

Supporting Information for:

Indoor and Outdoor Air Quality Impacts of Cooking and Cleaning Emissions
from a Commercial Kitchen

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S1. Further notes on PTR-MS calibrations for monochloramine

Two different sensitivities for monochloramine (NH_2Cl) were considered in this analysis. First, monochloramine sensitivity was determined theoretically following the approach in Sekimoto et al. (1). We treated monochloramine as a primary amine and calculated its polarizability and dipole moment to estimate its proton transfer rate constant (1). Based on the linear relationship between proton transfer rate constant and sensitivity for directly calibrated species (i.e., using the standard cylinder or liquid standard method discussed in *Materials and Methods*), we estimated the theoretical sensitivity for monochloramine to be 407 cps/ppb.

Second, we constrained monochloramine sensitivity using a measurement of total basic nitrogen-containing gases in the kitchen from a novel instrument that measured total reactive nitrogen species (2). Using the maximum mixing ratio for basic nitrogenous gases in the kitchen and attributing it entirely to monochloramine, this resulted in a monochloramine sensitivity of 324 cps/ppb. However, we emphasize that this is an upper limit sensitivity, as it is unlikely that the entire basic gas-phase nitrogen-containing signal would consist of monochloramine alone.

We compared these values to a sensitivity that was previously determined experimentally and measured with this same PTR-MS (3). We ratioed the monochloramine sensitivity from these prior experimental calibrations to the benzene sensitivity from the same time period, and then compared this ratio with the benzene sensitivity during the kitchen measurements discussed here. This resulted in an experimentally derived monochloramine sensitivity of 329 cps/ppb during our field measurements.

In this study, the value constrained with the total basic nitrogen measurement was applied; 324 cps/ppb was used to convert the PTR-MS ion signal to a mixing ratio. If the sensitivity used to convert signal to mixing ratio were lowered (as the 324 cps/ppb is an upper

limit), the monochloramine mixing ratios reported here would increase. However, we note that despite this uncertainty, these three sensitivity estimates agree quite well and are at most different by a factor of ~ 1.25 .

S2. Further notes on plume analysis methodology

For the plume analysis discussed here, a cooking “event” was defined as any time three of these five cooking tracers increased together and remained elevated over their baseline values for several minutes: carbon dioxide (from cooking fuel, food, as well as human emissions), nitrogen monoxide (from cooking fuel), methanol (from heating vegetables and stir frying(4)), acrolein (from heated cooking oils (4)), and the sum of BTEX ions (benzene, toluene, ethylbenzene, and xylenes, from cooking fuels and food (5,6)). An example is shown in Figure S8. By this definition, 68 cooking events were identified throughout the campaign, each lasting from 13-195 minutes, but on average lasting 66 ± 37 minutes (Table S1).

After the start and end times of each event were set, the area under each ion’s time series was computed for each event. Only ions with an assigned molecular formula were considered from PTR-MS data. Time series for CO₂ from the kitchen and exhaust were also integrated. A baseline value was subtracted from each integral. The baseline for each ion was defined as the minimum value at either the start or end of the event interval, similar to Wang et al.’s approach (Figure S8) (7). The volume sampled during each event was calculated for each instrument (i.e., the PTR-MS and the CO₂ monitors), and the area under each curve was normalized by volume sampled to enable event intercomparison. Across all times series integrals for the 68 cooking events, 7.5% of integrals were negative due to slight dips in signal below the set baseline. These negative areas were discarded.

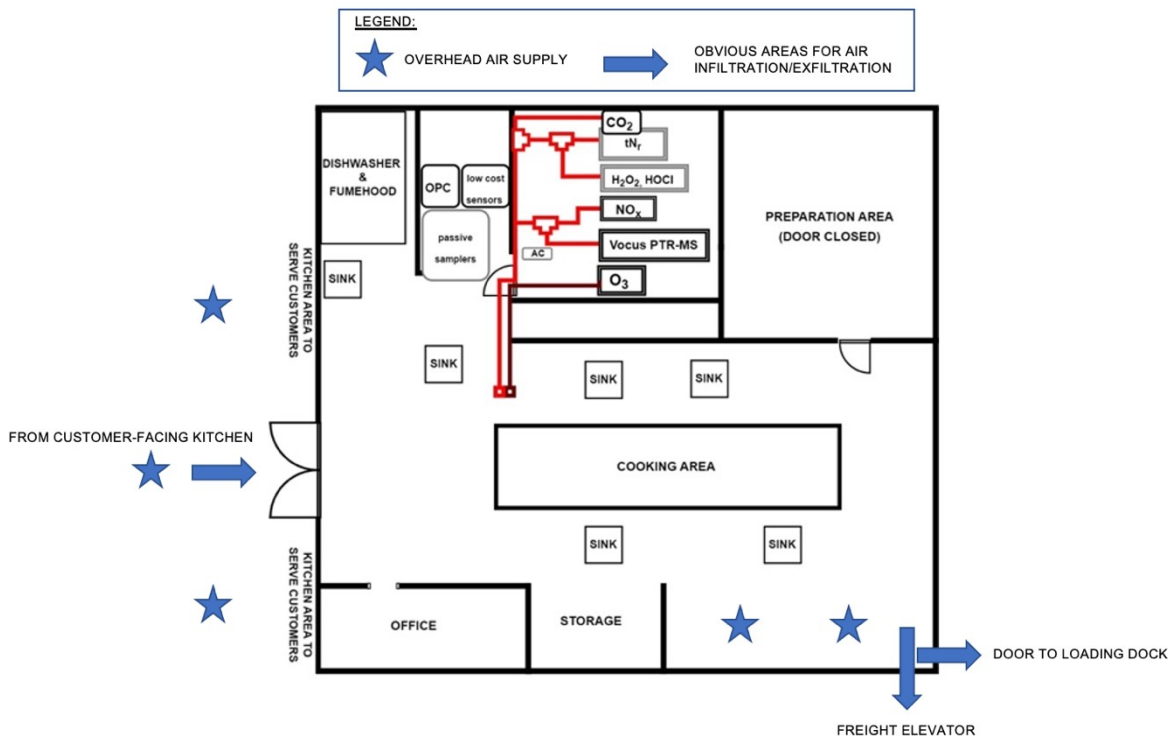


Figure S1. Simplified diagram of the kitchen. Red and maroon lines indicate instrument sampling tubing running between the office space where instruments were housed and the main kitchen area. The gas-phase inlets were positioned approximately 2 m away from the main cooking area, denoted by the rectangular region in the center of the diagram. Range hoods were positioned directly above the main cooking area. Overhead air supply locations are noted on the diagram with stars. Other obvious points for air infiltration and exfiltration are marked with arrows.

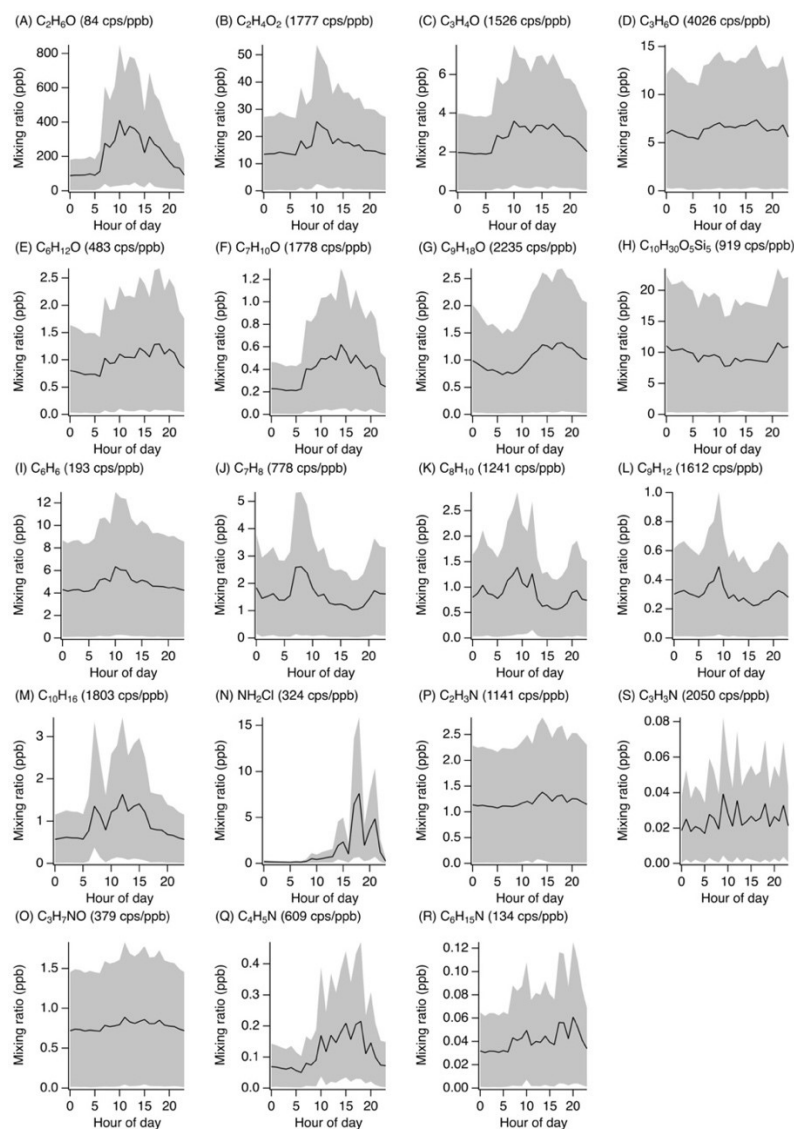


Figure S2. Diurnal time series for calibrated gases, with sensitivity during the field measurement period shown beside each molecular formula. The solid black line represents the mean, and the grey shading represents the range of mixing ratios observed. (A) C_2H_6O (calibrated with ethanol), (B) $C_2H_4O_2$ (calibrated with acetic acid), (C) C_3H_6O (calibrated with acetone), (D) C_3H_4O (calibrated with acrolein), (E) $C_6H_{12}O$ (calibrated with hexanal), (F) $C_9H_{18}O$ (calibrated with nonanal), (G) $C_7H_{10}O$ (calibrated with heptadienal), (H) $C_{10}H_{30}O_5Si_5$ (D5-siloxane, calibrated with D4-siloxane), (I) C_6H_6 (calibrated with benzene), (J) C_7H_8 (calibrated with toluene), (K) C_8H_{10} (xylenes, calibrated with o-xylene), (L) C_9H_{12} (trimethylbenzenes, calibrated with 1,3,5-trimethylbenzene), (M) $C_{10}H_{16}$ (monoterpenes, calibrated with limonene), (N) NH_2Cl (calibrated with monochloramine), (O) C_3H_7NO (calibrated with propionamide), (P) C_2H_3N (calibrated with acetonitrile), (Q) C_4H_5N (calibrated with pyrrole), (R) $C_6H_{15}N$ (calibrated with triethylamine), and (S) C_3H_3N (calibrated with acrylonitrile). We note that the uncertainty of the ethanol measurement is especially high, due to its very low sensitivity in the PTR-MS and due to possible contributions to the signal from dimethyl ether (possibly arising from refrigerants), with even lower sensitivity. Thus, even a small amount of dimethyl ether present, with its very low instrument response, would drive the ethanol mixing ratio up.

