Atmospheric
Chemistry
and Physics

*Supplement of*

# Characterization of volatile organic compounds and submicron organic aerosol in a traffic environment

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# Supplemental material

**Table S1.** Detection limits (DL), average (± stdev) concentrations and reaction rate coefficients of studied VOCs.

| VOC species | DL ng m$^{-3}$ | Conc ng m$^{-3}$ (ave ± stdev) | kOH (298K) cm$^{-3}$ s$^{-1}$ | kO$_3$ (298K) cm$^{-3}$ s$^{-1}$ | kNO$_3$ (298K) cm$^{-3}$ s$^{-1}$ |
|---|---|---|---|---|---|
| Benzene | 5.3 | 340 ± 220 | 1.2E-12 | - | n.a. |
| Toluene | 18 | 1630 ± 1340 | 5.6E-12 | - | n.a. |
| Ethylbenzene | 2.7 | 370 ± 360 | 7.0E-12 | - | 1.2E-16 |
| p/m-xylene | 4.1 | 1070 ± 1060 | 3.7E-11 (avg) | - | 2.8E-16 (avg) |
| styrene | 11 | 65 ± 78 | 5.8E-11 | - | 1.5E-12 |
| o-xylene | 1.6 | 400 ± 410 | 1.4E-11 | - | 4.1E-16 |
| 3-ethyltoluene | 0.4 | 190 ± 2020 | 1.9E-11 | - | 4.5E-16 |
| 4-ethyltoluene | 0.6 | 83 ± 110 | 1.2E-11 | - | 8.6E-16 |
| 1,3,5-trimethylbenzene | 0.7 | 93 ± 130 | 5.7E-11 | - | 8.8E-16 |
| 2-ethyltoluene | 1.6 | 110 ± 150 | 1.2E-11 | - | 7.1E-16 |
| 1,2,4-trimethylbenzene | 0.9 | 390 ± 560 | 3.3E-11 | - | 1.8E-15 |
| 1,2,3-trimethylbenzene | 0.4 | 83 ± 140 | 3.3E-11 | - | 1.9E-15 |
| aVOCs sum | | 4820 ± 4390 | | | |
| isoprene | 14 | 38 ± 35 | 1.0E-10 | 1.3E-17 | 6.5E-13 |
| α-pinene | 9 | 200 ± 310 | 5.3E-11 | 9.4E-17 | 6.2E-12 |
| camphene | 1.9 | 13 ± 20 | 7.8E-11 | 6.8E-19 | 6.2E-13 |
| β-pinene | 1.1 | 78 ± 142 | 7.4E-11 | 1.9E-17 | 2.5E-12 |
| Δ3-carene | 4.5 | 92 ± 194 | 8.8E-11 | 4.8E-17 | 9.1E-12 |
| p-cymene | 3.3 | 27 ± 27 | 1.5E-11 | 5.0E-20 | n.a. |
| 1,8-cineol | 4.6 | 33 ± 27 | 1.1E-11 | 1.5E-19 | n.a. |
| limonene | 5.6 | 54 ± 63 | 1.6E-10 | 2.1E-16 | 1.2E-11 |
| terpinolene | 6.3 | 15 ± 21 | 2.3E-10 | 1.6E-15 | 9.7E-11 |
| longicyclene | 2.5 | 0.1 ± 1.1 | 9.4E-12 | - | n.a. |
| iso-longifolene | 7 | 0.13 ± 1.1 | 9.6E-11 | 1.1E-17 | 3.9E-12 |
| β-caryophyllene | 6.7 | 3.7 ± 7.5 | 2.0E-10 | 1.2E-14 | 1.9E-11 |
| α-humulene | 7 | 0.04 ± 0.63 | 2.6E-10 | 1.2E-16 | 3.5E-11 |
| nopinone | 4.5 | 32 ± 25 | 1.4E-11 | - | n.a. |
| bVOCs sum | | 570 ± 770 | | | |

'-': irrelevant, 'n.a.': reaction rate not available
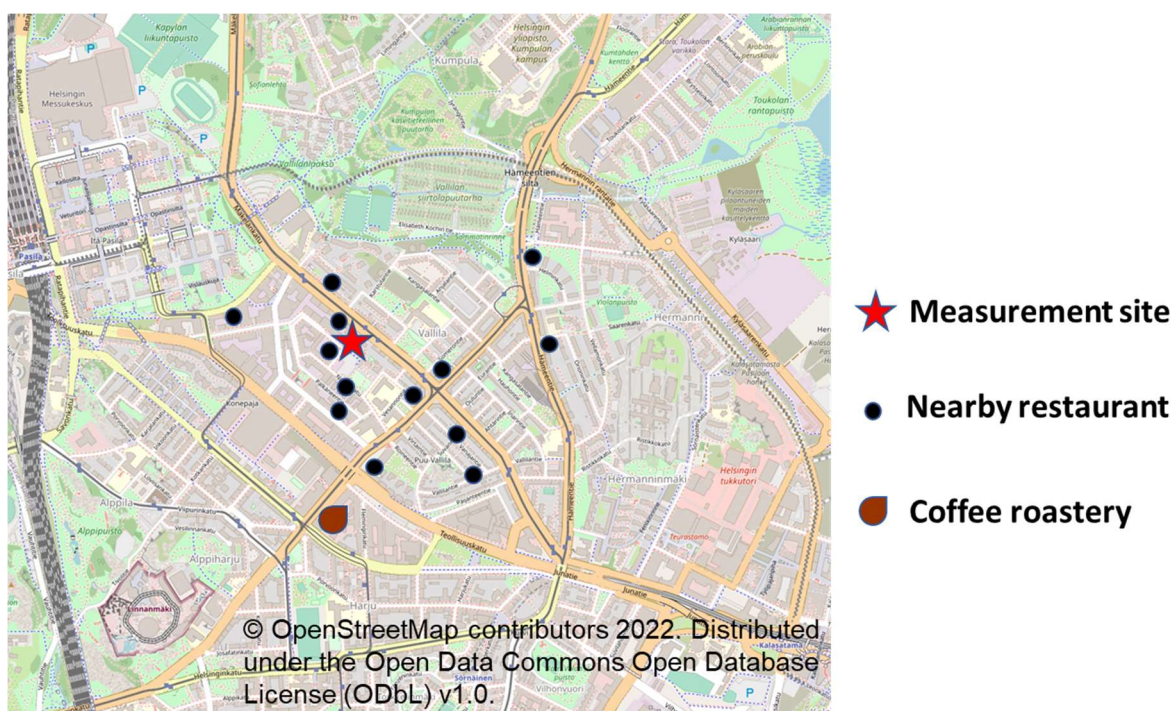
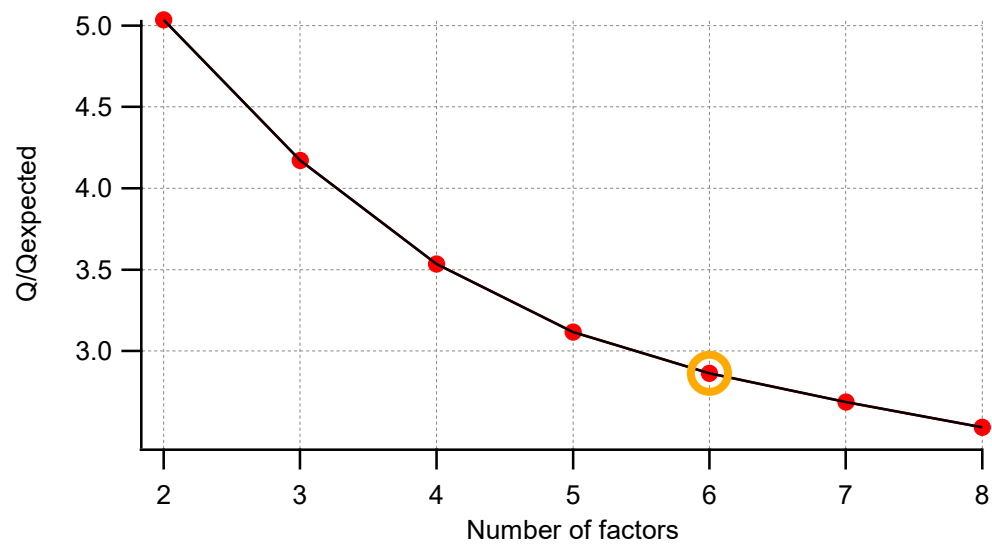**Figure S1.** The location of the measurement site, nearby restaurants and coffee roastery.



