

Supplement of

Multi-year characterization of low volatility vapors in a boreal forest

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Reference

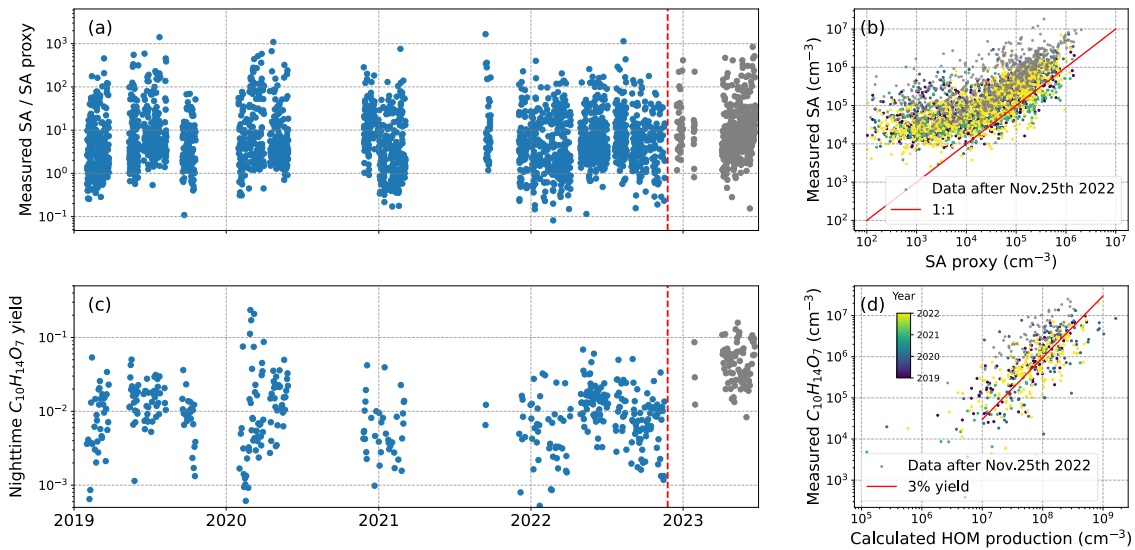


Figure S1: Comparison between measured concentration and proxy of sulfuric acid (SA) and $C_{10}H_{14}O_7$. (a) Time series of the ratio of measured SA to SA proxy. Hourly SA proxy is calculated according to (Dada et al., 2020); (b) Scatter plot of Measured SA and SA proxy; (c) Time series of $C_{10}H_{14}O_7$ yield; (d) Scatter plot of Measured and Calculated HOM production. Nighttime HOM production is calculated between 0:00-3:00 to minimize the influence from terminating species (OH, NO etc.) The HOM production is calculated by $k_{MT+O_3} \cdot [MT] \cdot [O_3]/CS$, where $k_{MT+O_3} = 8.05 \times 10^{16} \cdot \exp\left(\frac{-640}{T}\right) \cdot 0.6$, with T representing the temperature (K).

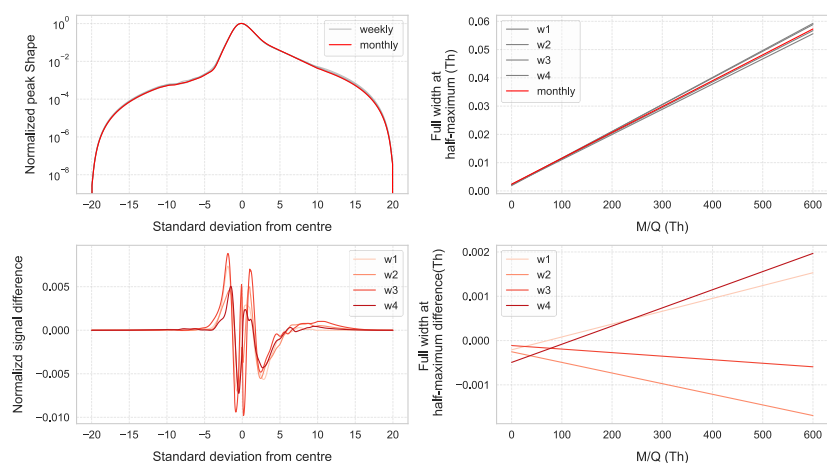


Figure S2: Peak shape and width comparison between weekly and monthly processed data.