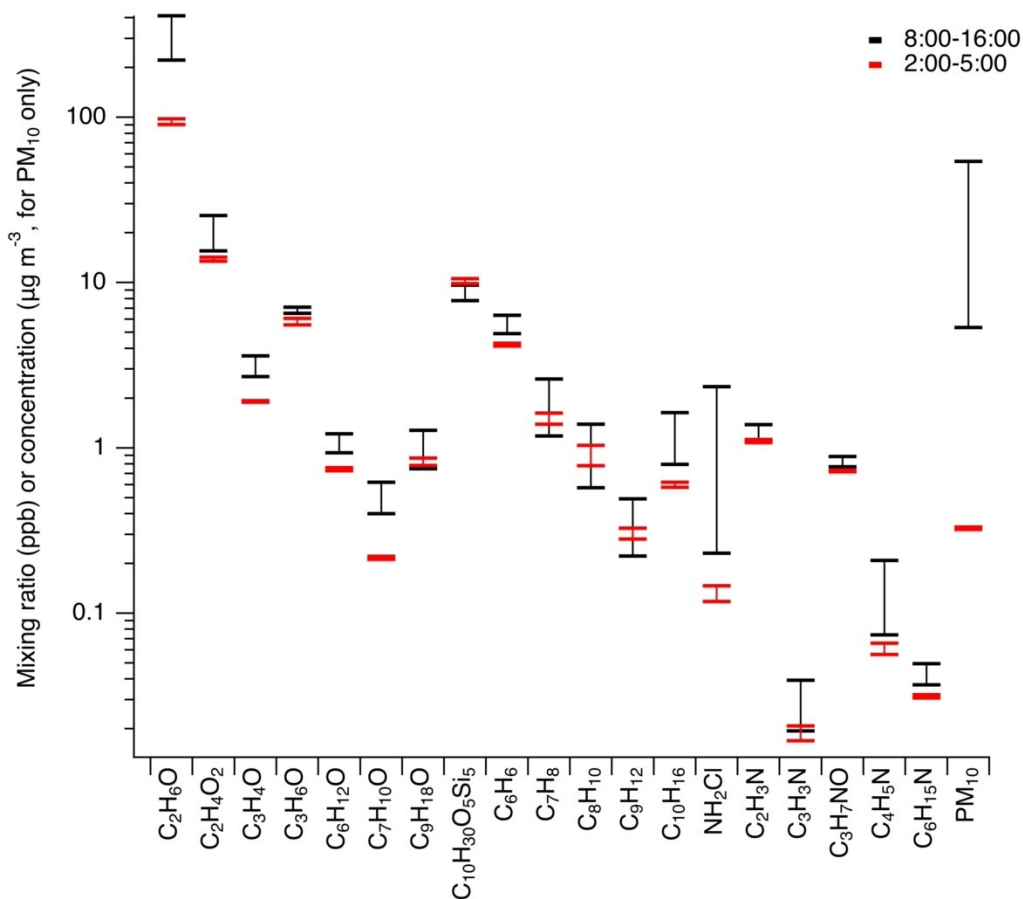


Figure S3. Mixing ratio range for calibrated gases and concentration range for total PM₁₀ from diurnal profiles. Bars represent minimum and maximum for each diurnal profile. The overnight background period (2:00-5:00) is compared to the main cooking period (8:00-16:00) to emphasize the relatively high background signals overnight and to highlight the important role of surface reservoirs in the kitchen.

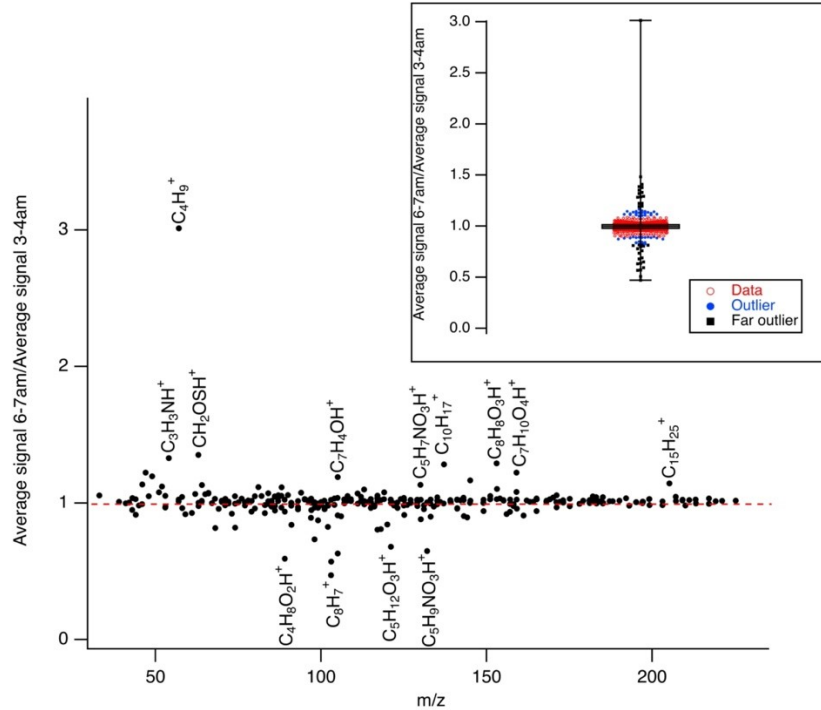


Figure S4. Average VOC signal for all ions with molecular formula assignments, calculated from 6:00-7:00 (after ventilation was turned on) and 3:00-4:00 (before ventilation was turned on). The red dotted line indicates a ratio of 1. The inset shows a box plot with whiskers at the minimum and maximum ratio value, data points in red, outlier points in blue ($1.5 \times$ interquartile range), and far outlier points in black ($3 \times$ interquartile range), emphasizing the tightness of the distribution around a ratio of 1 pre- and post-ventilation.

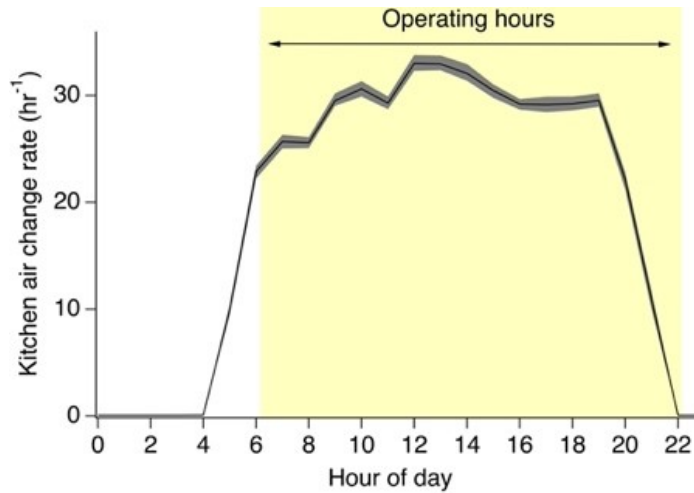


Figure S5. Diurnal plot of the air change rate in the kitchen (black line) and its lower and upper limit values (shading).