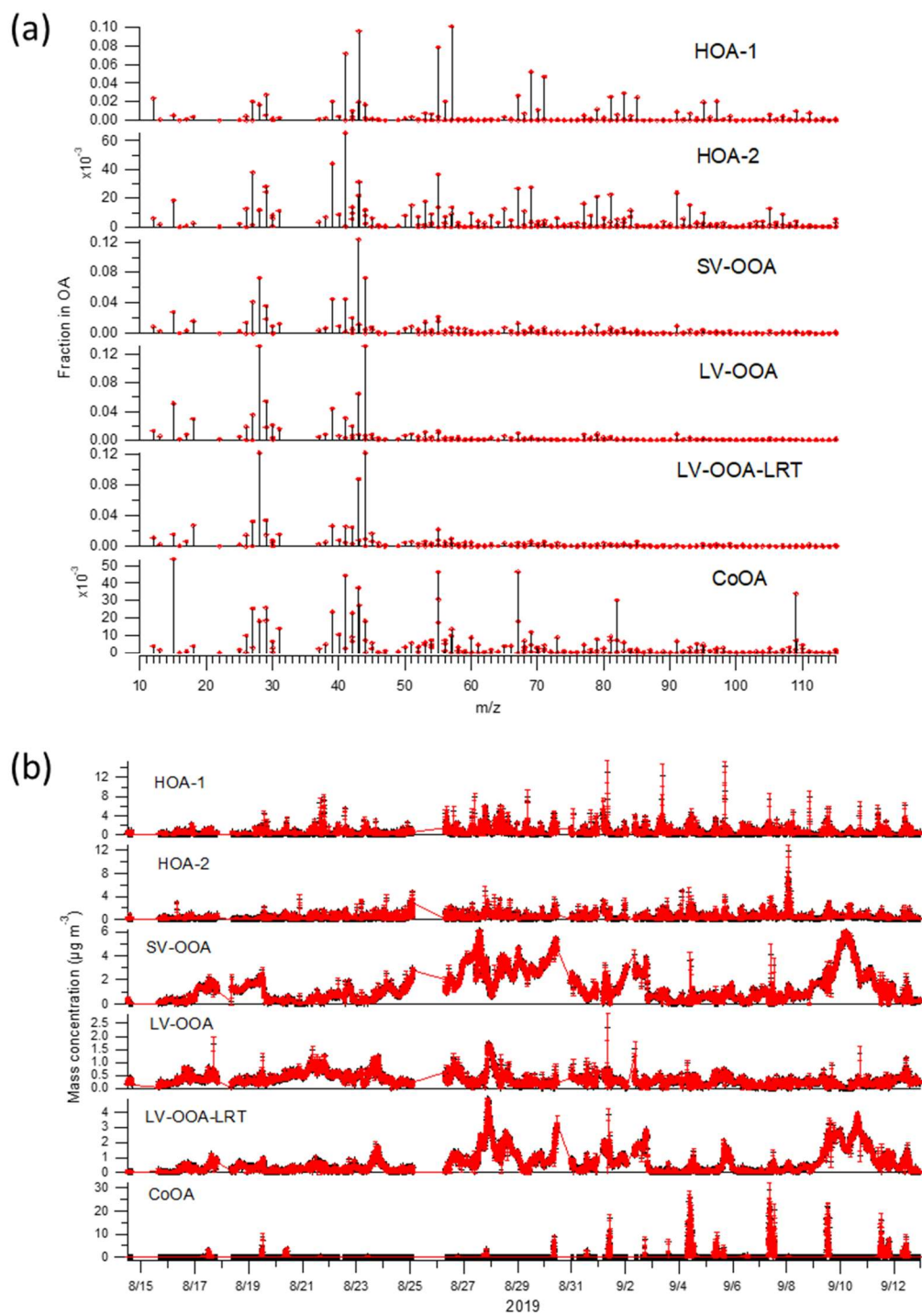**Figure S2.** Q/Q$_{expected}$ vs. number of factors.

**Figure S3**. PMF solution with 6 factors calculated with various seeds. Average mass spectra (a) and time-series (b) with standard deviations (red).