Table S1: HOM classification method

HOM group	Classification criteria
R	$C_{7-10}H_{8,10,12,14,16,18}O_{6-19}$
$C_{7-10}RO_2$	$C_{7-10}H_{7,9,11,13,15,17}O_{6-19}$
$C_{7-10}H_yO_zN$	$C_{7-10}H_{7,9,11,13,15,17}N_{1,2}O_{6-19}$
$C_{17-20}H_yO_z$	$C_{17-20}H_{24,26,28,30,32,34}O_{6-19}$
$C_{17-20}H_yO_zN$	$C_{17-20}H_{23,25,27,29,31,33}N_{1,2}O_{6-19}$
Other $C_{<20}H_yO_z(N)$	Other compounds with C<20
Other $C_{>20}H_yO_z(N)$	Other compounds with C>20

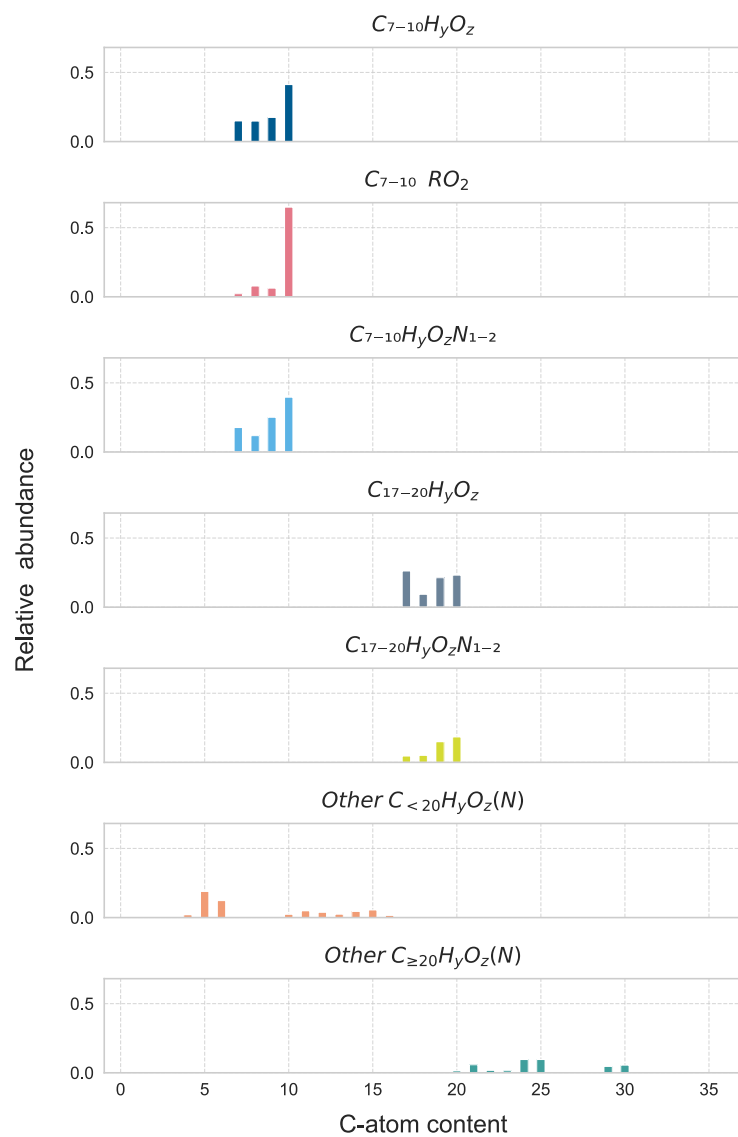


Figure S3: C-atom content distribution in different HOM subgroups

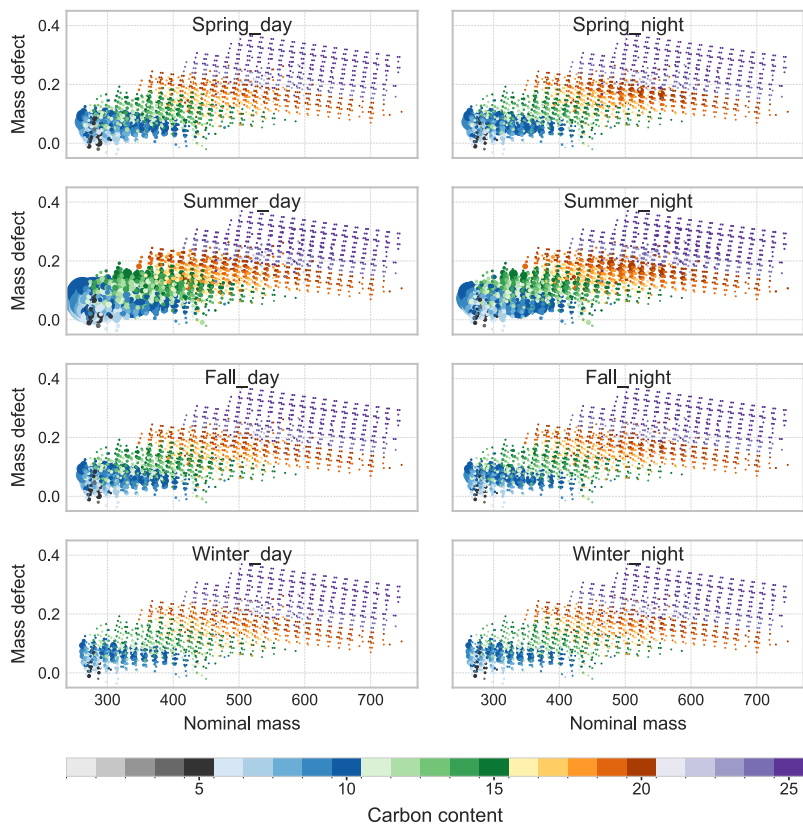


Figure S6: Average daytime and nighttime mass defect plot across seasons (NO_3^- ionization). Daytime and nighttime periods were defined as 10:00–14:00 and 22:00–02:00 (+1) (UTC+2), respectively. Dots areas are linearly proportional to the concentration of species. The colors indicate the carbon numbers of each species. Only species with a median concentration above 1000 molecules cm^{-3} are shown. $\text{C}_{15}\text{H}_{26}\text{O}_5$ and $\text{C}_{17}\text{H}_{28}\text{O}_6$ are not shown in the plot for better visualization, which will be discussed later in conjunction with Fig 5.