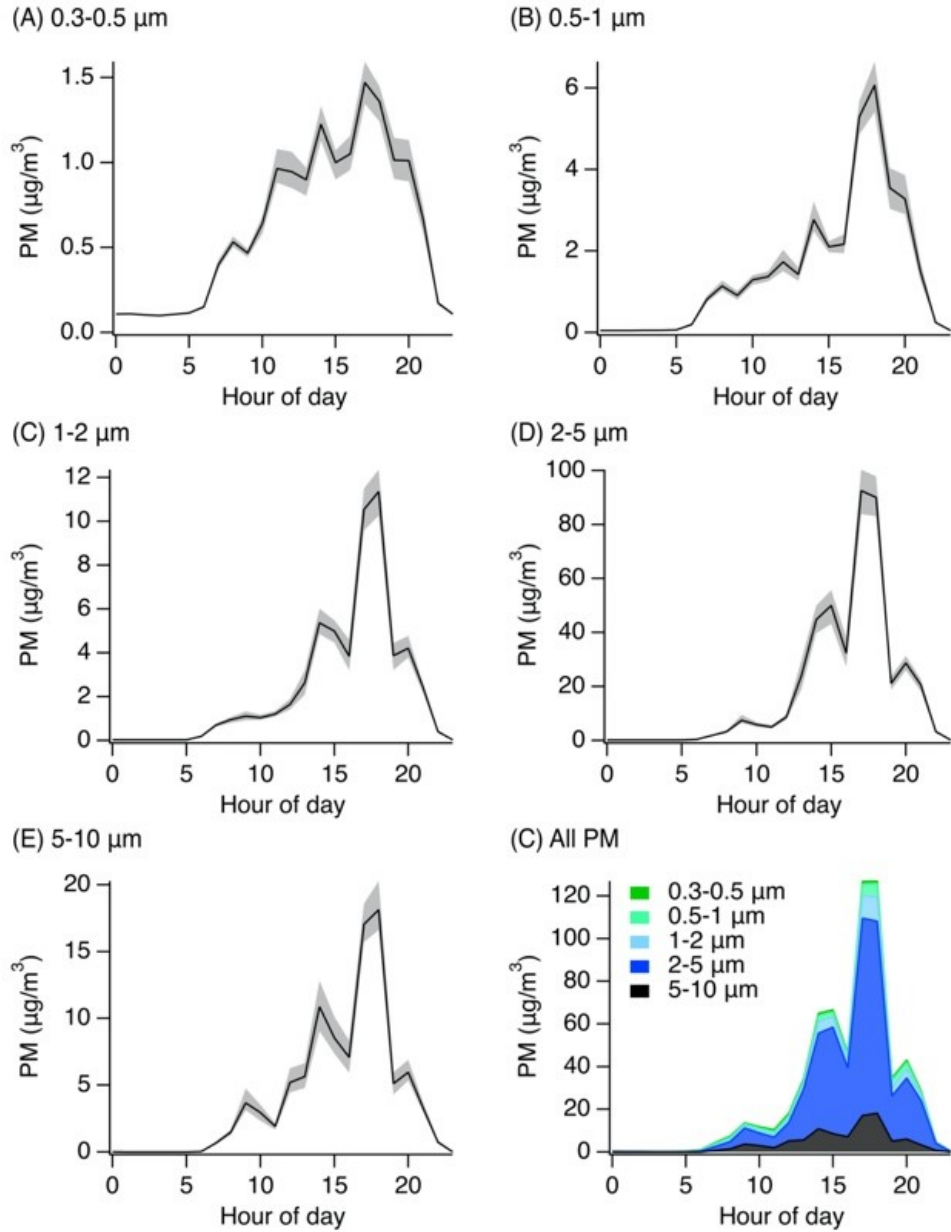
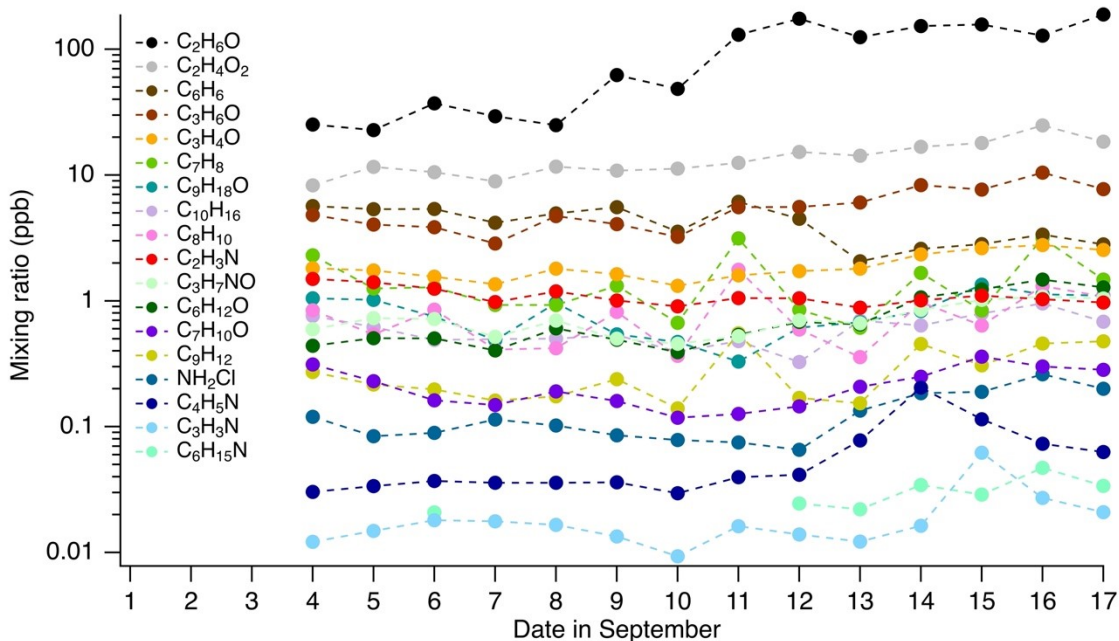


Figure S6. Diurnal plots of particulate matter concentration, showing (A) $PM_{0.3-0.5}$, (B) $PM_{0.5-1}$, (C) PM_{1-2} , (D) PM_{2-5} , (E) PM_{5-10} , (F) all sizes together. The smallest particles ($0.3-0.5 \mu\text{m}$) had a strong outdoor air source; their concentrations indoors increased with increased outdoor air supplied. While the inlet air was filtered, the smallest particles had the lowest collection efficiency and thus likely infiltrated the kitchen. For example, when the ventilation turned on around 6:00, an increase in $PM_{0.3-0.5}$ was observed. Larger particles become more important later in the afternoon during cleaning, peaking around 17:00-18:00.

(A) Average gas-phase mixing ratios during background periods overnight (2:00-5:00)



(B) Average temperature and relative humidity difference relative to September 4 (first day of gas-phase data) during background periods overnight (2:00-5:00)

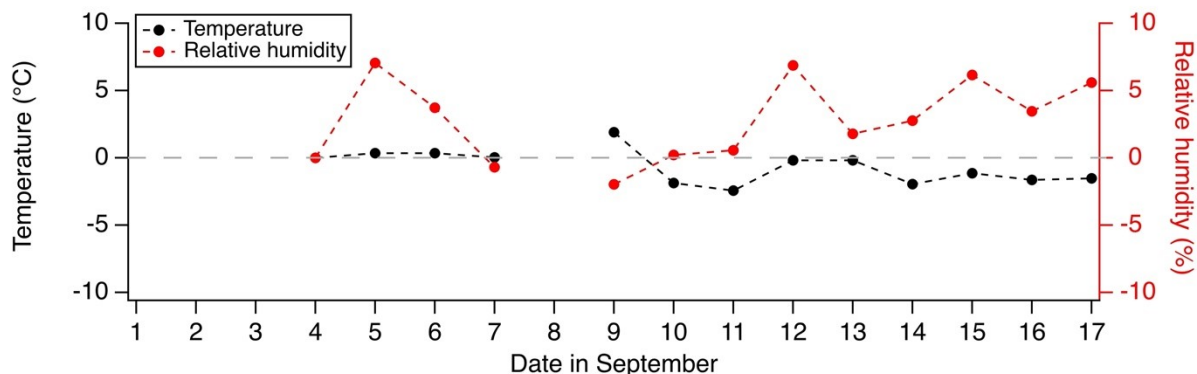


Figure S7. (A) Average background mixing ratios for quantified gases, calculated from 2:00-5:00 each day from ion time series. (B) Average temperature and relative humidity during the same background periods, shown as a difference relative to the conditions on the first day of gas-phase measurements (September 4). These data are shown here to emphasize that there was no consistently increasing temperature throughout the campaign that drove increased evaporation of gases from surfaces.

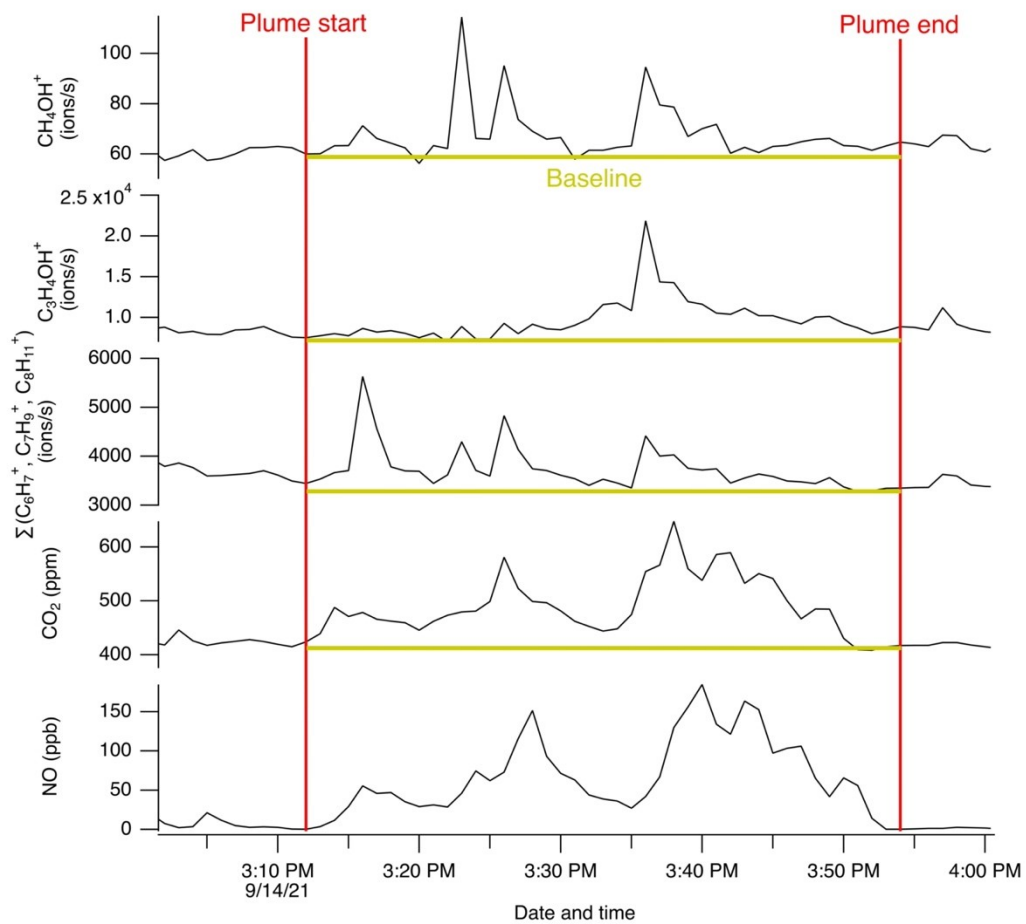
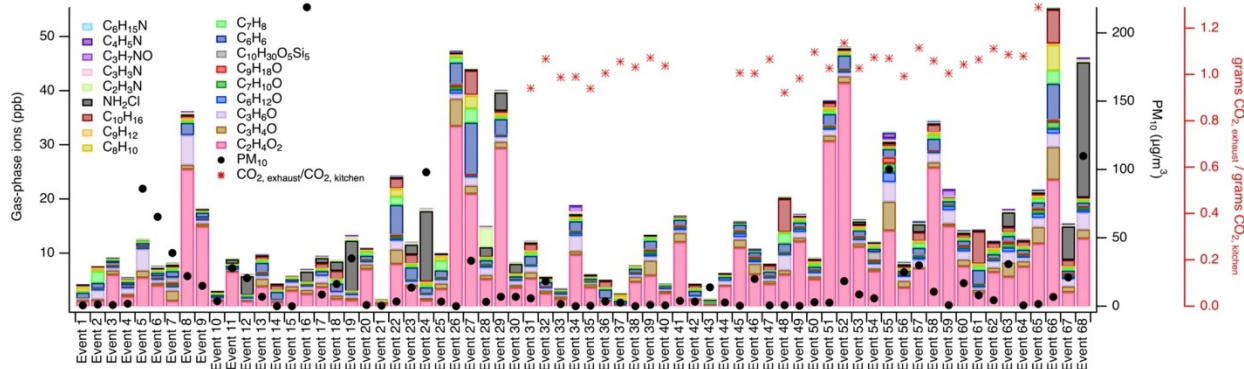


Figure S8. Example of plume and baseline definitions using cooking tracers.