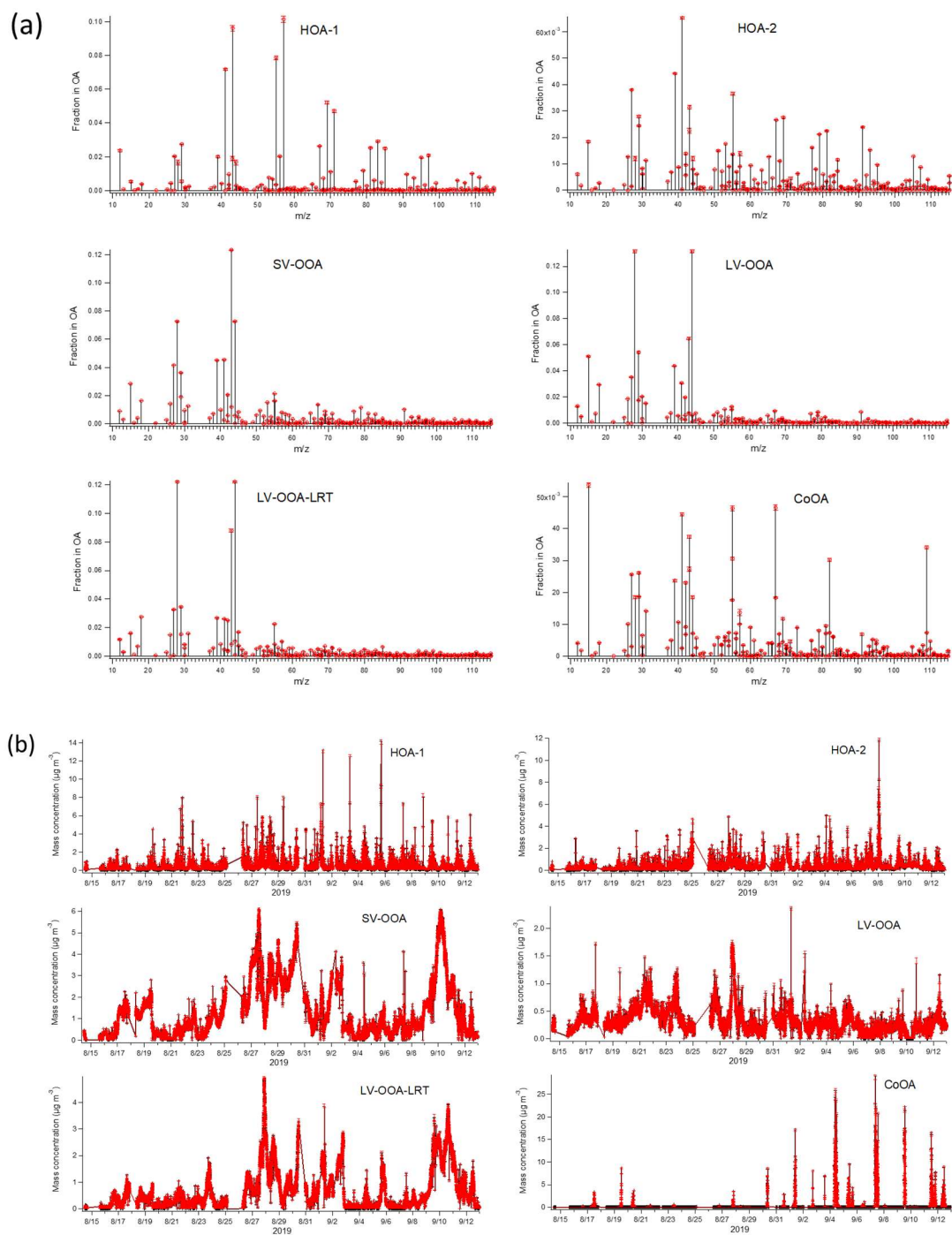
**Figure S4**. Bootstrapping analysis for the PMF solution with 6 factors. Average mass spectra (a) and time-series (b) with standard deviations (red).
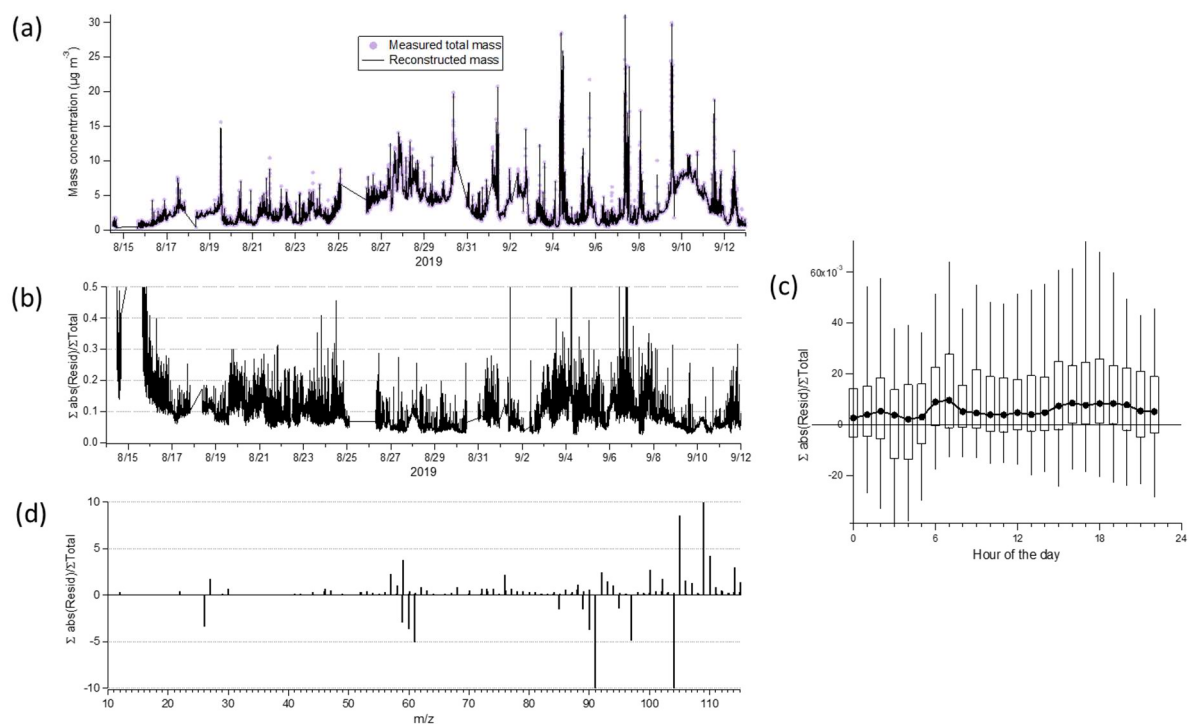
**Figure S5**. Residual analysis. Measured total OA mass vs. reconstructed OA mass (a), the fraction of residuals in total OA mass as time-series (b) and diurnal hour (c), and mass spectra (d). In (c) markers presents median, bars 25 and 75 percentiles, and thin vertical bars minimum and maximum values.