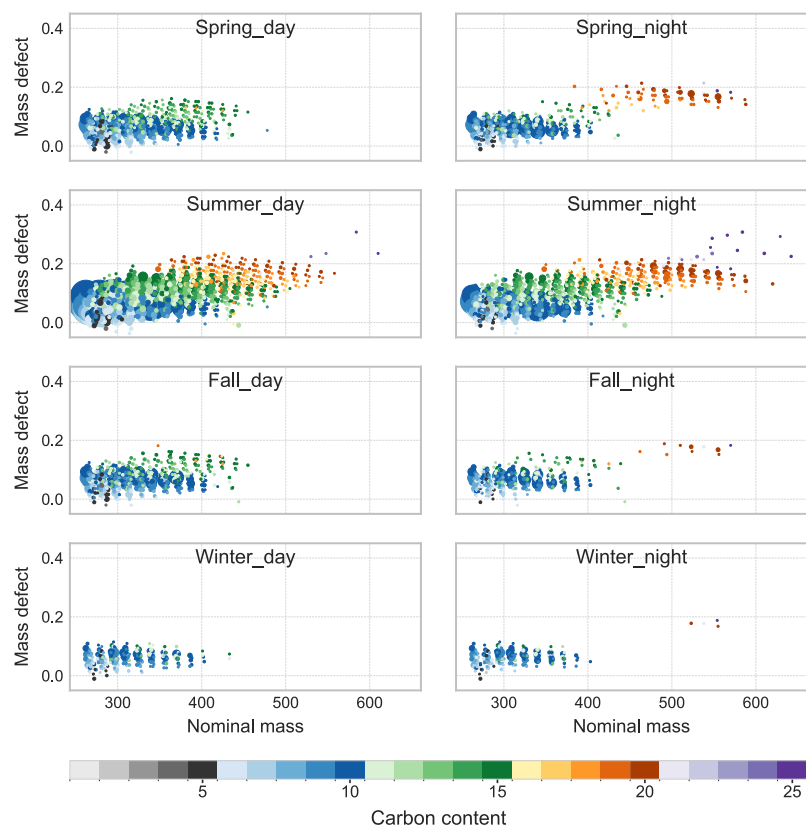


Figure S7: Average daytime and nighttime mass defect plot across seasons (NO_3^- ionization). Daytime and nighttime periods were defined as 10:00–14:00 and 22:00–02:00 (+1) (UTC+2), respectively. Dots areas are linearly proportional to the concentration of species. The colors indicate the carbon numbers of each species. Only species with a median concentration above 10000 molecules cm^{-3} are shown. $\text{C}_{15}\text{H}_{26}\text{O}_5$ and $\text{C}_{17}\text{H}_{28}\text{O}_6$ are not shown in the plot for better visualization, which will be discussed later in conjunction with Fig 5.

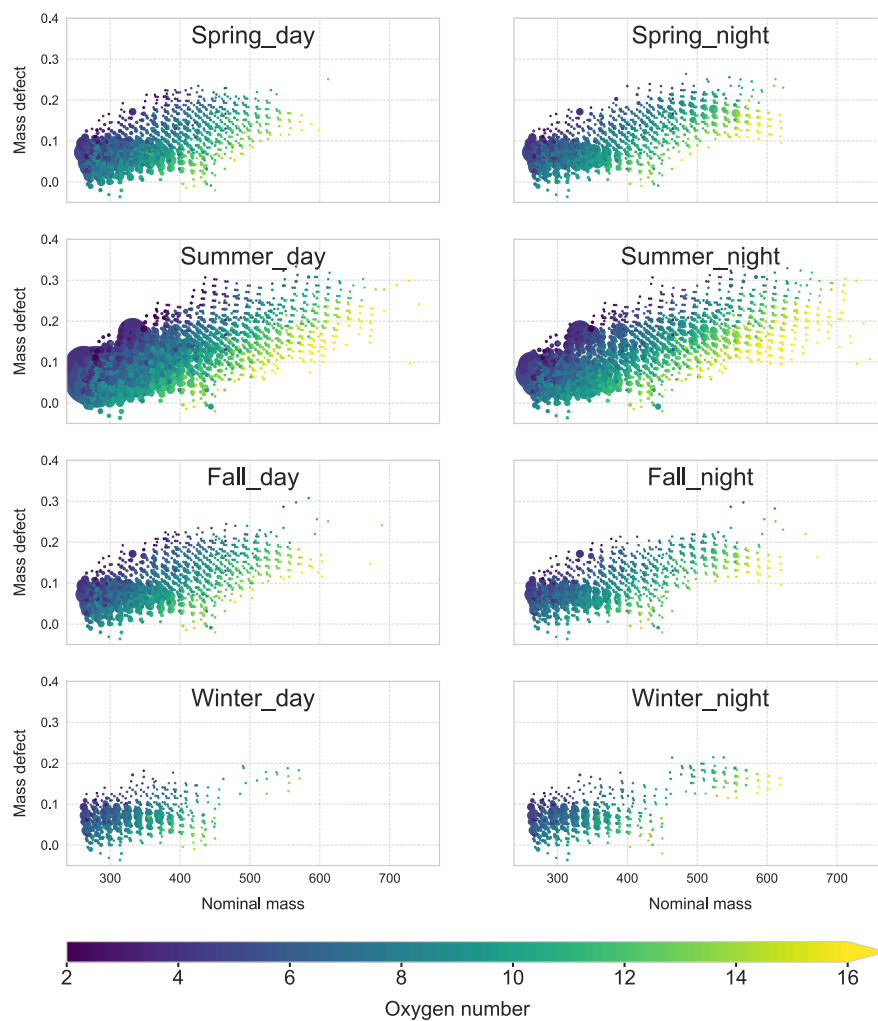


Figure S8. Averaged daytime and nighttime mass defect plot across seasons (NO_3^- ionization mode). Daytime and nighttime periods were defined as 10:00–14:00 and 22:00–02:00 (+1) (UTC+2), respectively. Dots areas are linearly proportional to the concentration of species. The colors indicate O-atom content. Only species with a median concentration above 3500 molecules cm^{-3} are shown. $\text{C}_{15}\text{H}_{26}\text{O}_5$ and $\text{C}_{17}\text{H}_{28}\text{O}_6$ are not shown in the plot for better visualization, which will be discussed later in conjunction with Fig 5.

