Supplementary Information: Nocturnal vertical gradients in O_3, PAN and PAA in a boreal forest: The role of chemical reactions, deposition and entrainment

Simone T. Andersen[1*], Carolina Nelson[1], Laura Wüst[1], Patrick Dewald[1], Gunther N. T. E. Türk[1], Jan Schuladen[1], Horst Fischer[1], Mikael Ehn[2], Tuukka Petäjä[2], Üllar Rannik[2], Ilona Ylivinkka[2,3], Lauri R. Ahonen[2,3], Robby Rynek[4], Helko Borsdorf[4], Thomas Mayer[4], Jos Lelieveld[1] and John N. Crowley[1*]

[1]Atmospheric Chemistry Department, Max-Planck-Institute for Chemistry, 55128-Mainz, Germany

[2]Institute for Atmospheric and Earth System Research (INAR)/Physics, Faculty of Science, University of Helsinki, Helsinki 00014, Finland

[3]Station for Measuring Ecosystem - Atmosphere Relations II (SMEAR II), University of Helsinki, Korkeakoski, 35500, Finland

[4]Department Monitoring and Exploration Technologies, UFZ Helmholtz Centre for Environmental Research, Permoserstraße 15, 04318 Leipzig, Germany

**Correspondence to*: Simone T. Andersen (simone.andersen@mpic.de) and John N. Crowley (john.crowley@mpic.de)

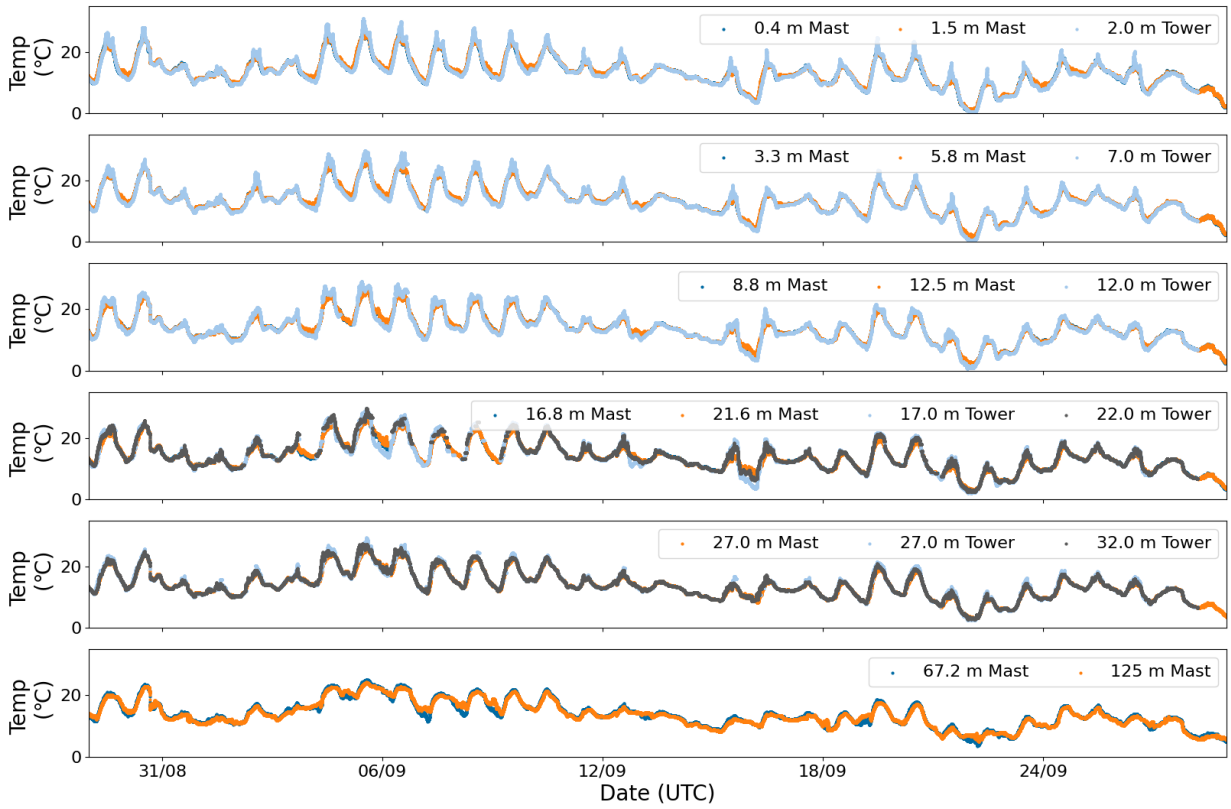

Figure S1: Temperature measurements from the 128 m mast and the 35 m tower at the Hyytiälä Forest Site.