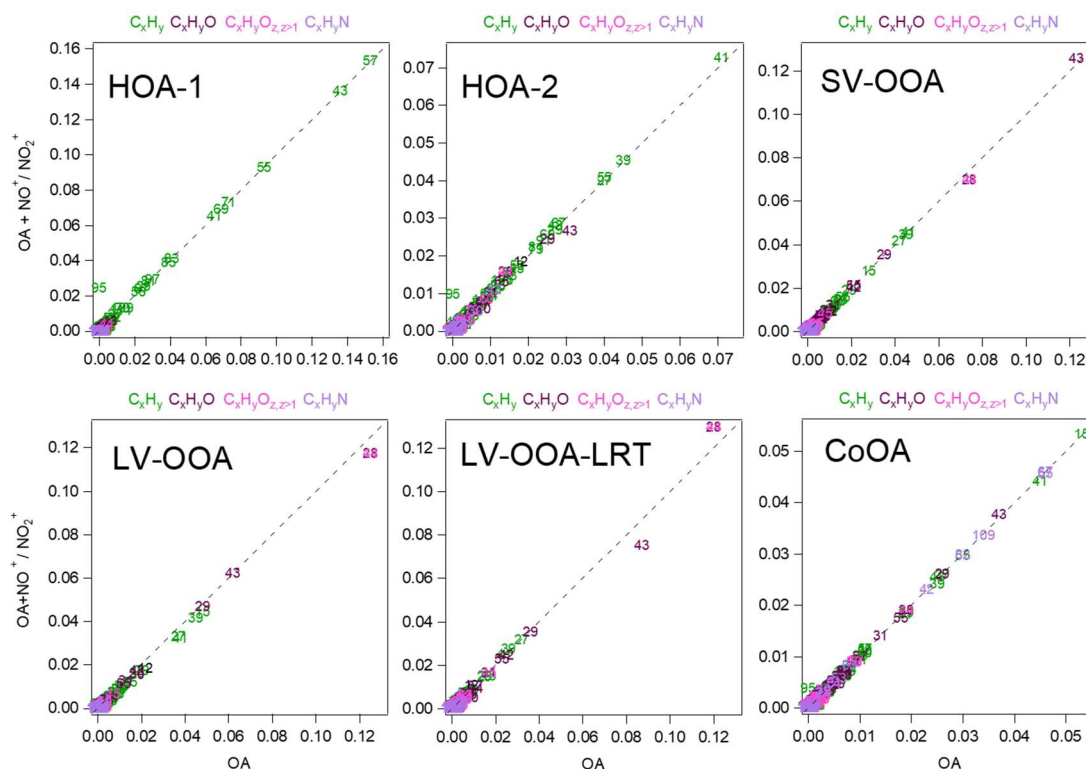
**Figure S6.** Comparison of the mass spectra for the PMF factors calculated with OA and OA + $NO^+/NO_2^+$ ions. Units are fraction in OA.
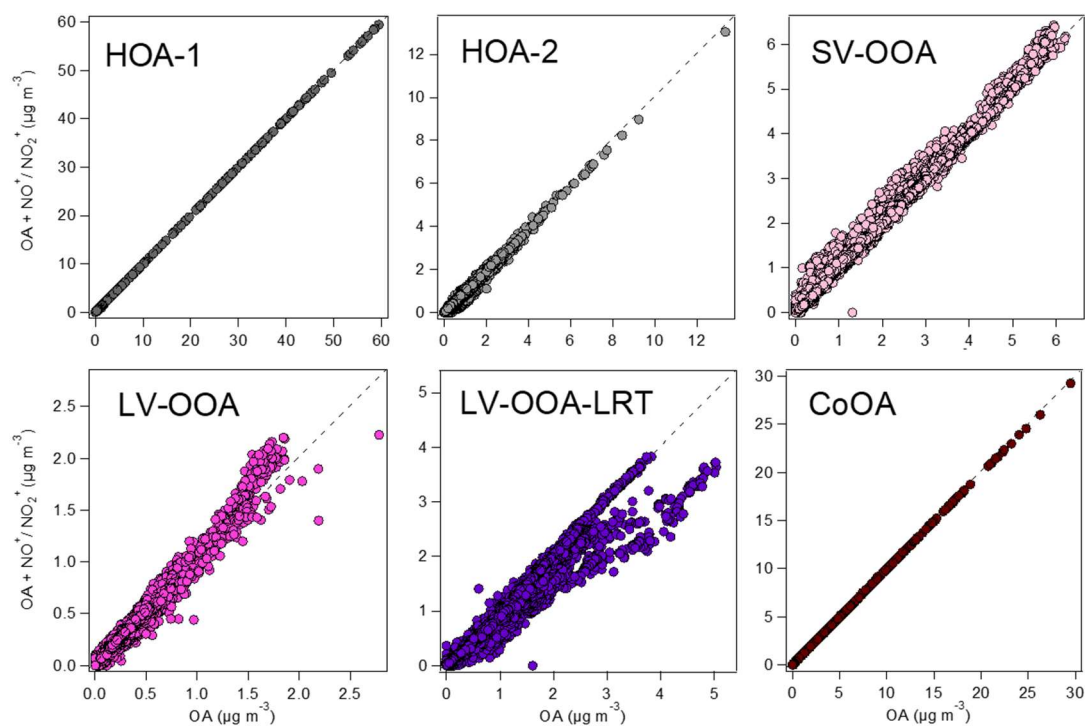


**Figure S7**. Comparison of the mass concentrations for the PMF factors calculated with OA and OA + $NO^+/NO_2^+$ ions.
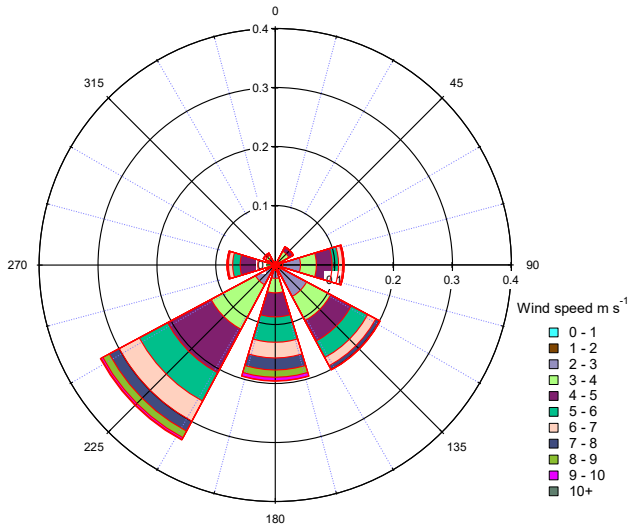
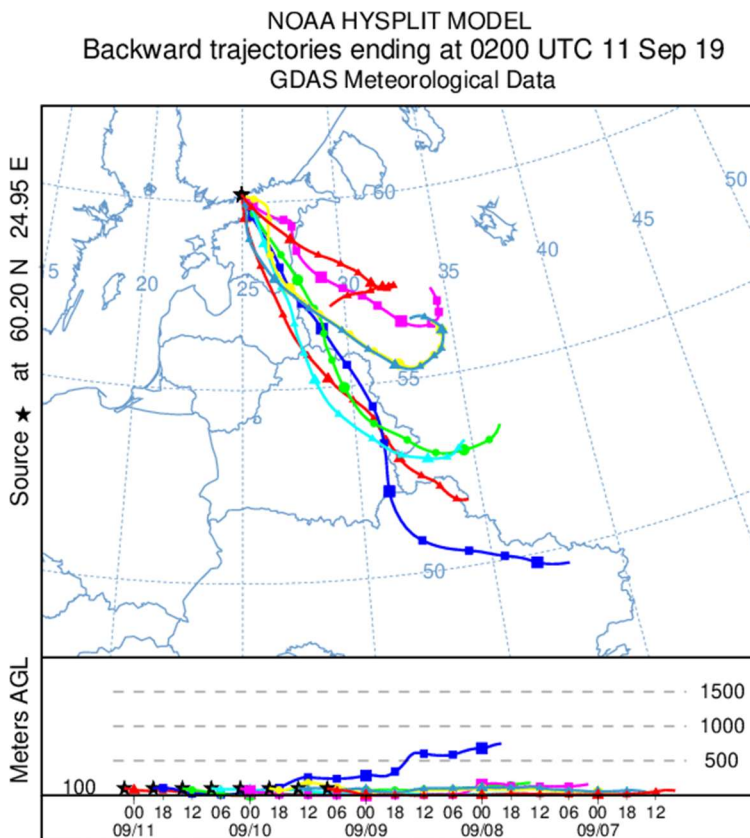**Figure S8**. Wind speed and direction during the measurement campaign.