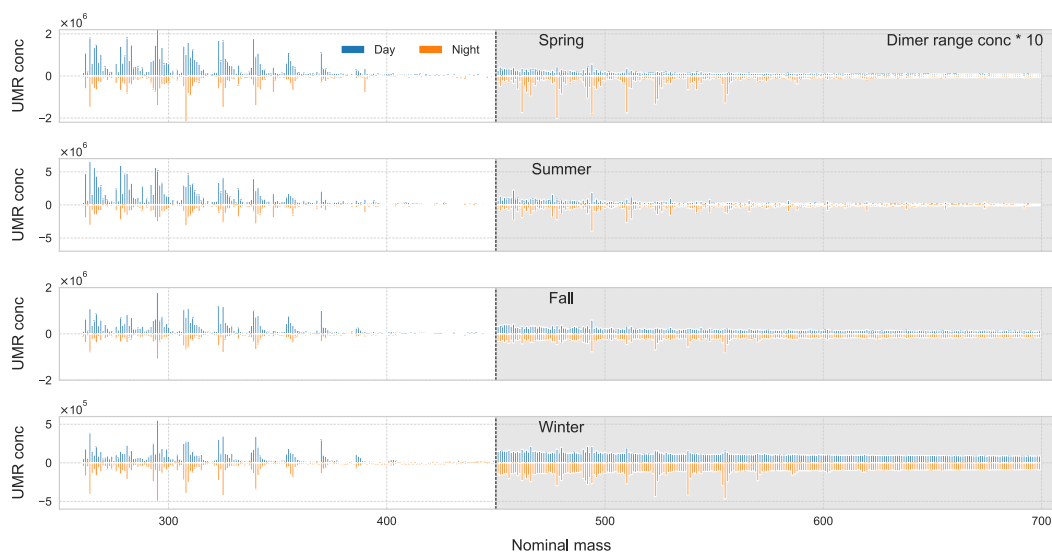


Figure S9. Mean mass spectrum in different seasons.

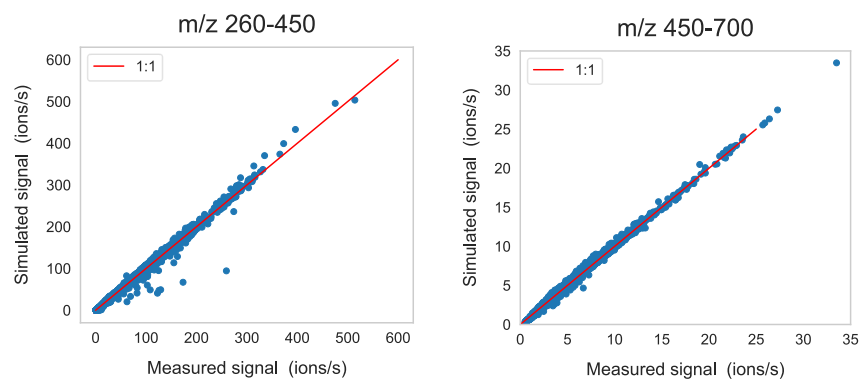


Figure S10. Comparison of measured and simulated signal in the low (m/z 260-450) and the high (m/z 450-700) mass range.

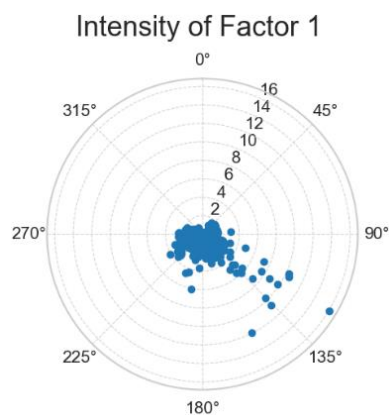


Figure S11. Wind rose plot showing the intensity of Factor 1 in m/z 260-450 according to wind direction.

