Supplement

Derivation of the growth rate from the ion size distribution

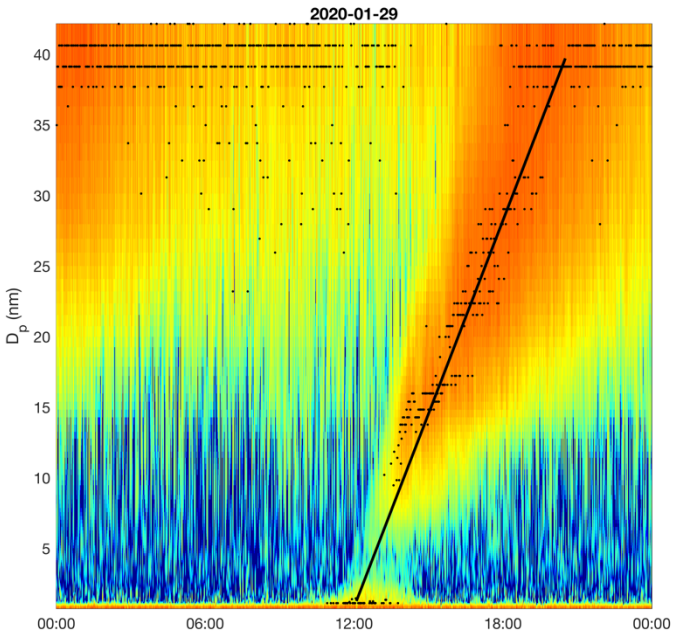

Figure S1. Particle formation event recorded by NAIS (negative ions) on 29. January 2020 depicted on linear dimeter scale. Maximum normalized concentration ($dN/dlogD_p$) of the size distribution is marked with dots. Growth rate, GR is the slope of the linear fitting to maximum concentration vs. time data, in this example 4.5 nm / hour. GR_2 derived from sulphuric acid concentration according to Eq. 3 during the intensive nucleation is 0.26 nm / hour.

New particle formation and growth during 10th – 12th November 2019

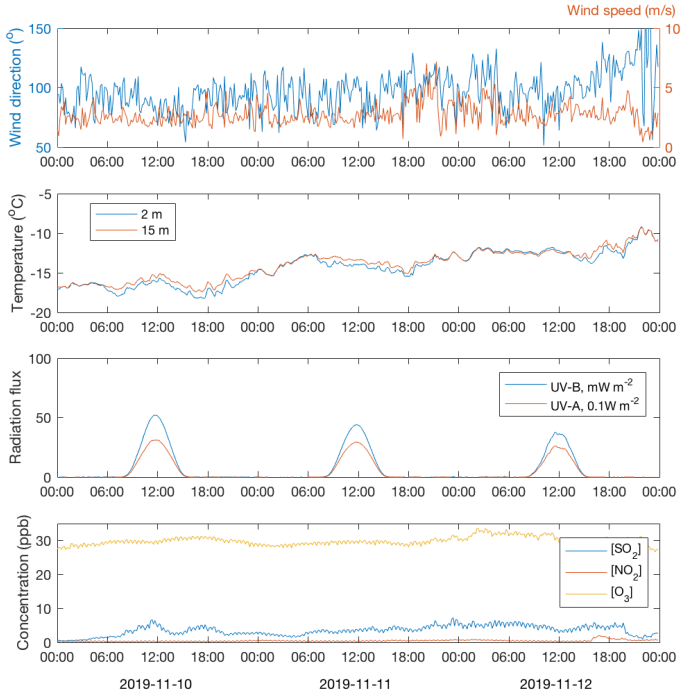

Figure S2. Wind speed and direction at 16 m height (a), air temperature at two heights (b) , UV-B and UVA radiation (c) and concentrations of SO_2, NO_2, O_3 (d) during 10th-12th November 2019.