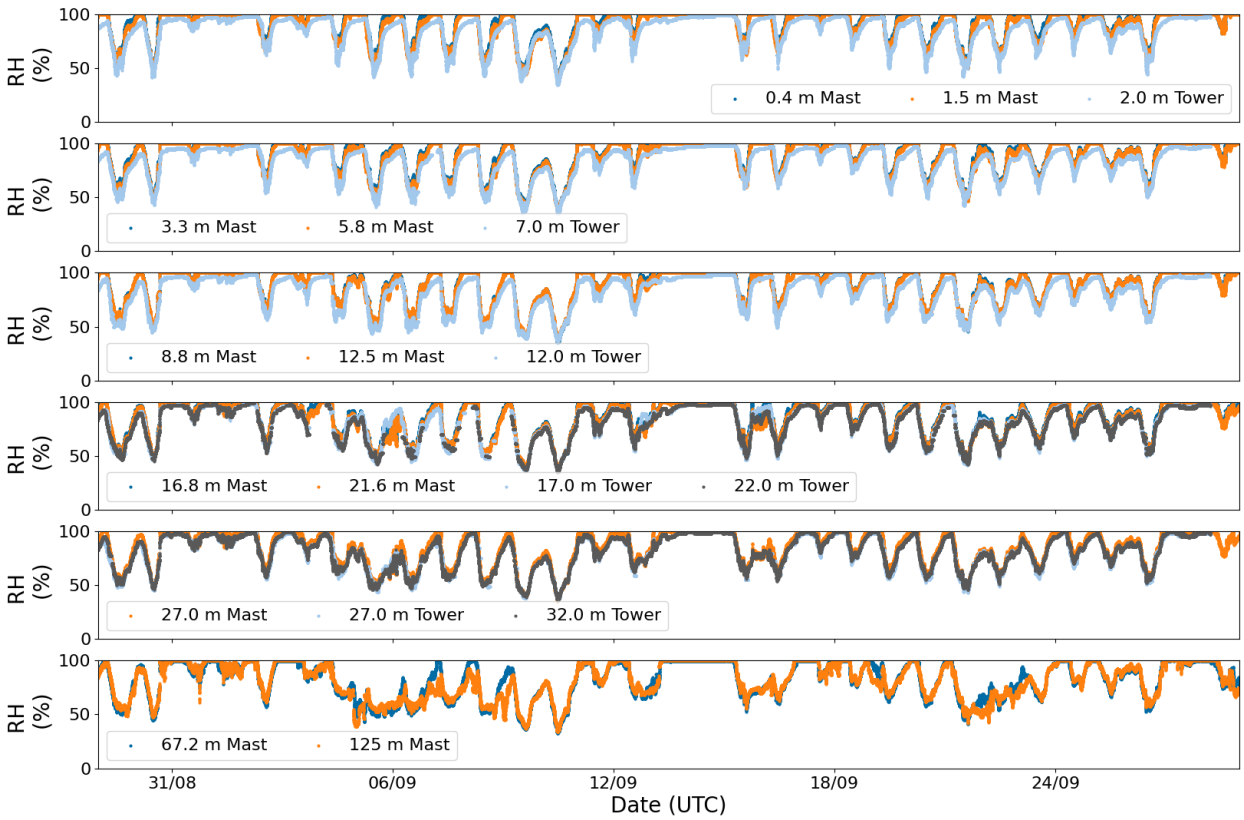

Figure S2: Relative humidity (RH) measurements from the 128 m mast and the 35 m tower at the Hyytiälä Forest Site.