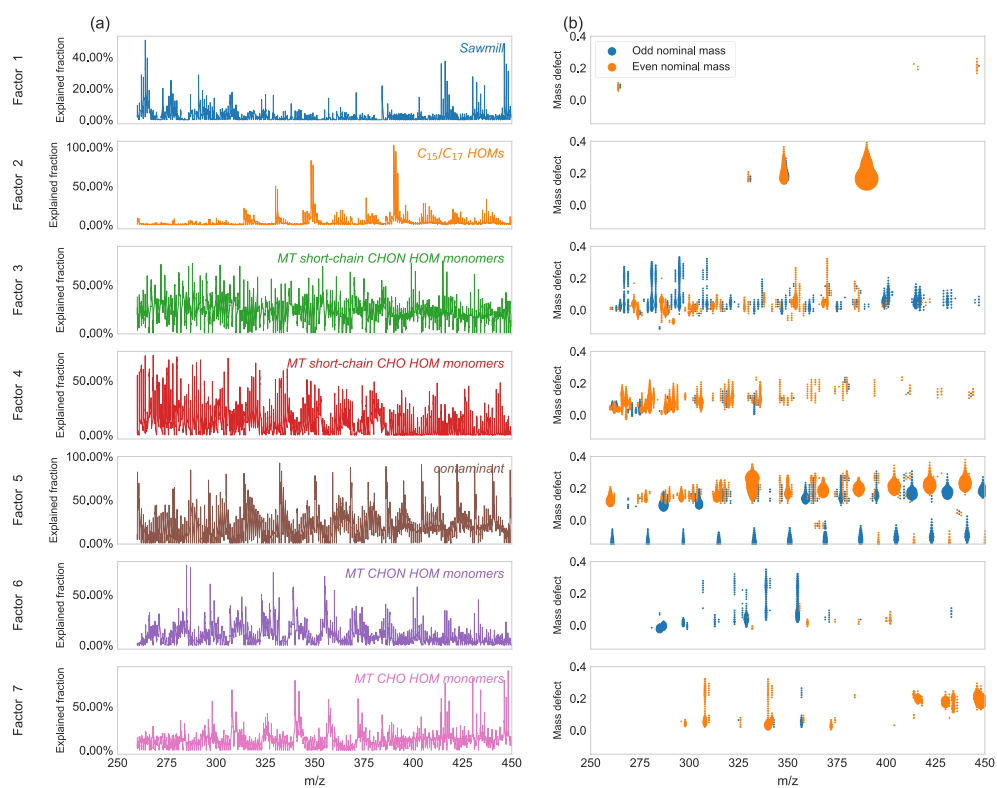


Figure S12: Bin-NMF results for the mass spectrum in the range of m/z 260-450. (a) Explained fraction profiles. The explained fraction for each bin is defined as the ratio of the modeled signal in the factor to the total measured signal for that bin.; (b) Mass defect plot of bins with an explained fraction greater than 35% for the factor.