(A) Distribution of quantified species from plume analysis without ethanol



(B) Distribution of quantified species from plume analysis with ethanol

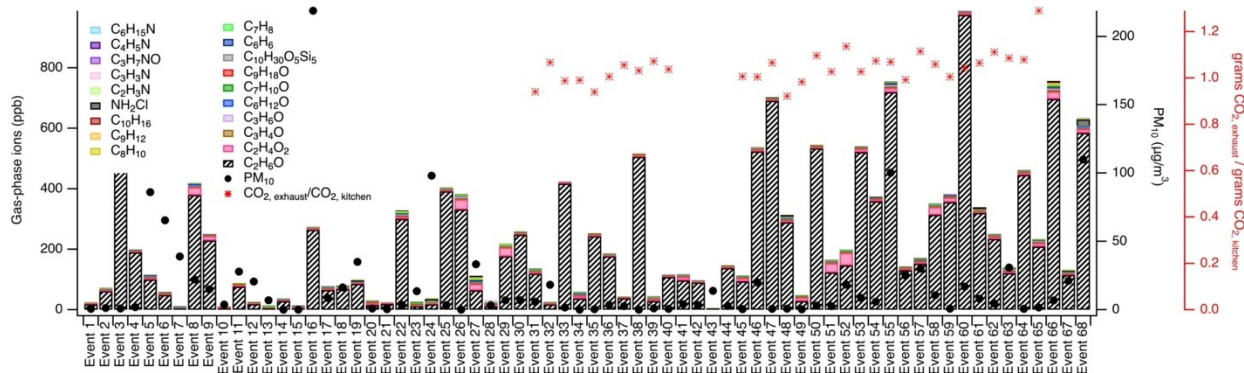


Figure S9. Results from plume analysis. (A) Distribution of quantified gases (left hand side axis), total PM₁₀ (black markers, right hand side axis) and ratio of CO₂ in exhaust to CO₂ in kitchen (red markers, right hand side axis) for each defined cooking event. Ethanol is excluded here to better visualize the contributions from the rest of the gases. (B) The same data as shown in (A) but with ethanol included to highlight its large contribution to the gas-phase species observed.

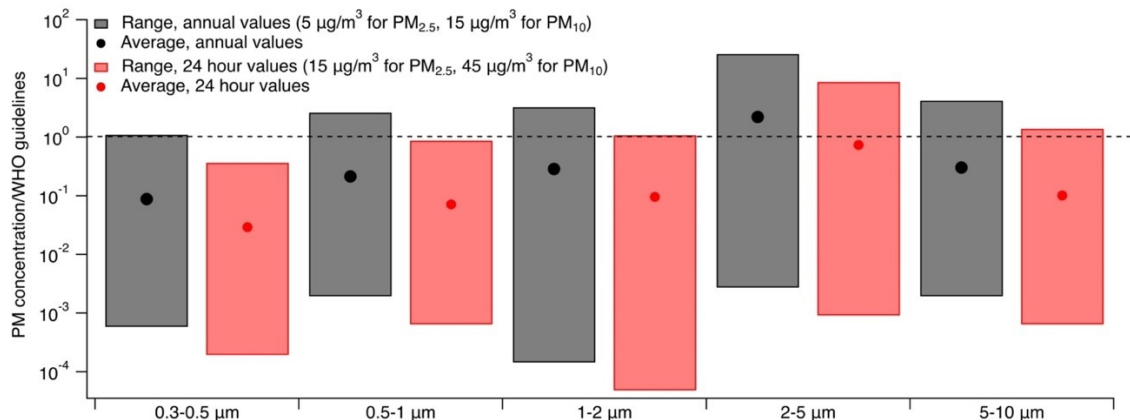


Figure S10. Comparison of particulate matter concentrations to World Health Organization concentration guidelines. Averages and ranges that surpass a ratio of 1 indicate that the observed concentration was greater than the World Health Organization concentration guideline.

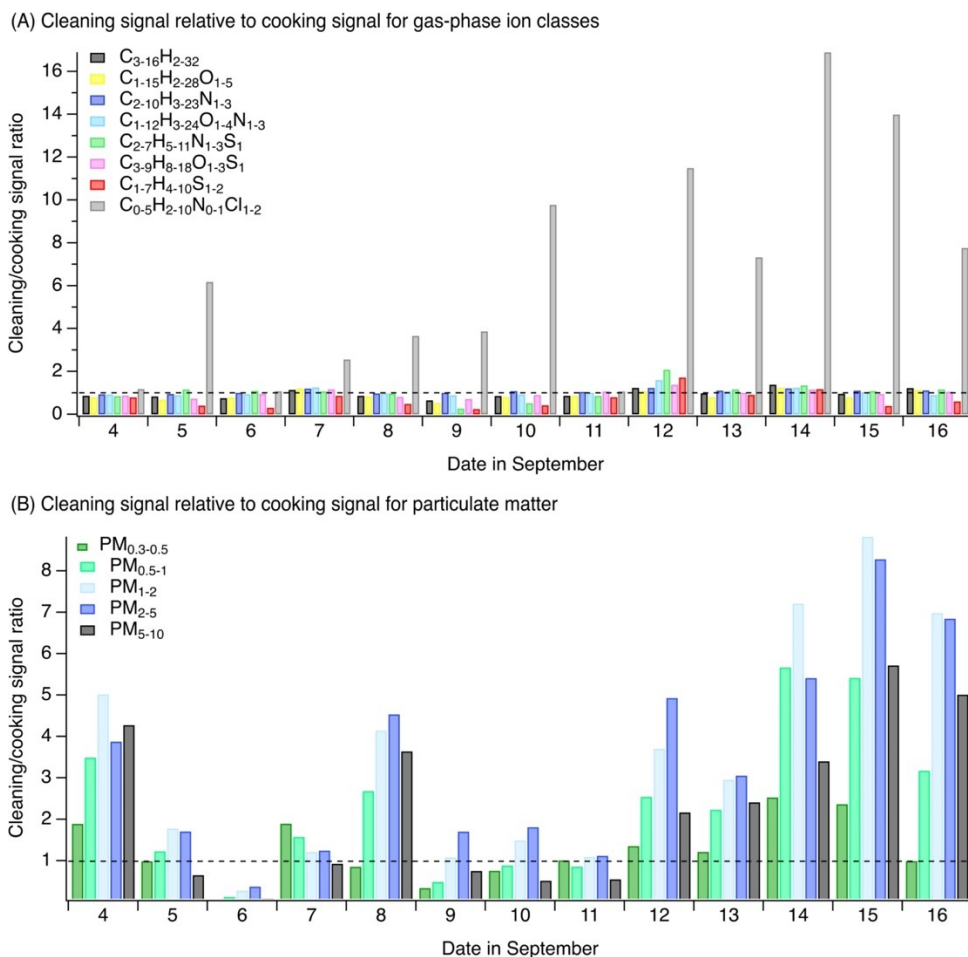


Figure S11. (A) Ion class signal from cleaning (typically 17:00-22:00) compared to signal from cooking (typically 8:00-16:00), and (B) particulate matter signal from cleaning (typically 17:00-22:00) compared to signal from cooking (typically 8:00-16:00), where the dotted line indicates a 1:1 ratio between the two periods.

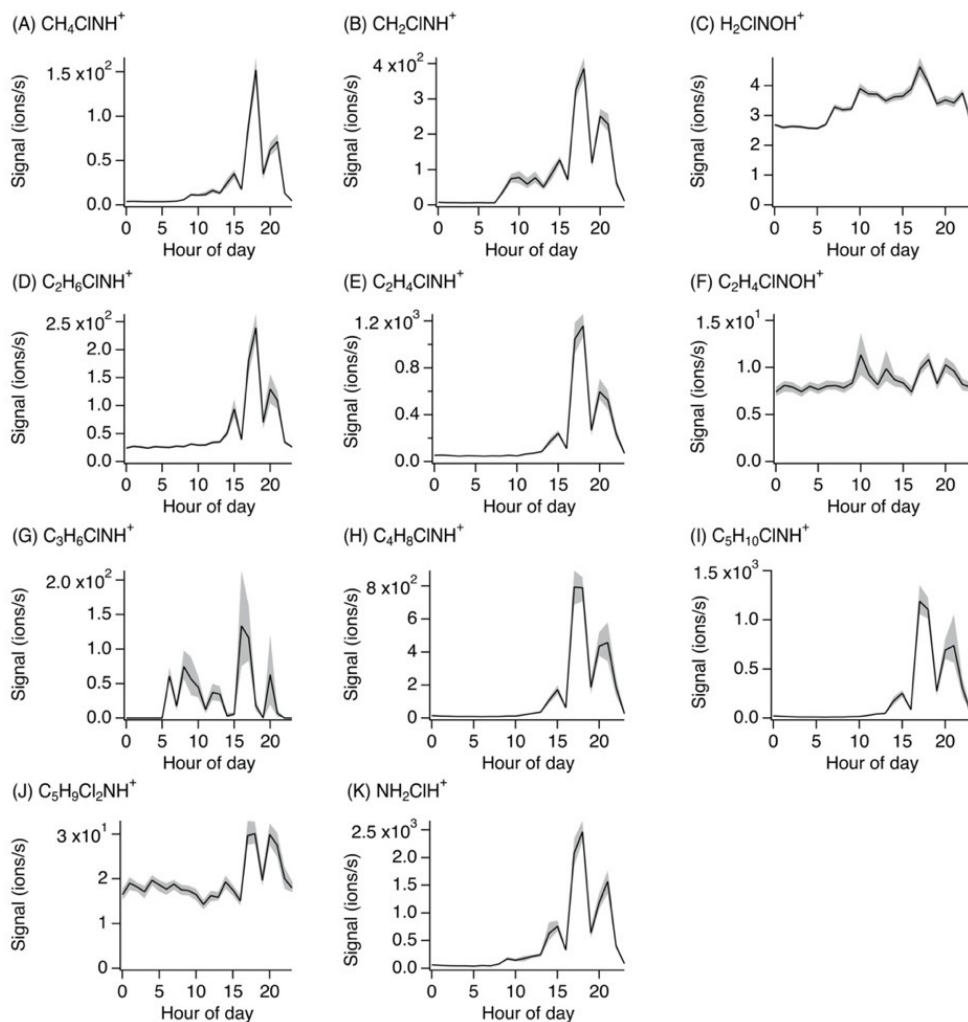


Figure S12. Diurnal trends of the observed chlorinated ions, where the black trace shows the mean signal and the grey shading represents the range of observed diurnal signals.