**Figure S9**. 96-hour backward trajectories showing air arriving in Helsinki in the early hours of 11 September 2019. Trajectories were calculated at the height of 100 m above sea level.
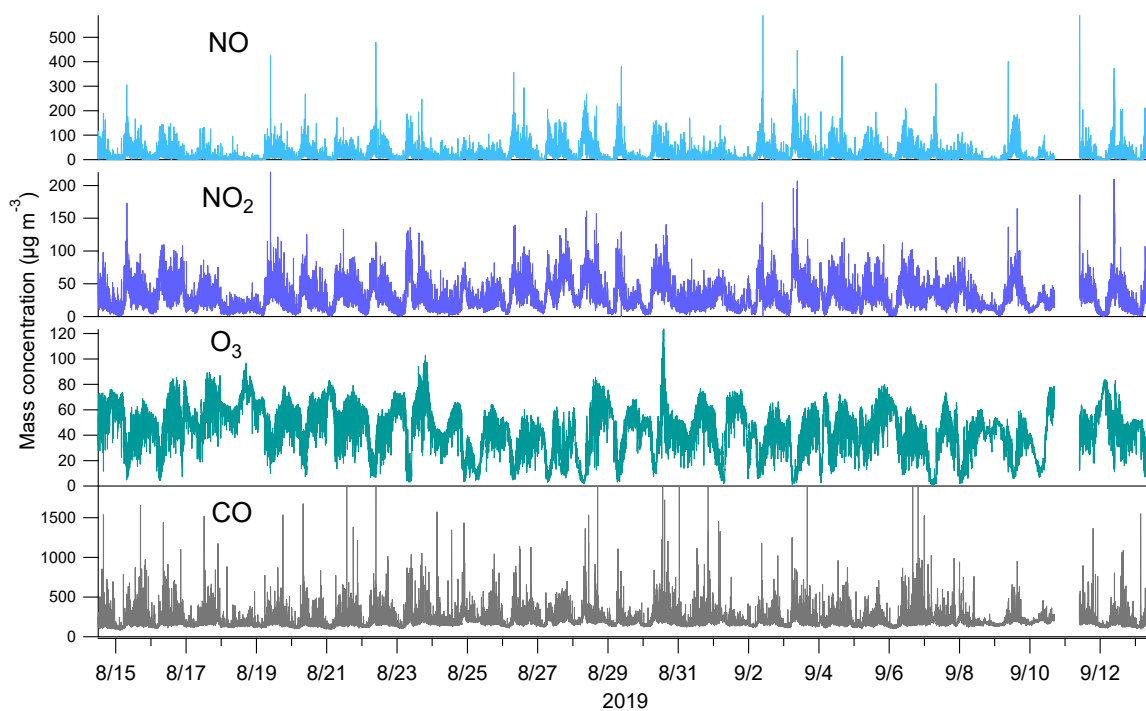
**Figure S10**. Time-series of NO, NO₂, O₃ and CO during the measurement campaign.
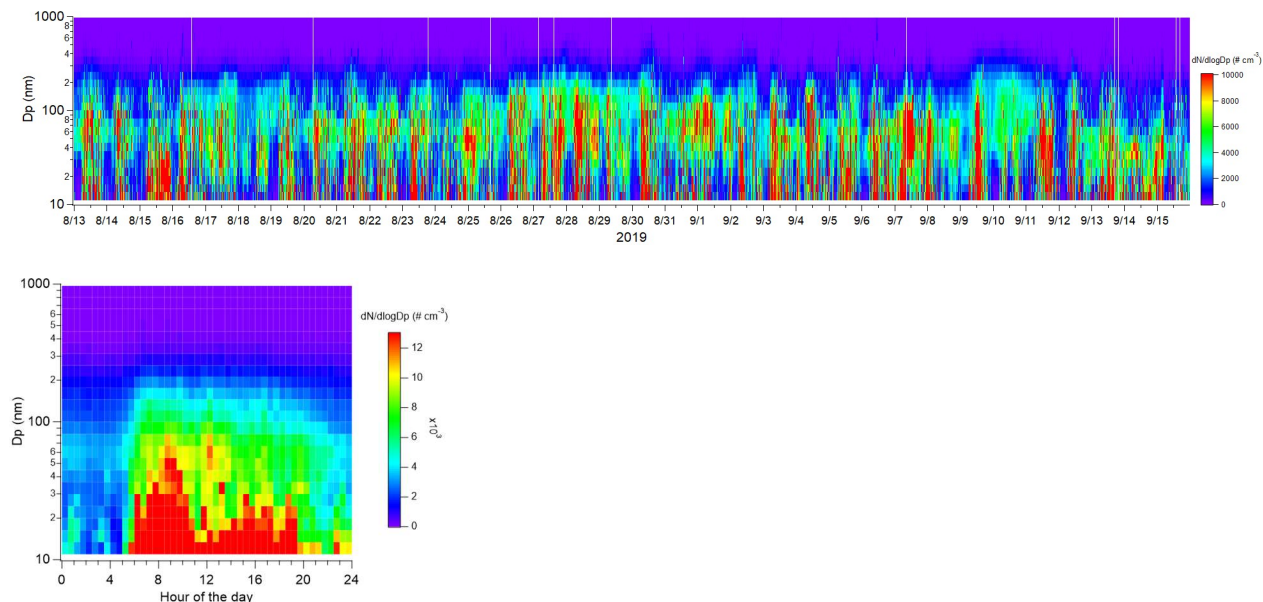


**Figure S11.** Time series of particle number size distribution (10–1000 nm) measured with the DMPS for the whole measurement period and the diurnal trend for weekdays.