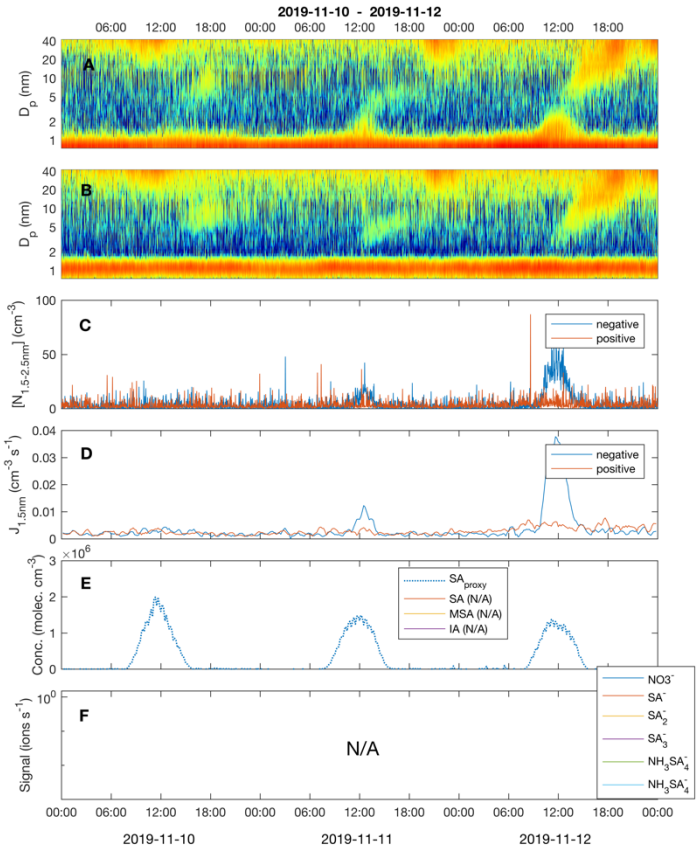

Figure S3. Size distribution of negative (a) and positive (b) clusters and particles, concentration of freshly nucleated, charged 1.5-2.5 nm clusters (c), formation rate of negative and positive 1.5 nm clusters (d) and sulphuric acid concentration estimated by proxy calculation (e) during 10th – 12th November 2019. CI-APi-TOF Mass spectrometer was not operational during the depicted period and thus no measurement data on H_2SO_4, MSA, IA and ion clusters exist.

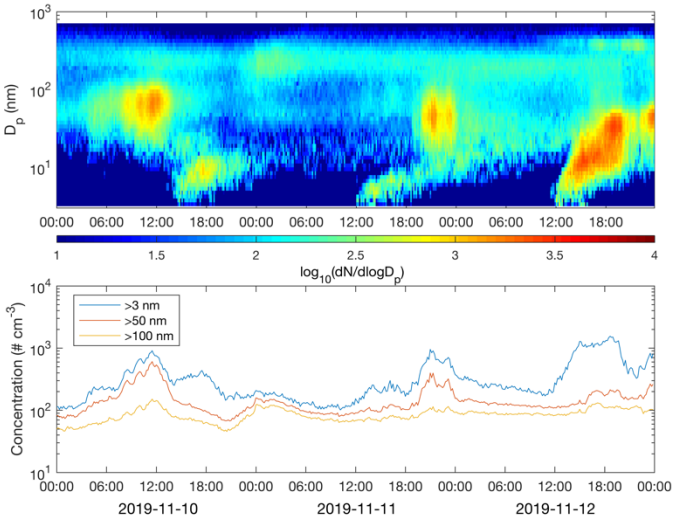

Figure S4. Particle size distribution and concentrations of particles larger than 3 nm, 50 nm and 100 nm recorded by DMPS during 10th-12th November 2019.

New particle formation and growth 11th March 2020

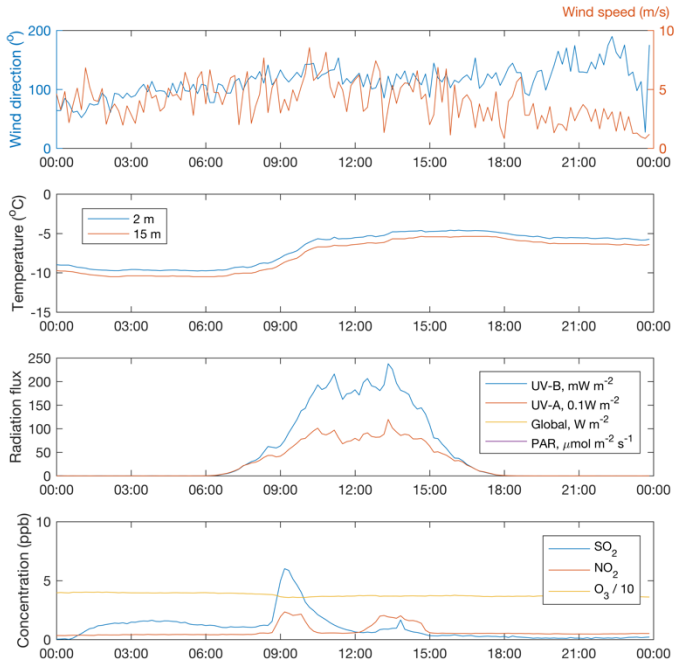

Figure S5. Wind speed and direction at 16 m height (a), air temperature at two heights (b) , UV-B and UVA radiation (c) and concentrations of SO_2, NO_2, O_3 (d) on 11th March 2020.