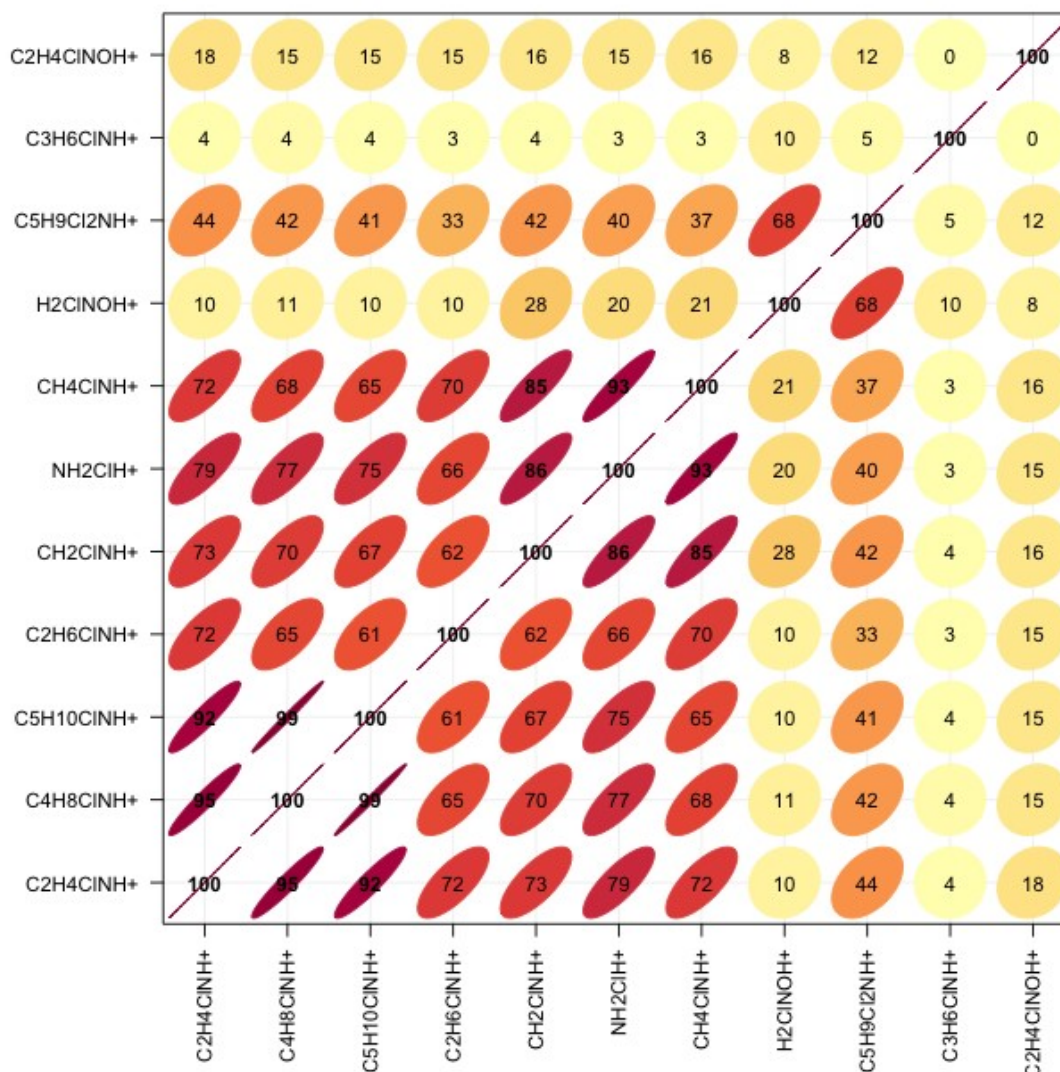


Figure S13. Correlation plot comparing chlorinated ion time series. Each chlorinated ion, except for HOClH⁺ due to its very low signal, is shown both on the x- and y-axis. Numbers represent the Pearson correlation coefficient, multiplied by 100, between time series of each ion on the x-axis compared to each ion on the y-axis. Colors range from yellow to red, where yellow depicts lower correlation coefficient and red depicts higher correlation coefficient. The shape of the colored area is a visualization of the scatter plot between the two time series, where poorly correlated time series result in a circular shape on the plot, and very well-correlated time series end up with a narrow ellipse drawn at a 45 degree angle. All specifications here are from CorPlot function in the OpenAir R package.

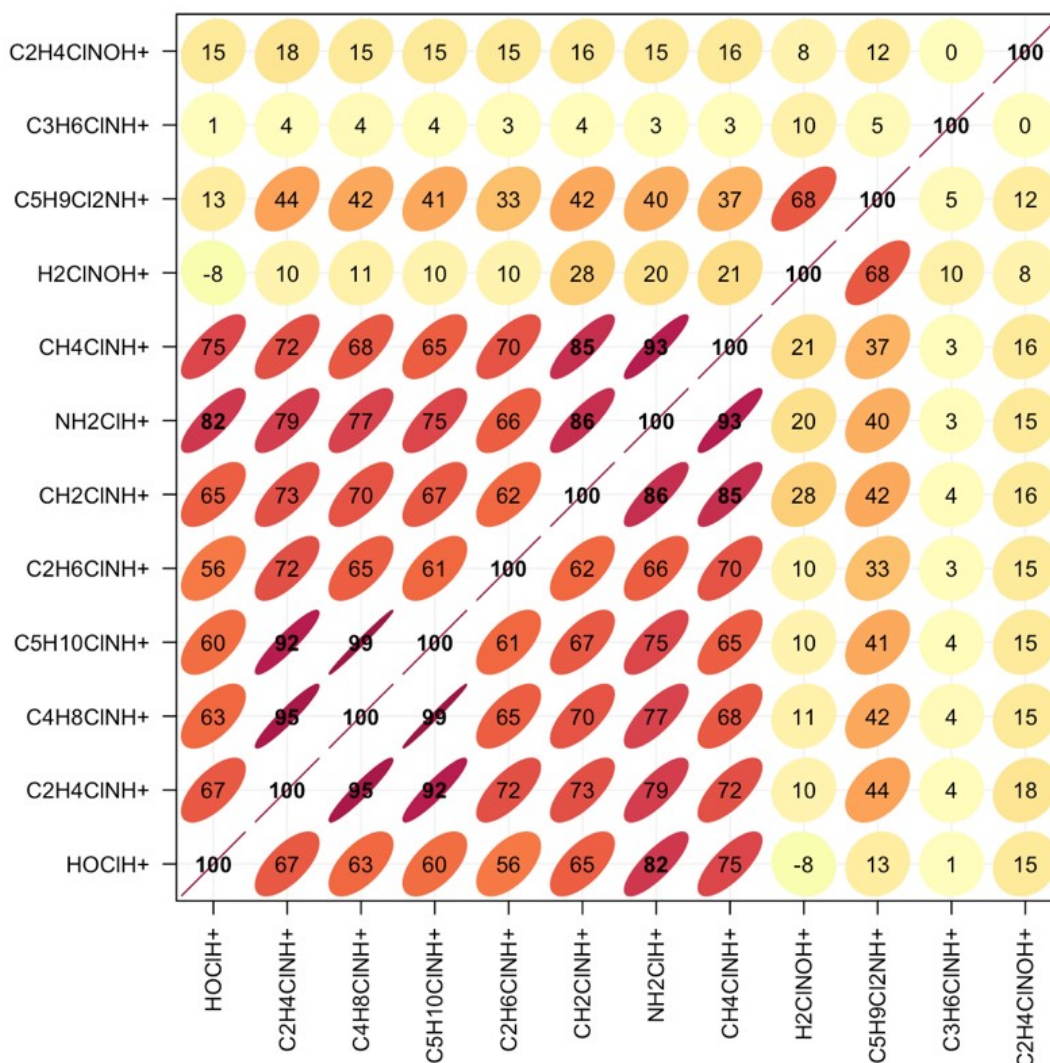


Figure S14. Correlation plot comparing chlorinated ion time series, with HOCIH⁺ added. HOCIH⁺ is otherwise not included elsewhere due to its very low signal.