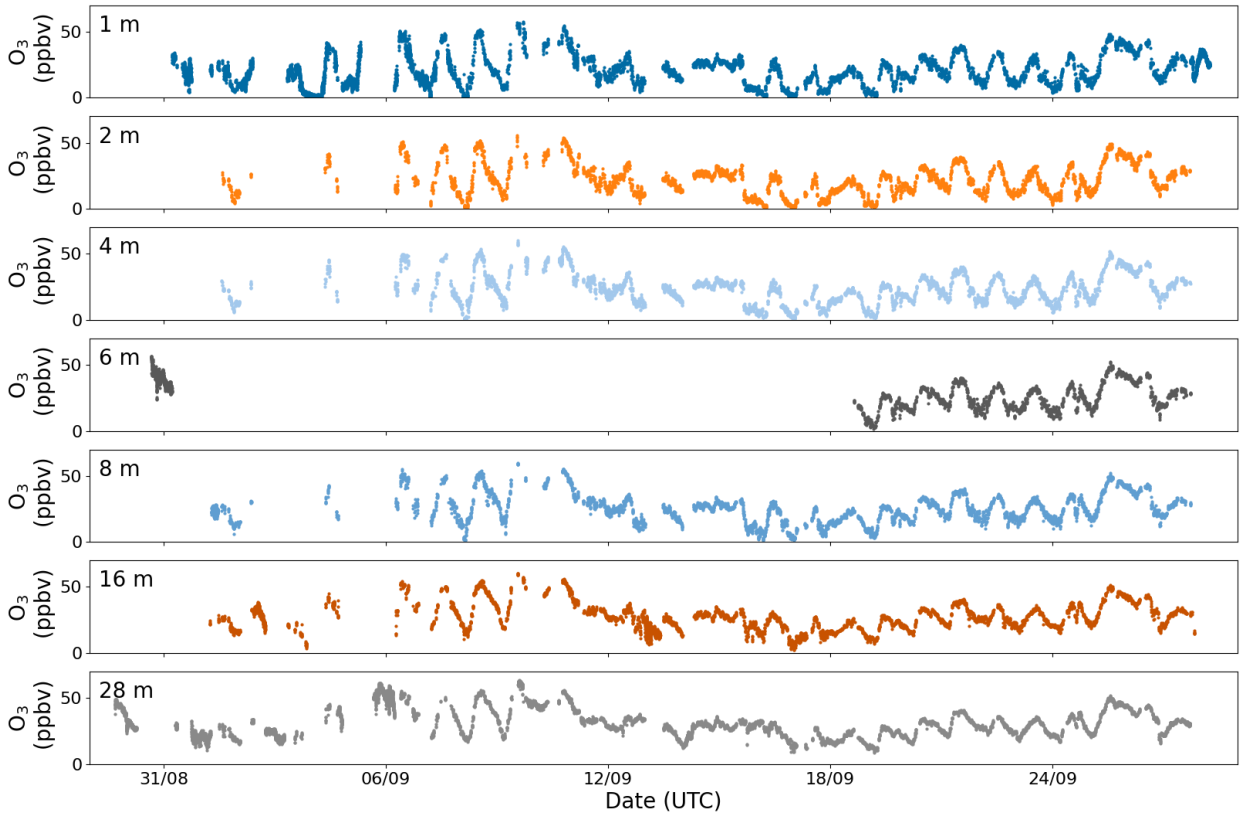

Figure S3: Time series of the O_3 measurements at different heights.