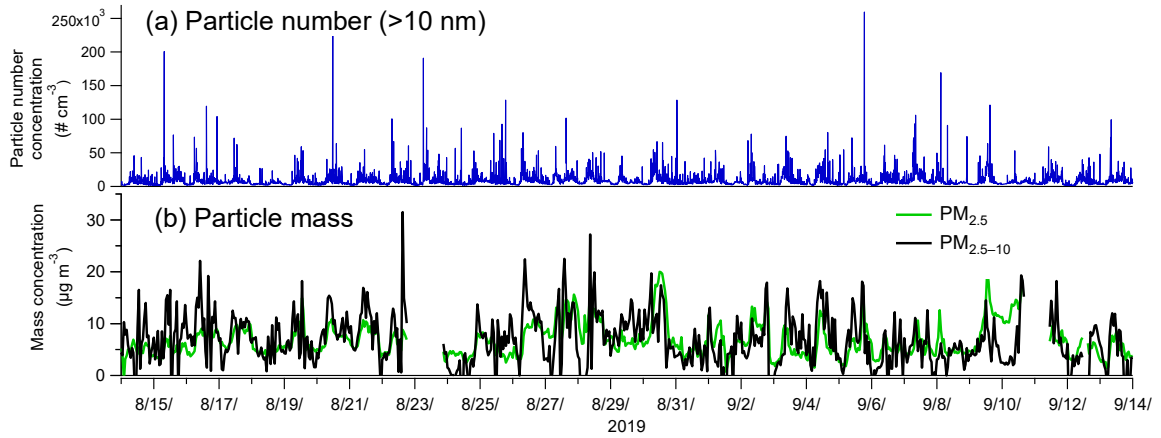
**Figure S12.** Particle number (> 10 nm) (a) and $PM_{2.5}$ and $PM_{2.5-10}$ concentrations during the measurement period. Number concentrations are presented with 9 minutes time-resolution and $PM_{2.5}$ and $PM_{2.5-10}$ as 1-hour averages.
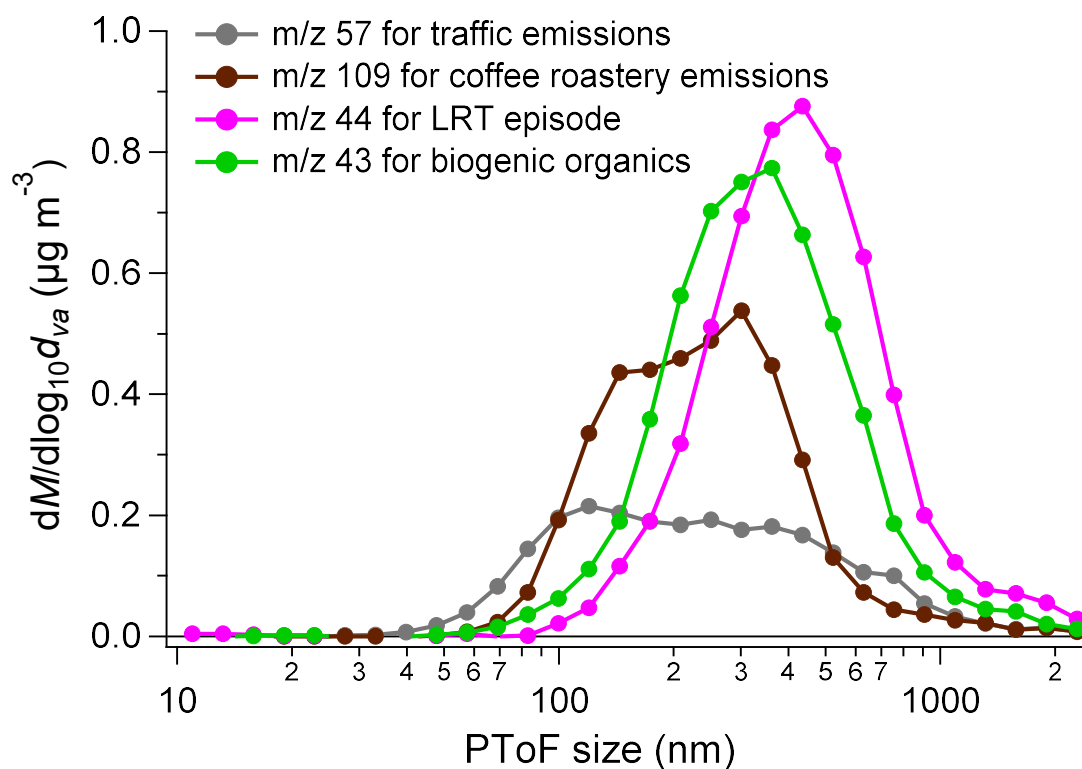
**Figure S13** Average mass size distributions for unit mass resolution m/z 57, 109, 44 and 43 during traffic emissions, coffee roastery emissions, LRT episode and biogenic organics event. Traffic emissions period consisted of data from six mornings based on the high $NO_x$ and NO concentrations ($NO_x$ >160 and NO >70 μg m$^{-3}$). Coffee roastery emissions period included a short time period on 7 September (8:10 to 13:40). LRT episode contained a two-day period from the morning of 9 September to the morning of 11 September. Biogenic organics event included the data measured at ambient temperature > 20 °C but at the same time, the concentration of aromatics needed to be less than 3 μg m$^{-3}$ to exclude the traffic influence.