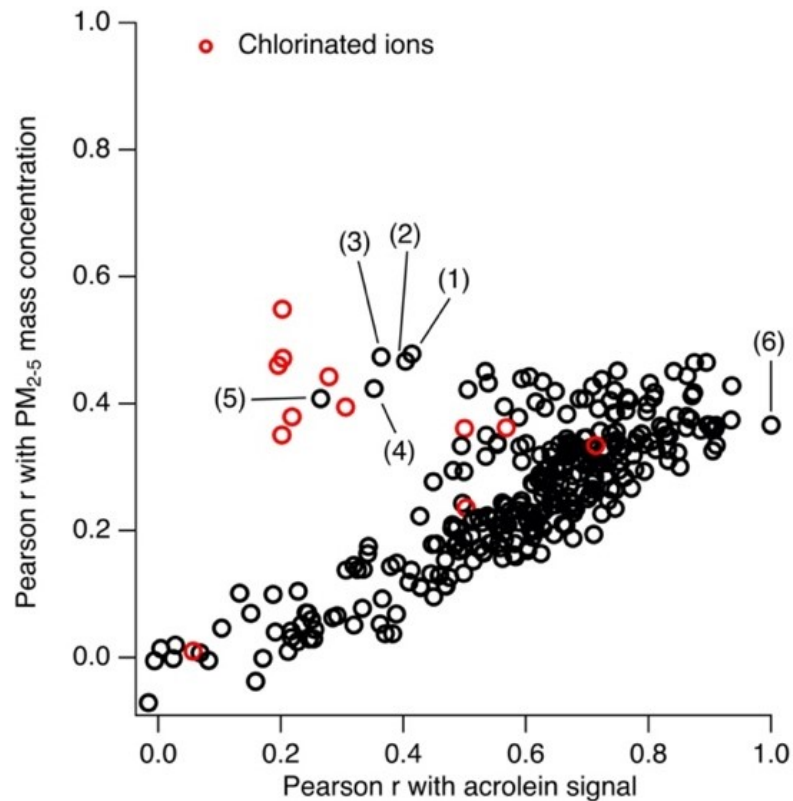


Figure S15. Pearson correlation coefficients for all identified gas-phase species with PM_{2.5} concentration (which showed an increased contribution in the evening during cleaning) and with acrolein (which is known to be emitted from cooking, from the thermal degradation of heated cooking oils). Red markers represent chlorinated species, which were identified in Figure 4A. Numbered ions are non-chlorinated ions that showed strong correlations with PM_{2.5} concentration, that are *not* identified in Figure 4A: (1) C₆H₇N₃H⁺, (2) C₄H₈NH⁺, (3) C₅H₅N₃O₃H⁺, (4) C₅H₁₁NOH⁺, (5) C₅H₉NH⁺, (6) C₃H₅O⁺ (acrolein and isomers).

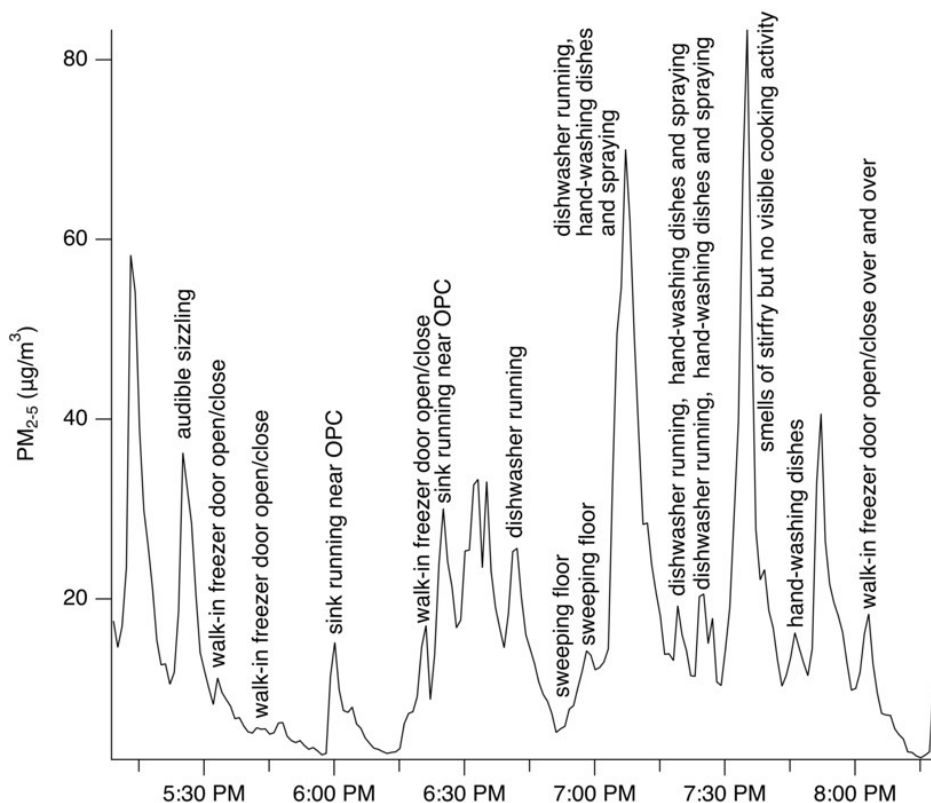


Figure S16. PM_{2.5} concentration from the OPC, measured during a repeat sampling trip to kitchen post-campaign. Measurements were collected in the evening during kitchen cleaning. Specific cleaning-related activities are annotated.

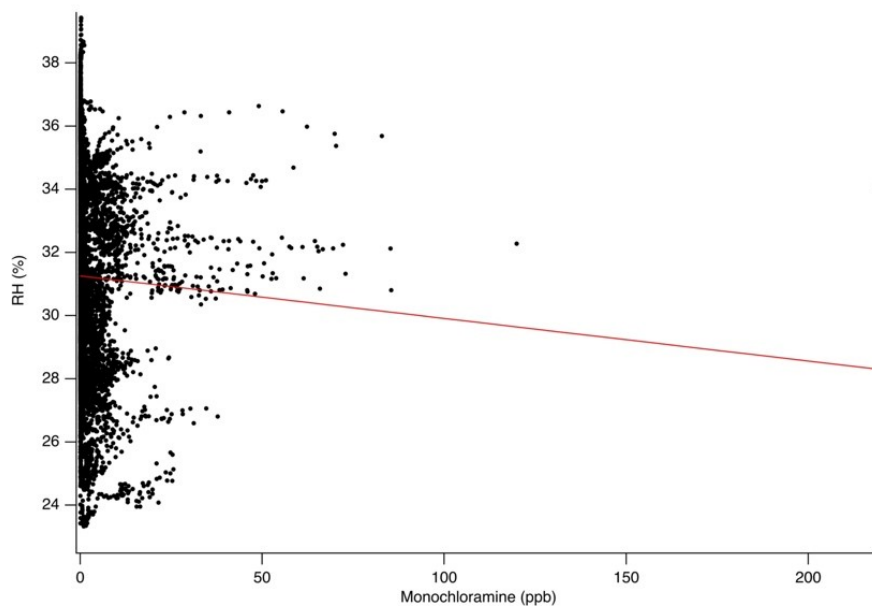


Figure S17. Scatter plot showing relative humidity in the kitchen (y-axis) vs. the monochloramine mixing ratio (x-axis). The best fit line is shown in red. The Pearson correlation coefficient was -0.02 for this distribution of datapoints, emphasizing the lack of correlation between monochloramine mixing ratio and kitchen relative humidity.

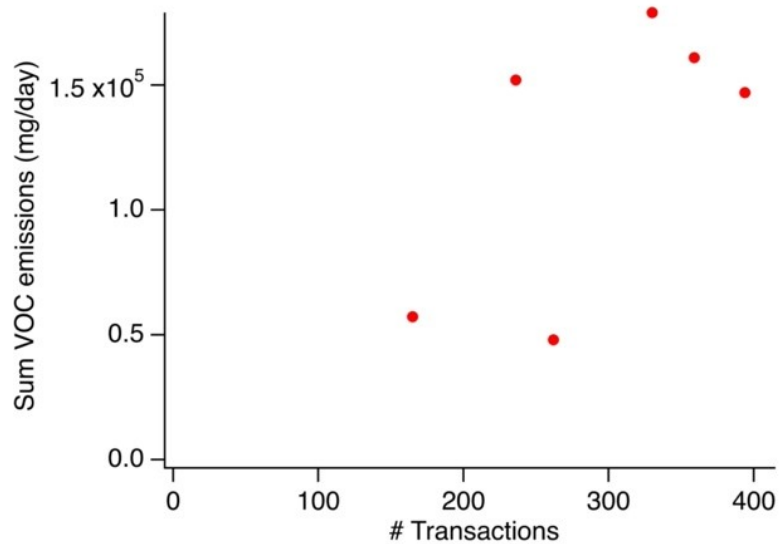


Figure S18. The sum of VOC emissions for each day between September 10-15, plotted against the number of transactions per day in that time range. This shows that the VOC emissions scaled with the number of daily transactions (which is related to the number of meals prepared per day).

Table S1. Defined cooking events. The early morning cooking periods were likely a result of kitchen staff beginning the day’s cooking earlier than the typical ~8:00, but could also contain influence from outdoor air as the ventilation was turned on at ~6:00 each day. “No log” indicates no log from the main kitchen cooking, but does not preclude customer-facing kitchen emissions.

Event	Time	Notes	Food prepared based on main kitchen log (using best estimations from cooking end times reported)
Event 1	2021-09-04 06:08:00 to 2021-09-04 08:06:00	Early morning	No log
Event 2	2021-09-04 08:24:00 to 2021-09-04 10:47:00		No log
Event 3	2021-09-04 10:47:00 to 2021-09-04 11:19:00		No log
Event 4	2021-09-04 11:37:00 to 2021-09-04 13:41:00		No log
Event 5	2021-09-04 16:14:00 to 2021-09-04 17:47:00	Cooking and cleaning	No log
Event 6	2021-09-04 18:15:00 to 2021-09-04 20:06:00	Cooking and cleaning	No log
Event 7	2021-09-05 08:57:00 to 2021-09-05 10:09:00		Macaroni, vegetables, lentils, rice
Event 8	2021-09-05 10:29:00 to 2021-09-05 11:39:00		Rice, enchiladas, souvlaki
Event 9	2021-09-05 12:21:00 to 2021-09-05 13:13:00		Souvlaki, rice noodles, enchiladas, rice
Event 10	2021-09-05 14:21:00 to 2021-09-05 14:38:00		No log
Event 11	2021-09-05 15:51:00 to 2021-09-05 16:40:00		Butter chicken, tagine, dahl, rice, vegetables
Event 12	2021-09-05 16:58:00 to 2021-09-05 17:54:00	Cooking and cleaning	No log
Event 13	2021-09-06 10:10:00 to 2021-09-06 11:55:00		Rice, peas, baked potato, salmon, chicken, broccoli, green beans
Event 14	2021-09-06 13:05:00 to 2021-09-06 15:00:00		Spaghetti, chicken, salmon, green beans, broccoli, potato, carrots
Event 15	2021-09-07 07:13:00 to 2021-09-07 07:51:00	Early morning	No log
Event 16	2021-09-07 09:50:00 to 2021-09-07 10:11:00		Spaghetti
Event 17	2021-09-07 10:11:00 to 2021-09-07 11:10:00		Vegetables, chicken, rice, stew
Event 18	2021-09-07 12:11:00 to 2021-09-07 13:48:00		Lentil pie, stroganoff
Event 19	2021-09-07 14:54:00 to 2021-09-07 15:57:00		Jerk chicken, pork, vegetables, rice
Event 20	2021-09-08 07:25:00 to 2021-09-08 08:02:00		No log
Event 21	2021-09-08 09:03:00 to 2021-09-08 09:23:00		Soup, rice
Event 22	2021-09-08 10:31:00 to 2021-09-08 11:47:00		Jerk chicken, rice, stroganoff, lentil pie, vegetables, quinoa
Event 23	2021-09-08 14:57:00 to 2021-09-08 16:27:00		Rice, stroganoff, vegetables, chicken, lentil pie
Event 24	2021-09-08 21:04:00 to 2021-09-08 21:48:00	Cooking and cleaning	No log
Event 25	2021-09-09 07:23:00 to 2021-09-09 09:03:00		Soup
Event 26	2021-09-09 10:30:00 to 2021-09-09 11:19:00		Chicken, rice, sole, vegetables