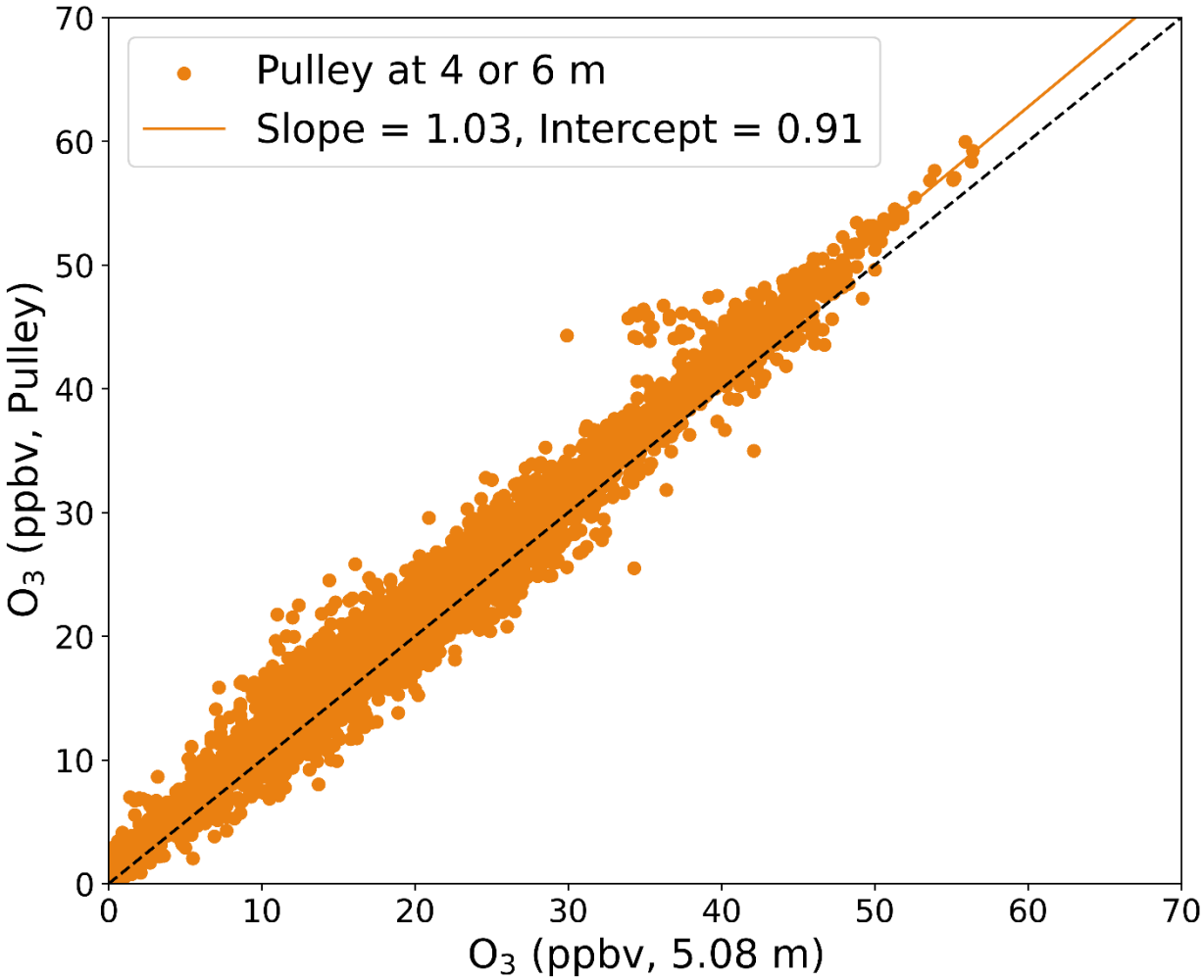

Figure S4: O_3 intercomparison between the instrument attached to the pulley at 4 or 6 m and the instrument continuously measuring on top of the container at 5 m. Each data point is an average of 1 min of measurements. The black dashed line shows the 1:1 line.