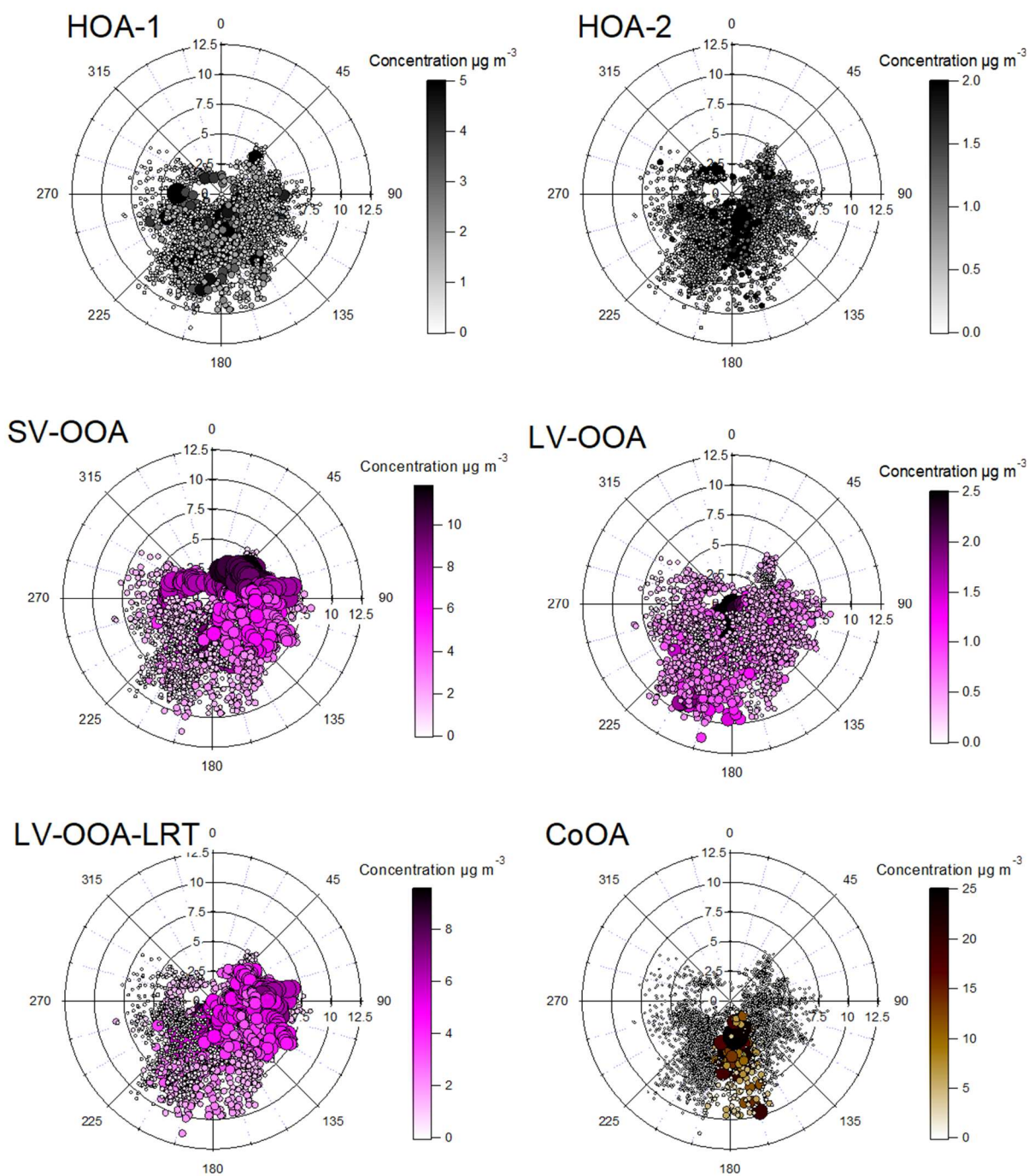
**Figure S14.** Concentrations of OA factors in terms of wind direction (angle) and wind speed (radius). Marker color and size represents the mass concentration of the OA factor.
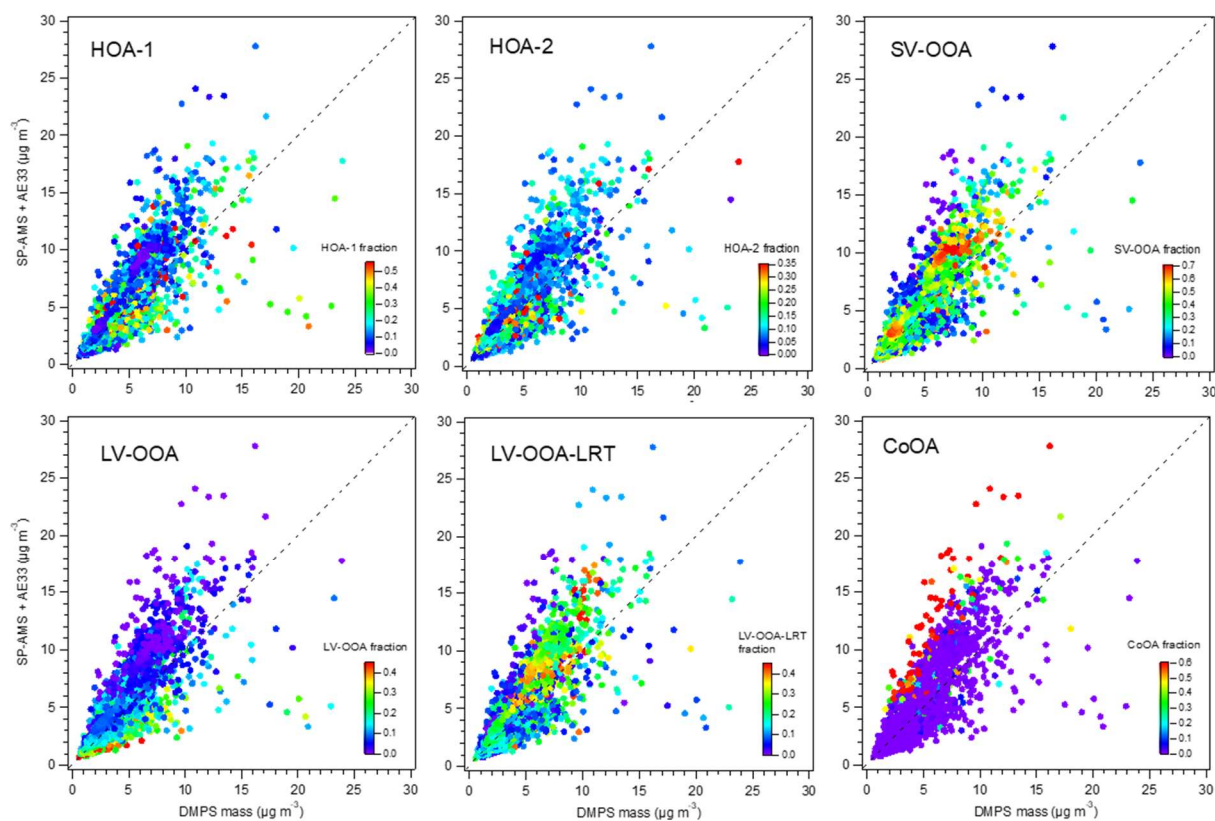
**Figure S15.** The comparison of $PM_1$ from the SP-AMS and AE33 against $PM_1$ from the DMPS in terms of the PMF factor contributions. DMPS number size distributions were converted to $PM_1$ by using the constant density of 1.42 g cm$^{-3}$.
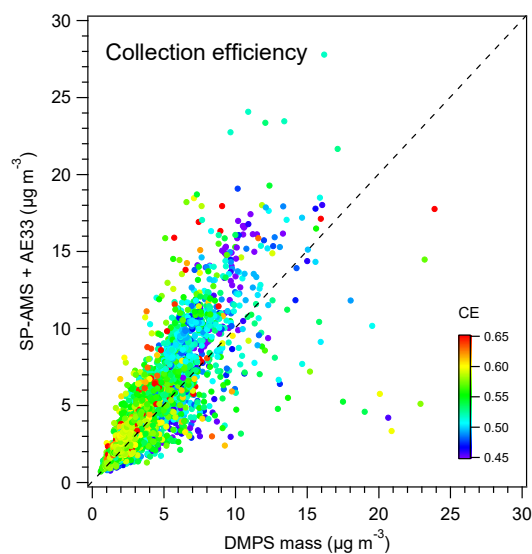


**Figure S16**. The comparison of $PM_1$ from the SP-AMS and AE33 against $PM_1$ from the DMPS for the collection efficiency (CE). DMPS number size distributions were converted to $PM_1$ by using the constant density of 1.42 g cm$^{-3}$.
