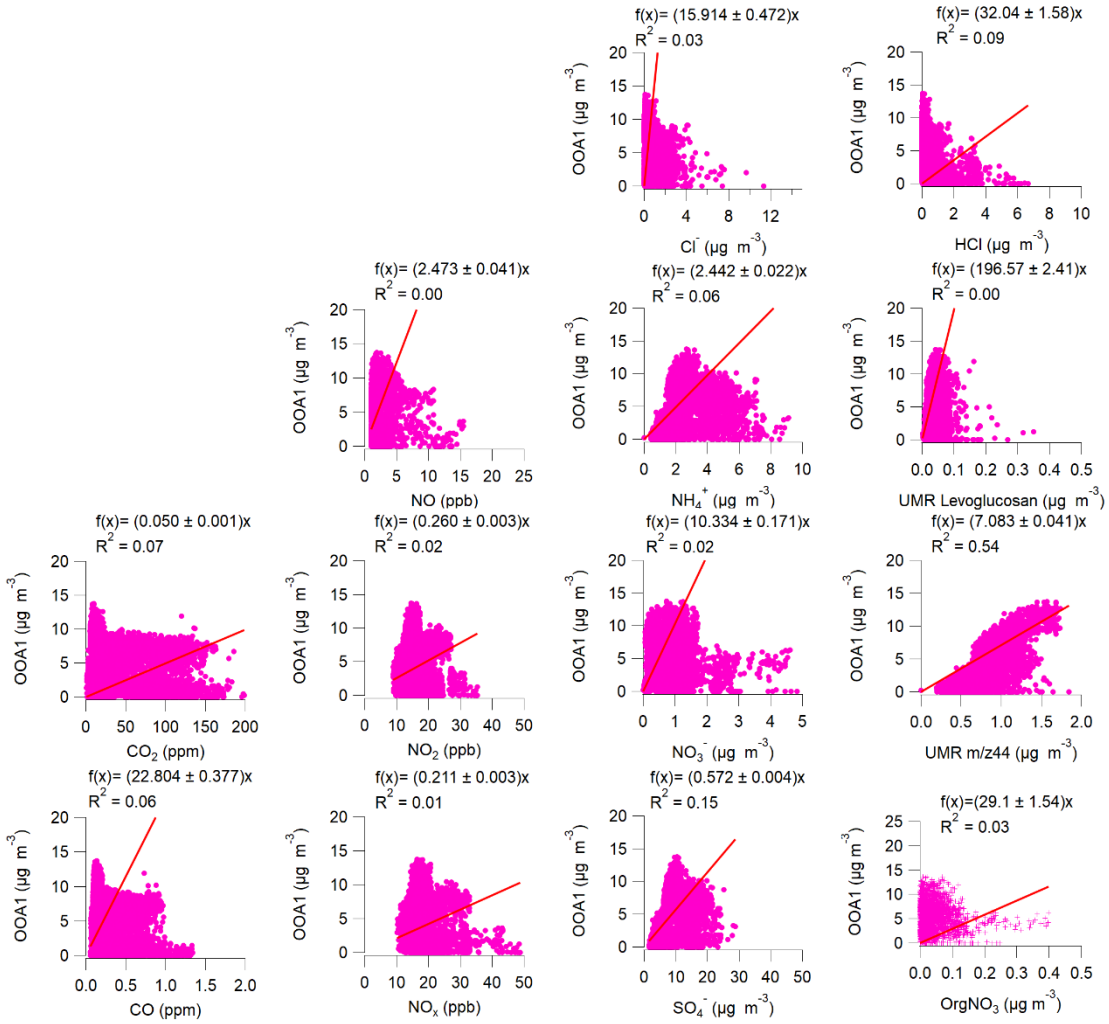

Figure SI16: Comparison of OOA1 to tracer aerosol and gas-phase species for NAMaSTE1 in April 2015 in Kathmandu Valley, Nepal.