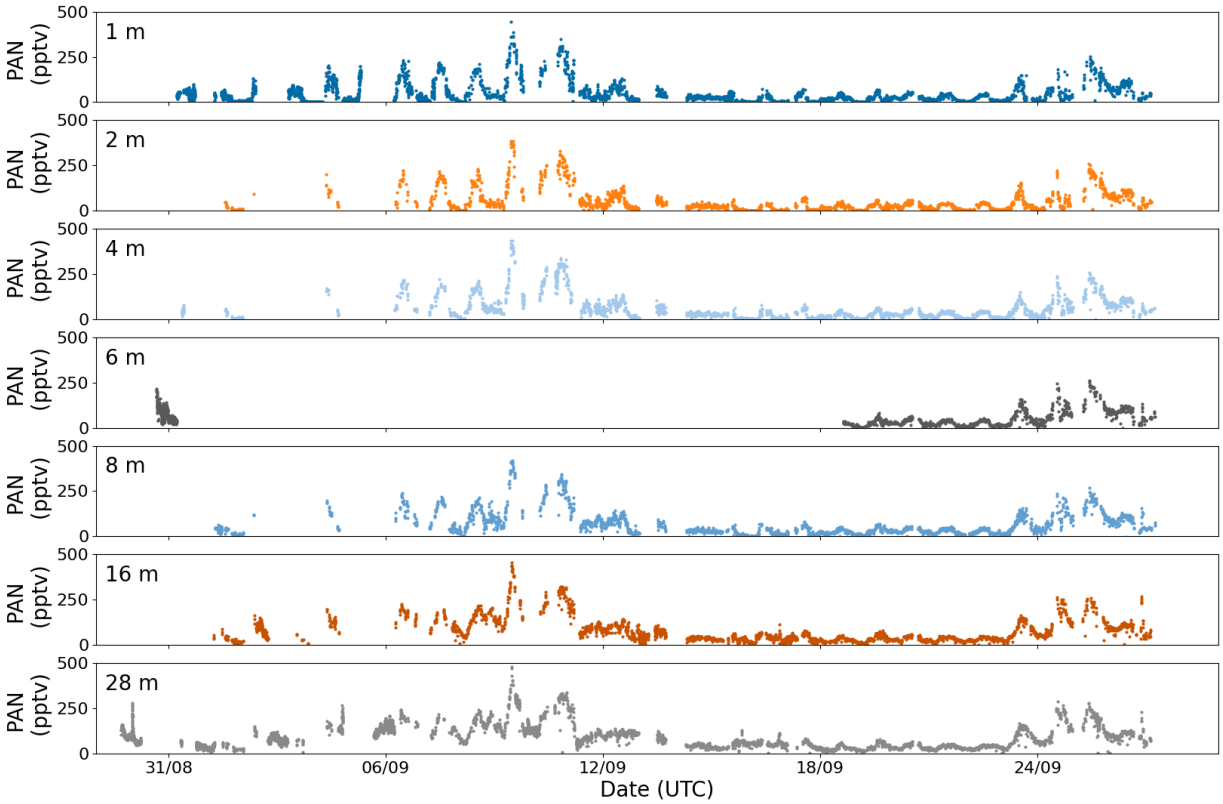

Figure S5: Time series of the PAN measurements at different heights.