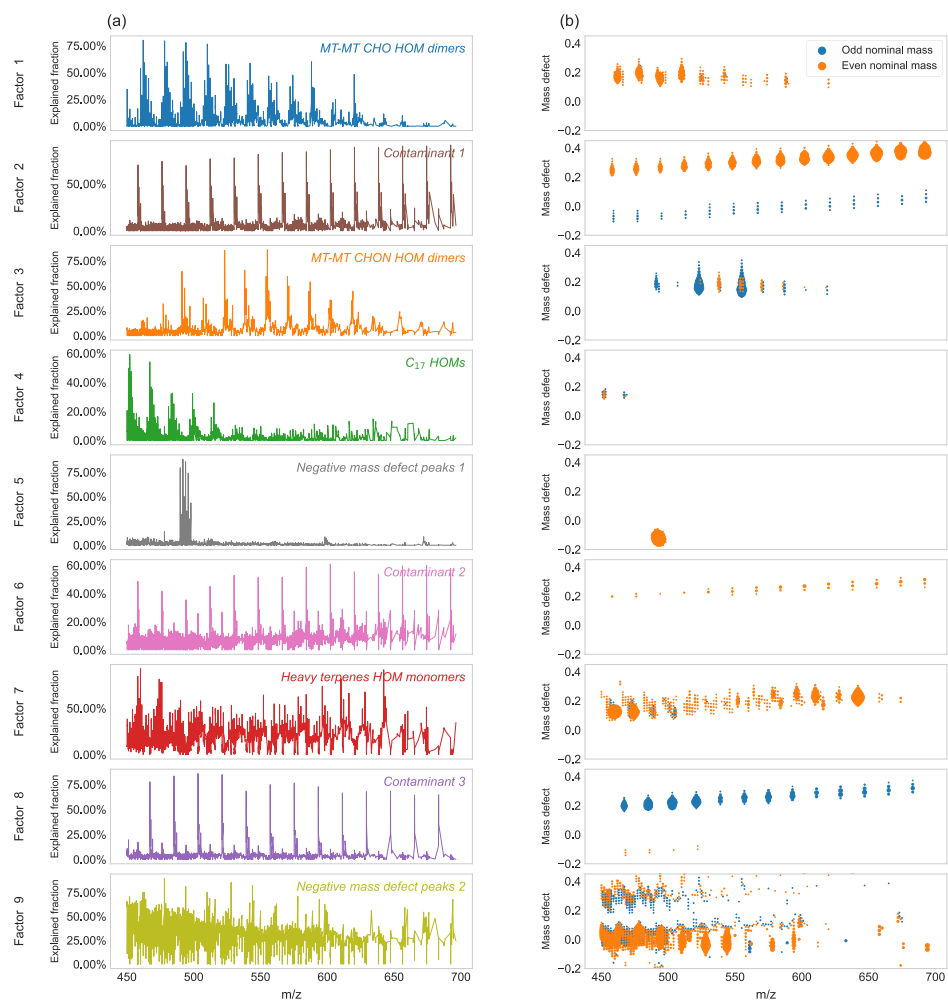


Figure S13: Bin-NMF results for the mass spectrum in the range of m/z 450-700. (a) Explained fraction profiles. The explained fraction for each bin is defined as the ratio of the modeled signal in the factor to the total measured signal for that bin.; (b) Mass defect plot of bins with an explained fraction greater than 35% for the factor.

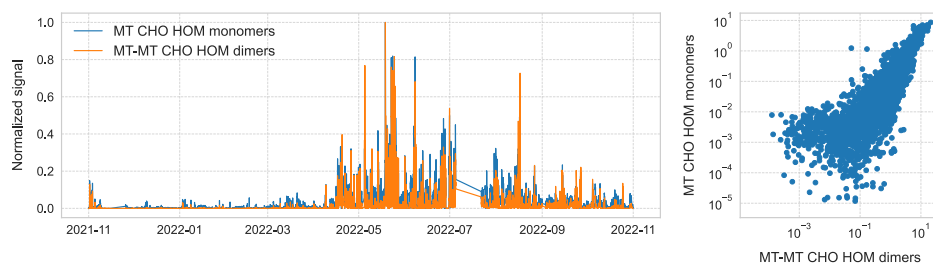


Figure S14: Time series comparison of MT CHO HOM monomers in the m/z 260-450 range and MT-MT CHO HOM dimers in the m/z 450-700 range.

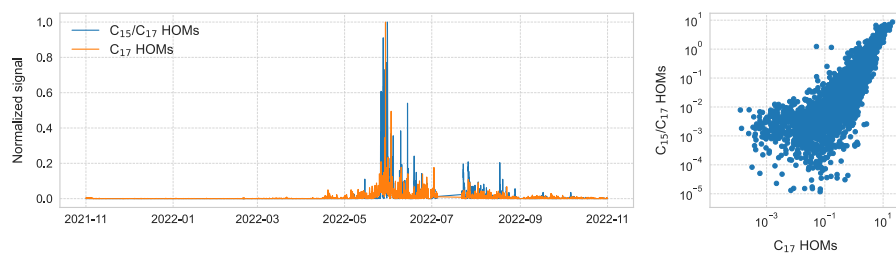


Figure S15: Time series comparison of C_{15}/C_{17} HOMs in the m/z 260-450 range and C_{17} HOMs in the m/z 450-700 range.