Event	Time	Notes	Food prepared based on main kitchen log (using best estimations from cooking end times reported)
Event 27	2021-09-09 11:20:00 to 2021-09-09 12:50:00		Rice, vindaloo, butter chicken, chickpeas
Event 28	2021-09-09 13:24:00 to 2021-09-09 13:37:00		Pork, carrots
Event 29	2021-09-09 14:53:00 to 2021-09-09 15:30:00		Sole, quinoa, cauliflower, edamame
Event 30	2021-09-09 16:16:00 to 2021-09-09 17:53:00	Cooking and cleaning	Rice, chicken
Event 31	2021-09-10 07:14:00 to 2021-09-10 09:23:00		Soup, souvlaki
Event 32	2021-09-10 09:43:00 to 2021-09-10 11:24:00		Chicken, rice, vindaloo, chickpeas, carrots, rice, tagine
Event 33	2021-09-10 12:17:00 to 2021-09-10 12:48:00		No log
Event 34	2021-09-10 15:03:00 to 2021-09-10 15:51:00		No log
Event 35	2021-09-10 16:21:00 to 2021-09-10 17:13:00	Cooking and cleaning	No log
Event 36	2021-09-10 19:02:00 to 2021-09-10 19:52:00	Cooking and cleaning	No log
Event 37	2021-09-10 20:11:00 to 2021-09-10 21:12:00	Cooking and cleaning	No log
Event 38	2021-09-11 12:17:00 to 2021-09-11 13:03:00		No log
Event 39	2021-09-11 14:51:00 to 2021-09-11 15:31:00		No log
Event 40	2021-09-11 16:07:00 to 2021-09-11 17:38:00	Cooking and cleaning	No log
Event 41	2021-09-12 07:22:00 to 2021-09-12 07:58:00	Early morning	No log
Event 42	2021-09-12 08:19:00 to 2021-09-12 08:57:00		No log
Event 43	2021-09-12 08:58:00 to 2021-09-12 09:53:00		No log
Event 44	2021-09-12 10:00:00 to 2021-09-12 10:59:00		Soup
Event 45	2021-09-12 12:15:00 to 2021-09-12 12:34:00		Chicken, baked potato
Event 46	2021-09-12 13:35:00 to 2021-09-12 14:41:00		Tofu
Event 47	2021-09-12 14:42:00 to 2021-09-12 15:19:00		Tagine, vegetables, rice, naan
Event 48	2021-09-13 06:21:00 to 2021-09-13 07:33:00	Early morning	No log
Event 49	2021-09-13 09:05:00 to 2021-09-13 09:21:00		Soup
Event 50	2021-09-13 09:22:00 to 2021-09-13 10:31:00		Chicken, potato, rice, peas
Event 51	2021-09-13 10:35:00 to 2021-09-13 11:45:00		Chicken, baked potato, salmon, cauliflower, tofu, green beans
Event 52	2021-09-13 13:48:00 to 2021-09-13 14:10:00		Chicken, baked potato, salmon, cauliflower, tofu, green beans
Event 53	2021-09-13 16:14:00 to 2021-09-13 17:33:00	Cooking and cleaning	No log
Event 54	2021-09-14 09:36:00 to 2021-09-14 10:34:00		Soup, spaghetti, rice, chicken
Event 55	2021-09-14 11:56:00 to 2021-09-14 15:11:00		Chicken, rice, potato, eggplant, bok choy, pork, carrot, butternut squash

Event	Time	Notes	Food prepared based on main kitchen log (using best estimations from cooking end times reported)
Event 56	2021-09-14 15:12:00 to 2021-09-14 16:03:00		No log
Event 57	2021-09-14 16:07:00 to 2021-09-14 16:47:00		Chicken, rice, vegetables
Event 58	2021-09-15 10:17:00 to 2021-09-15 11:19:00		Chicken, rice, lasagna, stew, vegetables, lentils
Event 59	2021-09-15 11:31:00 to 2021-09-15 11:57:00		Alfredo pasta
Event 60	2021-09-15 13:00:00 to 2021-09-15 14:06:00		Soup
Event 61	2021-09-15 14:23:00 to 2021-09-15 14:49:00		
Event 62	2021-09-15 14:54:00 to 2021-09-15 15:26:00		Chicken, rice, lasagna, stew, vegetables
Event 63	2021-09-15 15:27:00 to 2021-09-15 17:41:00	Cooking and cleaning	No log
Event 64	2021-09-16 06:53:00 to 2021-09-16 08:08:00	Early morning	No log
Event 65	2021-09-16 10:36:00 to 2021-09-16 11:25:00		Chicken, noodles, tofu, fish, broccoli, mushrooms
Event 66	2021-09-16 11:50:00 to 2021-09-16 12:40:00		Lentils, tagine, chicken
Event 67	2021-09-16 13:57:00 to 2021-09-16 16:39:00		Chicken, noodles, fish, broccoli, mushrooms, rice
Event 68	2021-09-16 17:37:00 to 2021-09-16 19:24:00	Cooking and cleaning	No log

Table S2. Average indoor emission ratios (ER) of each volatile organic compound (VOC) and of particulate matter (PM) relative to CO₂ concentrations measured in the kitchen.

VOC	Average ER, µgVOC/gCO ₂	Standard deviation, µgVOC/gCO ₂
C ₂ H ₆ O	3.51E+04	4.32E+04
C ₂ H ₄ O ₂	1.33E+03	1.73E+03
C ₃ H ₄ O	1.82E+02	2.59E+02
C ₃ H ₆ O	1.23E+02	1.26E+02
C ₆ H ₁₂ O	1.04E+02	1.53E+02
C ₇ H ₁₀ O	6.65E+01	9.79E+01
C ₉ H ₁₈ O	5.97E+01	8.63E+01
C ₁₀ H ₃₀ O ₅ Si ₅	3.21E+01	1.65E+02
C ₆ H ₆	2.57E+02	3.22E+02
C ₇ H ₈	7.51E+01	8.52E+01
C ₈ H ₁₀	3.36E+01	4.95E+01
C ₉ H ₁₂	1.16E+01	2.07E+01
C ₁₀ H ₁₆	2.13E+02	3.93E+02
NH ₂ Cl	1.98E+01	2.79E+01
C ₂ H ₃ N	4.20E+00	4.52E+00
C ₃ H ₃ N	1.16E+00	2.99E+00
C ₃ H ₇ NO	2.25E+01	3.63E+01
C ₄ H ₅ N	1.12E+01	1.58E+01
C ₆ H ₁₅ N	9.84E-01	2.14E+00
PM size bin	Average ER, µgPM/gCO ₂	Standard deviation, µgPM/gCO ₂
PM _{0.3-0.5}	1.68E+02	2.05E+02
PM _{0.5-1}	3.37E+02	4.79E+02
PM ₁₋₂	2.60E+02	3.27E+02
PM ₂₋₅	2.12E+03	2.68E+03
PM ₅₋₁₀	1.15E+03	1.55E+03

Table S3. Estimated tonnes/year emitted to the outdoors for this kitchen. We note that our measurements include isomers of each specified molecular formula and are therefore likely upper limits of emissions relative to the compound-specific literature estimates (except for xylenes and monoterpenes, which also account for multiple isomers). Lower and upper limit values are included, to represent 0.58 meals/day/person prepared commercially up to 3 meals/day/person prepared commercially.

VOC	Average estimated tonnes/year	Literature estimated tonnes/year
C ₂ H ₆ O	2.27E+02-1.17+03	
C ₂ H ₄ O ₂	8.60E+00-4.45E+01	
C ₃ H ₄ O	1.24E+00-6.39E+00	Acrolein: 7.70E+00 (8)
C ₃ H ₆ O	9.86E-01-5.10E+00	Acetone: 2.70E+00 (8), Propanal: 5.00E-01 (8)
C ₆ H ₁₂ O	6.64E-01-3.43E+00	
C ₇ H ₁₀ O	5.59E-01-2.89E+00	
C ₉ H ₁₈ O	4.42E-01-2.28E+00	Nonanal: 5.00E+00 (8)
C ₁₀ H ₃₀ O ₅ Si ₅	3.89E-01-2.01E+00	
C ₆ H ₆	1.65E+00-8.54E+00	Benzene: 8.20E+00 (5)
C ₇ H ₈	5.85E-01-3.02E+00	Toluene: 8.20E+00 (5)
C ₈ H ₁₀	2.43E-01-1.26E+00	Xylenes: 9.10E+00 (5)
C ₉ H ₁₂	8.83E-02-4.57E-01	
C ₁₀ H ₁₆	1.60E+00-8.28E+00	Monoterpenes: 3.60E+00 (5)
NH ₂ Cl	2.71E-01-1.40E+00	
C ₂ H ₃ N	3.29E-02-1.70E-01	Acetonitrile: 9.00E-01 (5)
C ₃ H ₃ N	3.99E-03-2.06E-02	
C ₃ H ₇ NO	1.42E-01-7.34E-01	
C ₄ H ₅ N	1.24E-01-6.40E-01	
C ₆ H ₁₅ N	8.56E-03-4.43E-02	
SUM	2.44E+02-1.26E+03 (equates to 8.75E-05-4.53E-04 tonnes/year-person in Toronto)	4.70E-05 tonnes/year-person in China (9)
PM size bin	Average estimated tonnes/year	Literature estimated tonnes/year
PM _{0.3-0.5}	2.51E-01-1.30E+00	
PM _{0.5-1}	5.50E-01-2.85E+00	
PM ₁₋₂	5.49E-01-2.84E+00	
PM ₂₋₅	3.61E+00-1.87E+01	
PM ₅₋₁₀	1.98E+00-1.03E+01	
SUM	6.94E+00-3.59E+01 (equates to 2.48E-06-1.28E-05 tonnes/year-person in Toronto)	Cooking organic aerosol (PM ₁): 7.25E+02 (5)

Table S4. NIOSH recommended exposure limits (REL), other exposure limits considered, and odor thresholds for calibrated compounds.