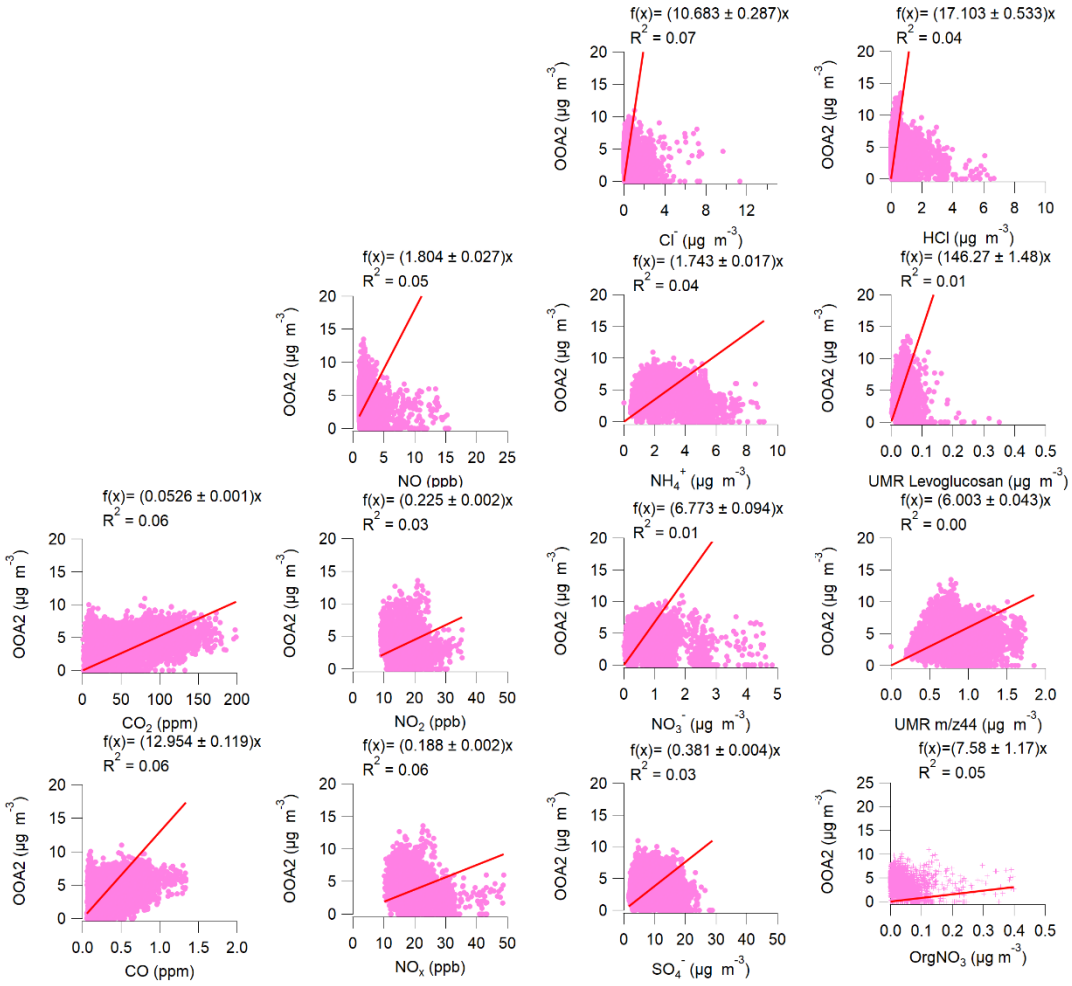

Figure SI17: Comparison of OOA2 to tracer aerosol and gas-phase species for NAMaSTE1 in April 2015 in Kathmandu Valley, Nepal.

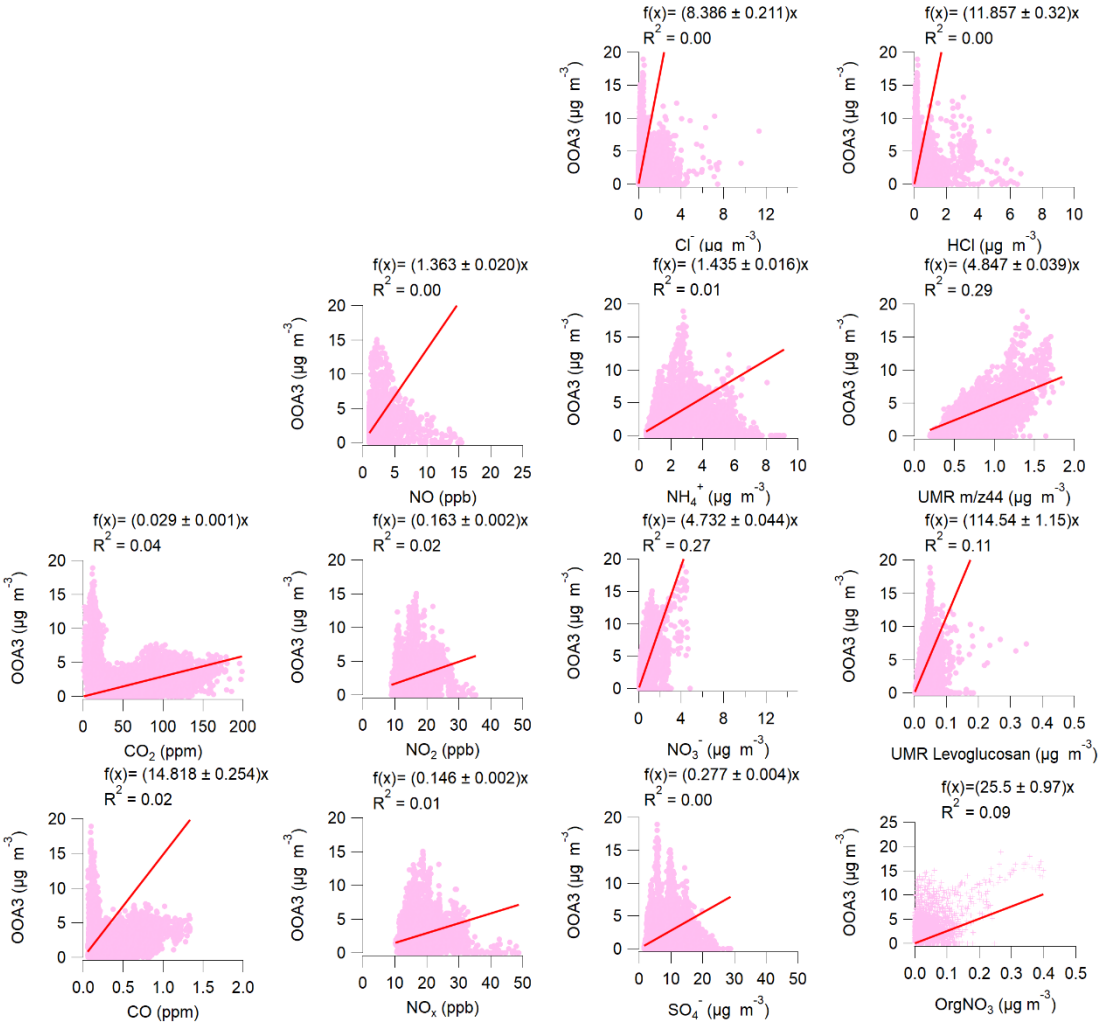

Figure SI18: Comparison of OOA3 to tracer aerosol and gas-phase species for NAMaSTE1in April 2015 in Kathmandu Valley, Nepal.