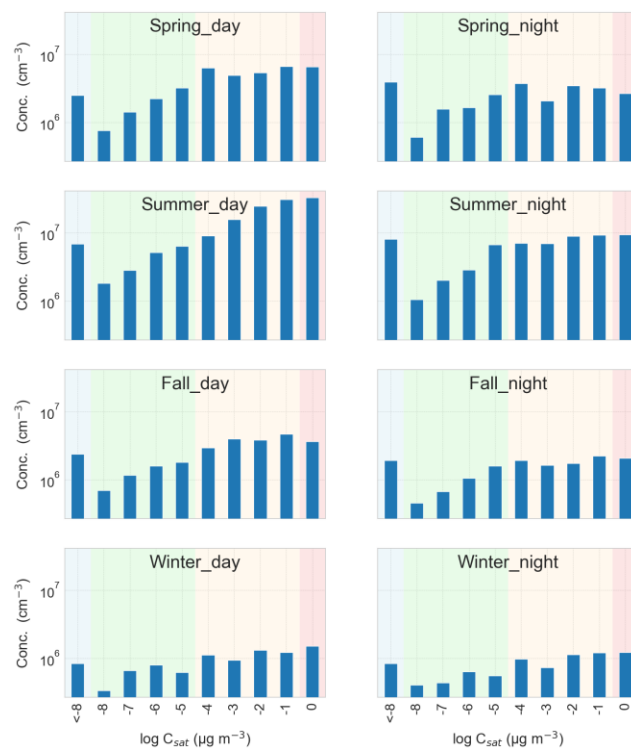


Figure S16 HOMs concentrations in each volatility bin across seasons. Only molecules with a $\log C_{\text{sat}}$ lower than $1 \mu\text{g m}^{-3}$ are shown.

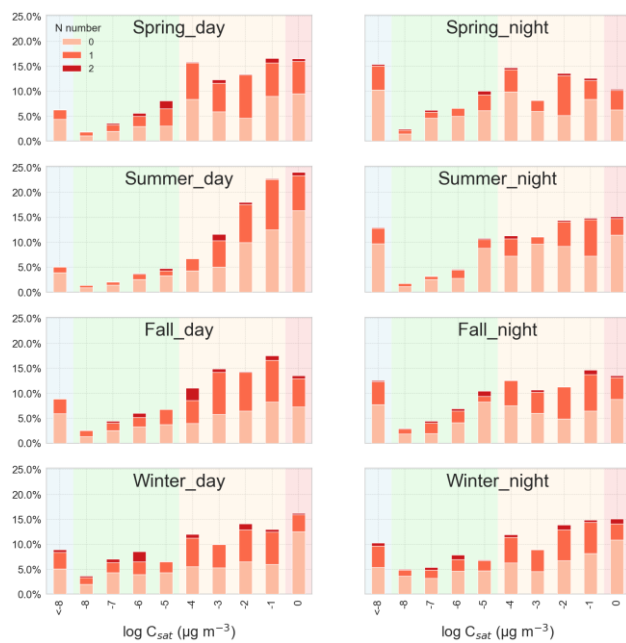


Figure S17 Volatility distribution of HOMs across seasons. Only molecules with a $\log C_{\text{sat}}$ lower than $1 \mu\text{g m}^{-3}$ are shown. The colors indicate the nitrogen numbers of each species.

Reference

Dada, L., Ylivinkka, I., Baalbaki, R., Li, C., Guo, Y., Yan, C., Yao, L., Sarnela, N., Jokinen, T., Daellenbach, K. R., Yin, R., Deng, C., Chu, B., Nieminen, T., Wang, Y., Lin, Z., Thakur, R. C., Kontkanen, J., Stolzenburg, D., Sipilä, M., Hussein, T., Paasonen, P., Bianchi, F., Salma, I., Weidinger, T., Pikridas, M., Sciare, J., Jiang, J., Liu, Y., Petäjä, T., Kerminen, V.-M., and Kulmala, M.: Sources and sinks driving sulfuric acid concentrations in contrasting environments: implications on proxy calculations, *Atmospheric Chemistry and Physics*, 20, 11747–11766, <https://doi.org/10.5194/acp-20-11747-2020>, 2020.