Compound	NIOSH REL (ppm) [link]	Other exposure limit (ppm)	Odor threshold (ppm)	Average mixing ratio from plume analysis (ppb)
Ethanol (C ₂ H ₆ O)	1000	-	10 [link]	211.5
Acetic acid (C ₂ H ₄ O ₂)	10	-	0.21-1 [link]	8.0
Acrolein (C ₃ H ₄ O)	0.1	-	60 [link]	1.1
Acetone (C ₃ H ₆ O)	250	-	13 [link]	1.0
Hexanal (C ₆ H ₁₂ O)	-	10* [link]	1 [link]	0.3
Heptadienal (C ₇ H ₁₀ O)	-	-	0.2-1.1 [link]	0.2
Nonanal (C ₉ H ₁₈ O)	-	-	-	0.1
D5-Siloaxne (C ₁₀ H ₃₀ O ₅ Si ₅)	-	10** [link]	-	0.1
Benzene (C ₆ H ₆)	0.1	-	4.68 [link]	1.4
Toluene (C ₇ H ₈)	100	-	2.14 [link]	0.5
o-Xylene (C ₈ H ₁₀)	100	-	1 [link]	0.3
1,3,5-Trimethylbenzene (C ₉ H ₁₂)	25	-	2.4 [link]	0.1
Limonene (C ₁₀ H ₁₆)	100	-	0.015 [link]	0.8
Monochloramine (NH ₂ Cl)	-	0.05*** [link]	-	1.3
Acetonitrile (C ₂ H ₃ N)	20	-	98 [link]	0.1
Acrylonitrile (C ₃ H ₃ N)	1	-	1.6 [link]	0.01
Propionamide (C ₃ H ₇ NO)	-	-	-	0.1
Pyrrole (C ₄ H ₅ N)	-	-	-	0.1
Triethylamine (C ₆ H ₁₅ N)	-	25**** [link]	0.1-0.48 [link]	0.004

*Hexanal reported to cause mild irritation after 2 hours of exposure at 10 ppm

** D5-siloxane exposure guideline is an 8-hour time weighted average workplace environmental exposure level where no adverse effects are expected, with a significant safety factor

*** Monochloramine exposure guidelines are uncertain and may be as low as 50 ppb, and an 8-hour timeweighted average occupational exposure limit for trichloramine is 20-40 ppb

****Triethylamine exposure limit is a NIOSH permissible exposure limit (PEL)

Table S5. Average VOC emissions computed per meal (obtained by summing together emissions from all cooking events per day and dividing by the number of transactions that day, from September 10-15), along with standard deviation.

VOC	Average, mg/meal	Standard deviation, mg/meal
C ₂ H ₆ O	383.4	180.8
C ₂ H ₄ O ₂	14.5	11.5
C ₃ H ₄ O	2.1	1.0
C ₃ H ₆ O	1.7	1.0
C ₆ H ₁₂ O	1.1	0.7
C ₇ H ₁₀ O	1.0	0.8
C ₉ H ₁₈ O	0.8	0.6
C ₁₀ H ₃₀ O ₅ Si ₅	0.7	1.5
C ₆ H ₆	2.8	1.6
C ₇ H ₈	1.0	0.8
C ₈ H ₁₀	0.4	0.4
C ₉ H ₁₂	0.2	0.1
C ₁₀ H ₁₆	2.8	1.8
NH ₂ Cl	0.5	0.6
C ₂ H ₃ N	0.05	0.05
C ₃ H ₃ N	0.007	0.005
C ₃ H ₇ NO	0.2	0.1
C ₄ H ₅ N	0.2	0.3
C ₆ H ₁₅ N	0.01	0.02
PM size bin	Average, mg/meal	Standard deviation, mg/meal
PM _{0.3-0.5}	0.4	0.6
PM _{0.5-1}	1.0	1.5
PM ₁₋₂	1.0	1.1
PM ₂₋₅	6.1	5.5
PM ₅₋₁₀	3.3	3.6

Table S6. Highest abundance ion signals with assigned molecular formulas, ranked by signal intensity (ions/s). All ions are assumed to be protonated.

Highest abundance 100 ions with assigned formula			
1. C ₂ H ₅ O ₂ H ⁺	26. C ₃ H ₈ OSH ⁺	51. C ₁₀ H ₁₂ OH ⁺	76. C ₁₀ H ₁₆ OH ⁺
2. C ₃ H ₆ OH ⁺	27. C ₇ H ₁₂ OH ⁺	52. C ₁₀ H ₁₅ ⁺	77. C ₆ H ₈ O ₂ H ⁺
3. C ₂ H ₆ OH ⁺	28. C ₄ H ₉ ⁺	53. C ₆ H ₁₀ O ₂ H ⁺	78. C ₃ H ₈ O ₃ H ⁺
4. C ₄ H ₈ OH ⁺	29. C ₂ H ₃ NO ₃ H ⁺	54. C ₈ H ₉ ⁺	79. C ₅ H ₆ OH ⁺
5. C ₁₀ H ₃₀ O ₅ Si ₅ H ⁺	30. C ₇ H ₆ OH ⁺	55. C ₆ H ₇ ⁺	80. C ₇ H ₁₂ O ₂ H ⁺
6. C ₂ H ₄ N ₂ H ⁺	31. C ₆ H ₁₀ OH ⁺	56. C ₇ H ₁₃ ⁺	81. C ₅ H ₁₀ OH ⁺
7. C ₂ H ₄ OH ⁺	32. C ₃ H ₄ O ₃ H ⁺	57. C ₆ H ₆ O ₃ H ⁺	82. C ₃ H ₆ O ₃ H ⁺
8. C ₂ H ₂ OH ⁺	33. C ₄ H ₈ O ₂ H ⁺	58. C ₂ H ₆ O ₂ H ⁺	83. C ₃ H ₂ O ₃ H ⁺
9. C ₉ H ₁₀ OH ⁺	34. C ₄ H ₆ OH ⁺	59. C ₉ H ₂₀ O ₂ H ⁺	84. C ₆ H ₁₃ ⁺
10. C ₅ H ₉ ⁺	35. C ₁₀ H ₁₈ OH ⁺	60. C ₅ H ₈ OH ⁺	85. C ₈ H ₁₆ OH ⁺
11. C ₆ H ₄ O ₂ H ⁺	36. C ₆ H ₄ O ₃ H ⁺	61. C ₇ H ₁₀ O ₄ H ⁺	86. C ₉ H ₁₃ ⁺
12. C ₃ H ₄ OH ⁺	37. C ₅ H ₁₁ ⁺	62. C ₆ H ₁₄ O ₃ H ⁺	87. CH ₃ NOH ⁺
13. C ₆ H ₆ OH ⁺	38. C ₅ H ₈ O ₂ H ⁺	63. C ₉ H ₁₇ ⁺	88. C ₄ H ₁₀ O ₂ H ⁺
14. C ₇ H ₁₁ ⁺	39. C ₂ H ₃ NH ⁺	64. C ₄ H ₄ O ₂ H ⁺	89. NH ₂ ClH ⁺
15. C ₆ H ₉ ⁺	40. C ₄ H ₄ O ₃ H ⁺	65. C ₃ H ₄ O ₄ H ⁺	90. C ₆ H ₁₂ OH ⁺
16. C ₃ H ₆ O ₂ H ⁺	41. C ₈ H ₁₅ ⁺	66. C ₅ H ₄ O ₃ H ⁺	91. C ₆ H ₈ OH ⁺
17. C ₂ H ₆ O ₃ H ⁺	42. C ₃ H ₈ O ₂ H ⁺	67. C ₁₁ H ₂₂ O ₂ H ⁺	92. C ₄ H ₆ O ₃ H ⁺
18. C ₈ H ₁₄ OH ⁺	43. C ₇ H ₉ ⁺	68. C ₃ H ₇ ⁺	93. C ₆ H ₁₂ O ₂ H ⁺
19. C ₆ H ₁₁ ⁺	44. C ₁₀ H ₂₀ O ₂ H ⁺	69. C ₇ H ₁₀ OH ⁺	94. C ₈ H ₁₆ O ₂ H ⁺
20. C ₉ H ₁₈ O ₂ H ⁺	45. C ₆ H ₈ N ₂ H ⁺	70. C ₂ H ₃ NO ₂ H ⁺	95. C ₁₀ H ₁₄ OH ⁺
21. C ₇ H ₇ ⁺	46. C ₅ H ₄ O ₂ H ⁺	71. C ₁₁ H ₂₀ OH ⁺	96. C ₂ H ₄ N ₂ O ₂ H ⁺
22. C ₃ H ₃ ⁺	47. C ₈ H ₁₁ ⁺	72. C ₉ H ₁₆ OH ⁺	97. C ₅ H ₁₀ O ₂ H ⁺
23. C ₉ H ₁₈ OH ⁺	48. C ₅ H ₇ ⁺	73. C ₉ H ₁₅ ⁺	98. C ₈ H ₁₄ O ₂ H ⁺
24. C ₄ H ₆ O ₂ H ⁺	49. C ₃ H ₂ O ₂ H ⁺	74. C ₅ H ₆ O ₂ H ⁺	99. C ₉ H ₁₂ O ₂ H ⁺
25. C ₁₀ H ₁₇ ⁺	50. C ₃ H ₅ ⁺	75. C ₄ H ₆ O ₄ H ⁺	100. C ₇ H ₁₄ OH ⁺

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