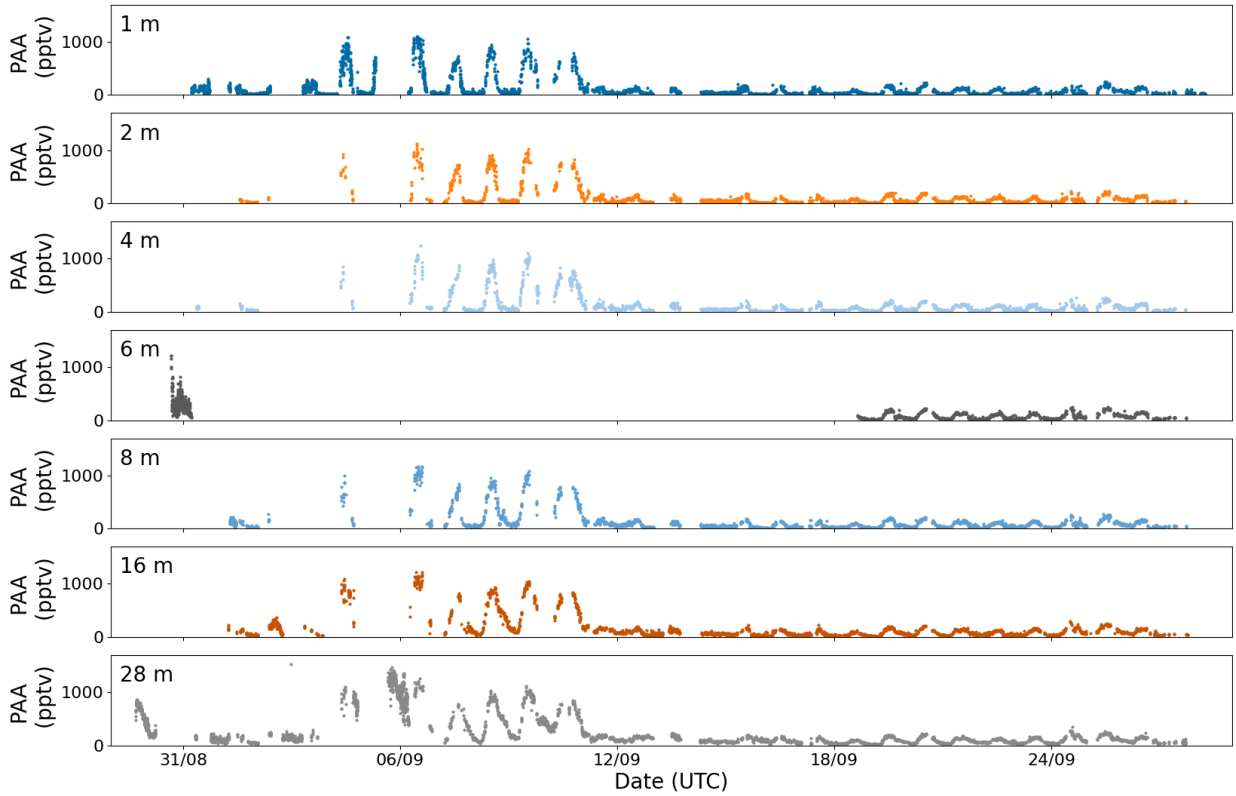

Figure S6: Time series of the PAA measurements at different heights.