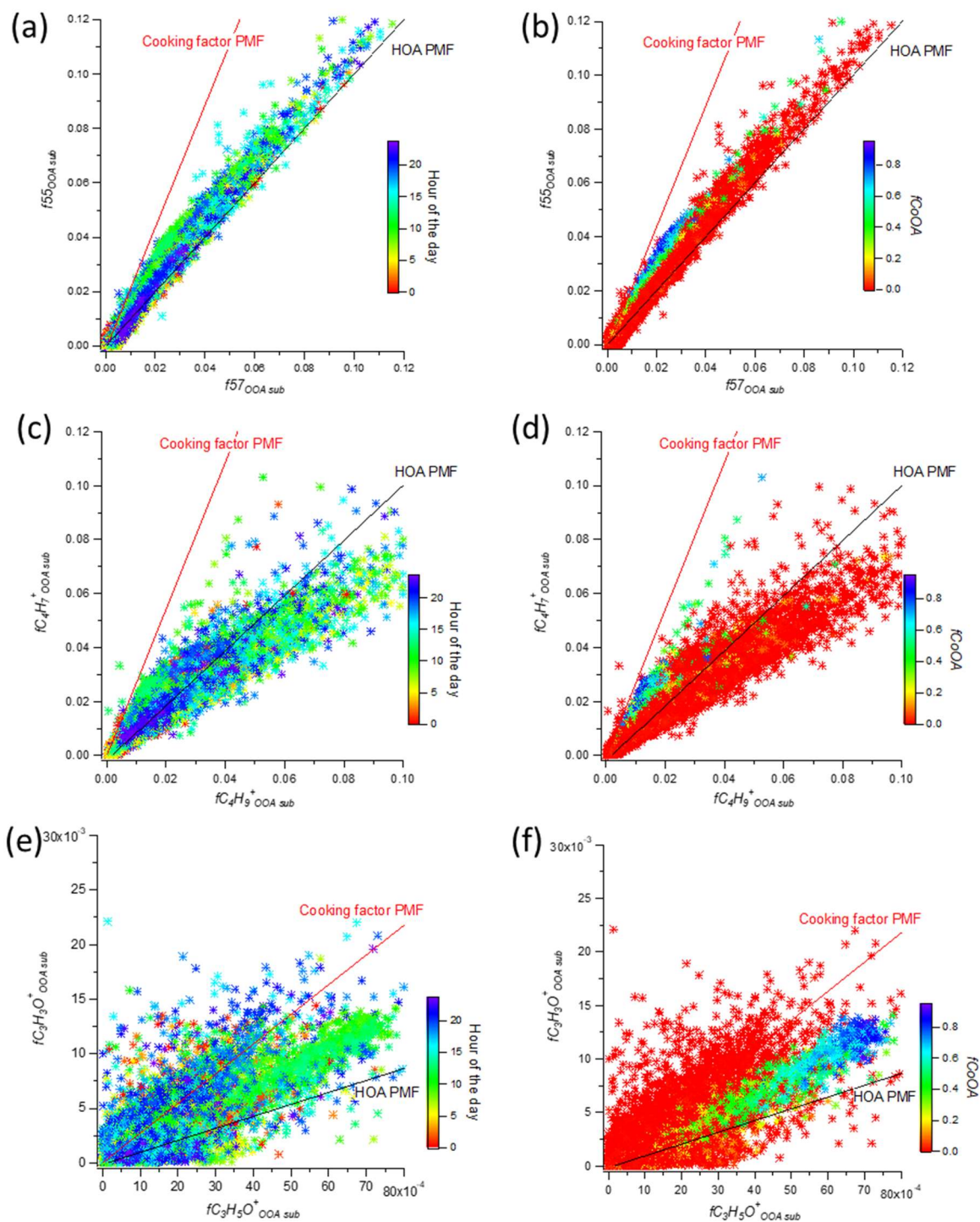
**Figure S17**. $f55_{OOAsub}$ plotted against $f57_{OOAsub}$ (a–b), $fC_4H_7{}^+{}_{OOAsub}$ plotted against $fC_4H_9{}^+{}_{OOAsub}$ (c–d) and $fC_3H_3O^+{}_{OOAsub}$ against $fC_3H_5O^+{}_{OOAsub}$ (e–f) for the whole dataset. Data points are colored according to the hour of the day (a, c, e) or the fraction of CoOA in total OA (*fCoOA*) (b, d, f). The ratios for cooking factor PMF and HOA PMF have been taken from Mohr et al. (2012).
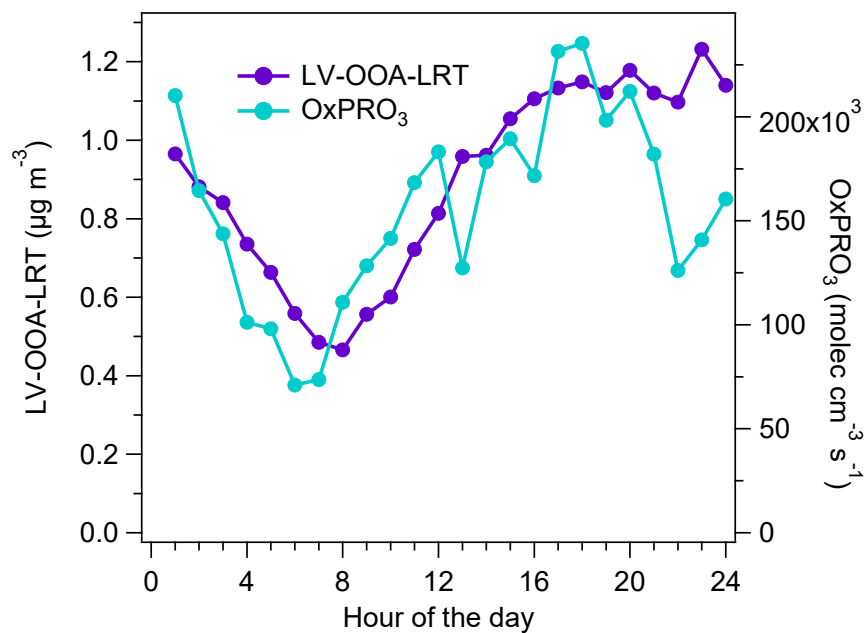
**Figure S18**. Average diurnal trends for LV-OOA-LRT and OxPRO$_3$.

## References

Mohr, C., DeCarlo, P. F., Heringa, M. F., Chirico, R., Slowik, J. G., Richter, R., Reche, C., Alastuey, A., Querol, X., Seco, R., Peñuelas, J., Jiménez, J. L., Crippa, M., Zimmermann, R., Baltensperger, U., and Prévôt, 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, https://doi.org/10.5194/acp-12-1649-2012, 2012.