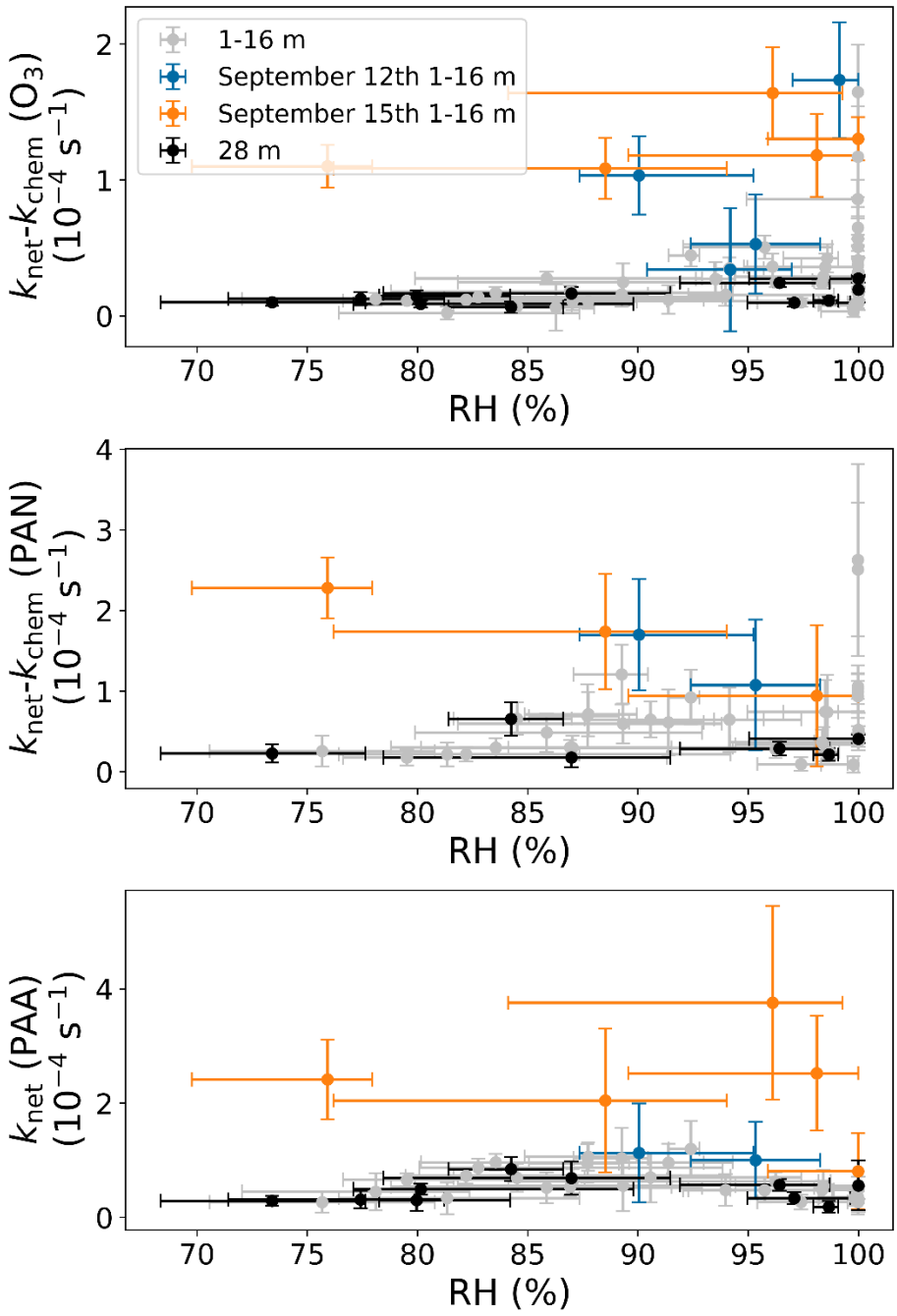

Figure S7: Net loss coefficients corrected for chemistry for O_3 (A), PAN (B), and PAA (C) plotted against the median relative humidity measured during the analysis period. The error bars indicate the standard deviation in the fits propagated with the uncertainties in the chemical loss term for O_3 and PAN and the 25^{th}-75^{th} quantile of the RH measured during the exponential fit.

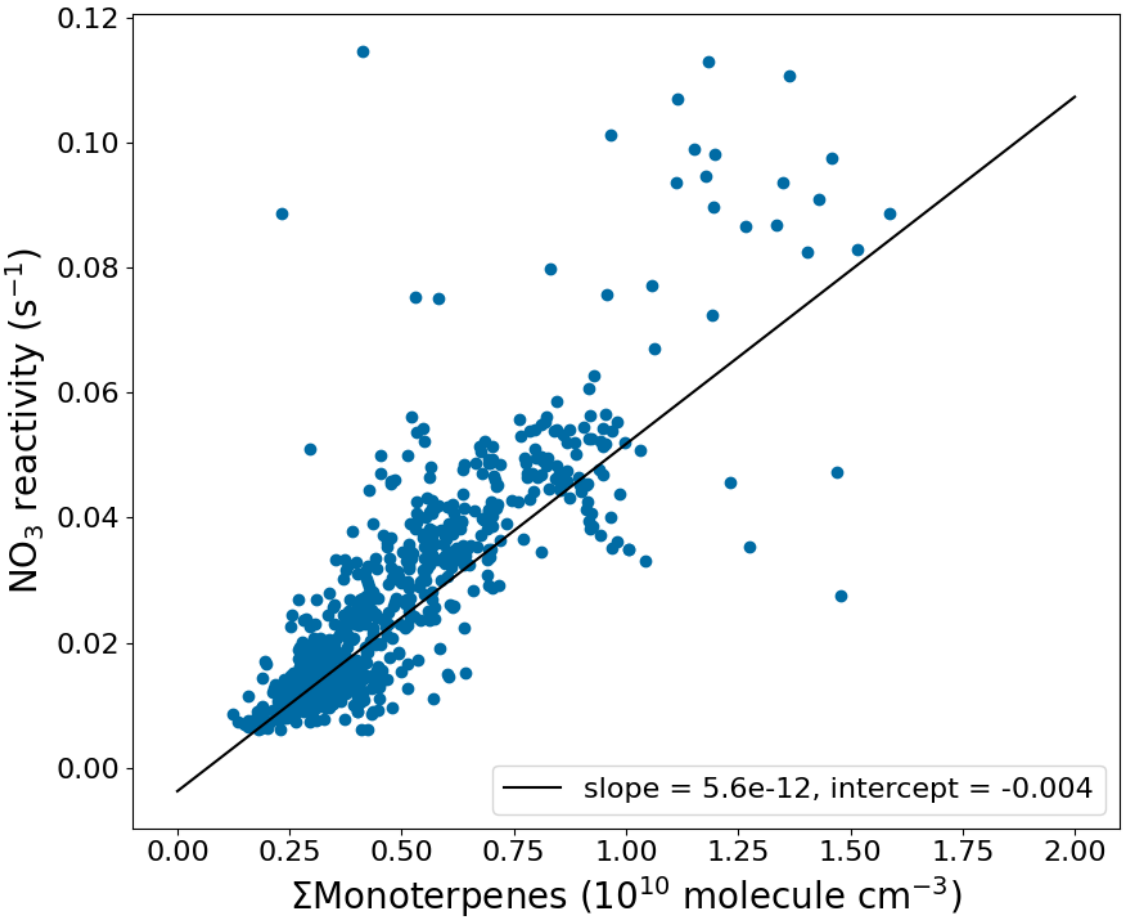

Figure S8: Measured NO_3 reactivity at 28 m between 9 and 17 UTC (local time is UTC+3) plotted against the sum of monoterpenes measured at 35 m. The solid line is an orthogonal distance regression which yields the effective rate coefficient (5.6×10^{-12} cm^3 $molecule^{-1}$ s^{-1}) of NO_3 radicals towards the monoterpene mixture.

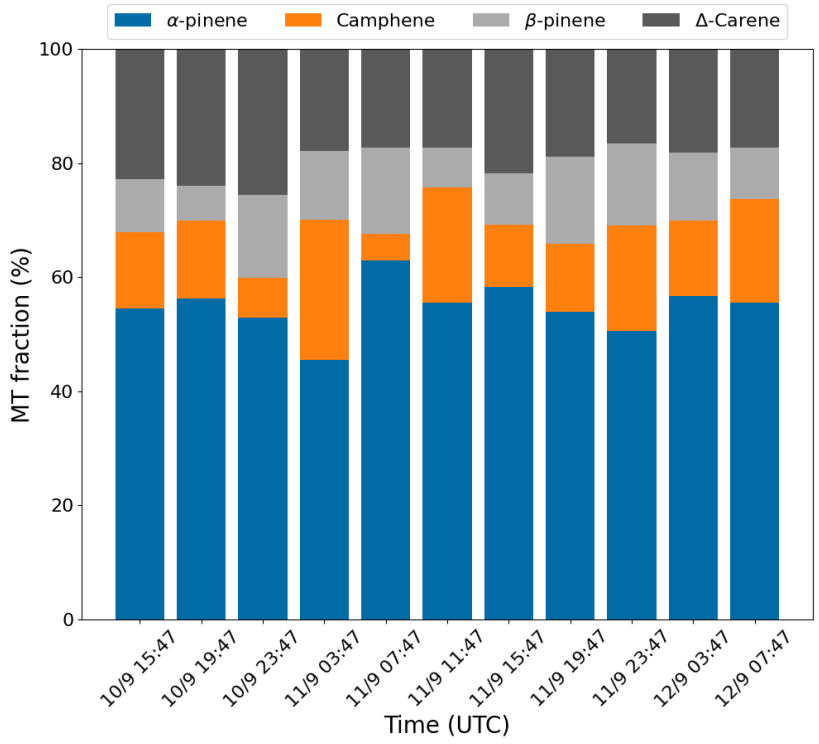

Figure S9: Monoterpene composition on September 10th-12th 2024 at the SMEAR II site measured at approximately 36 m.

Table S1: Measured monoterpenes for 4-hour sampling periods during BAIRN-VIP.

Time (UTC)	α-Pinene (ug m^{-3})	Camphene (ug m^{-3})	β-Pinene (ug m^{-3})	Δ-Carene (ug m^{-3})	∑MT (ug m^{-3})
10/9/2024 15:47	0.4236	0.1041	0.0727	0.1764	0.7768
10/9/2024 19:47	0.2129	0.0518	0.0236	0.0905	0.3788
10/9/2024 23:47	0.3662	0.0484	0.1005	0.1771	0.6922
11/9/2024 03:47	0.352	0.1906	0.0928	0.1383	0.7737
11/9/2024 07:47	0.3912	0.0283	0.0945	0.1068	0.6208
11/9/2024 11:47	0.393	0.1436	0.0493	0.1225	0.7084
11/9/2024 15:47	0.6734	0.1254	0.104	0.251	1.1538
11/9/2024 19:47	0.2769	0.061	0.0788	0.0967	0.5134
11/9/2024 23:47	0.2484	0.0909	0.071	0.081	0.4913
12/9/2024 03:47	0.2404	0.0561	0.0506	0.0767	0.4238
12/9/2024 07:47	0.3238	0.1056	0.0524	0.1004	0.5822