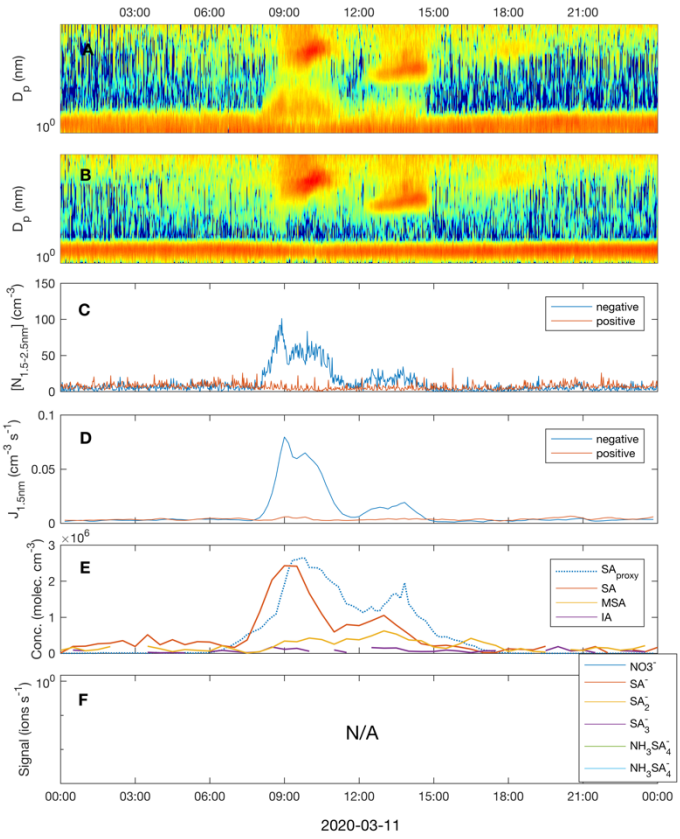

Figure S6. Size distribution of negative (a) and positive (b) clusters and particles, concentration of freshly nucleated, charged 1.5-2.5 nm clusters (c), formation rate of negative and positive 1.5 nm clusters (d) measured concentrations of sulphuric acid (H_2SO_4), methane sulphonic acid (MSA) and iodic acid (HIO_3) as well as sulphuric acid concentration estimated by proxy calculation (e) on 11th March 2020. Data on ion clusters is not available.

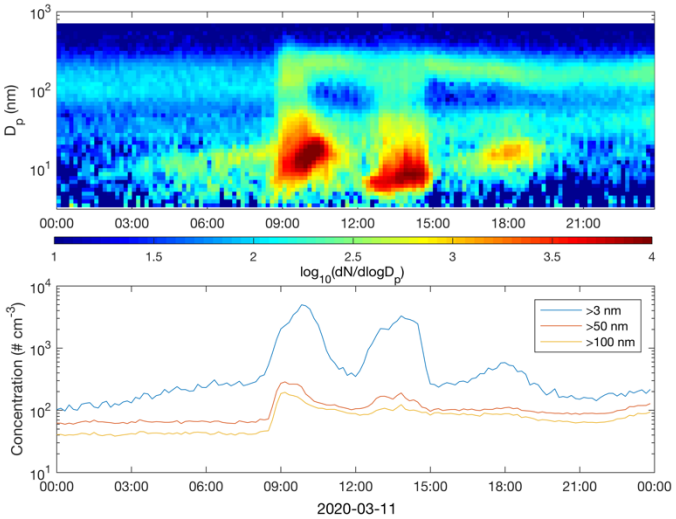

Figure S7. Particle size distribution and concentrations of particles larger than 3 nm, 50 nm and 100 nm recorded by DMPS 11th March 2020.

New particle formation and growth 3rd December 2019

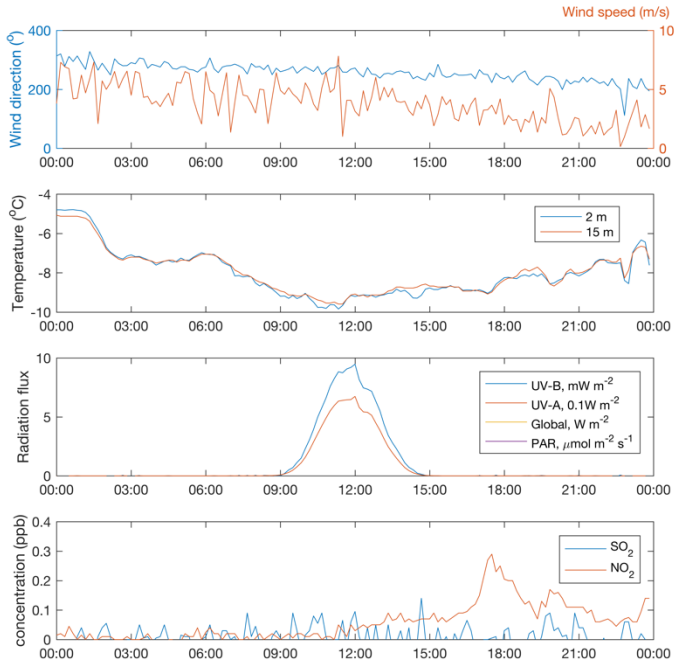

Figure S8. Wind speed and direction at 16 m height (a), air temperature at two heights (b) , UV-B and UVA radiation (c) and concentrations of SO_2, NO_2, O_3 (d) on 3rd December 2019.

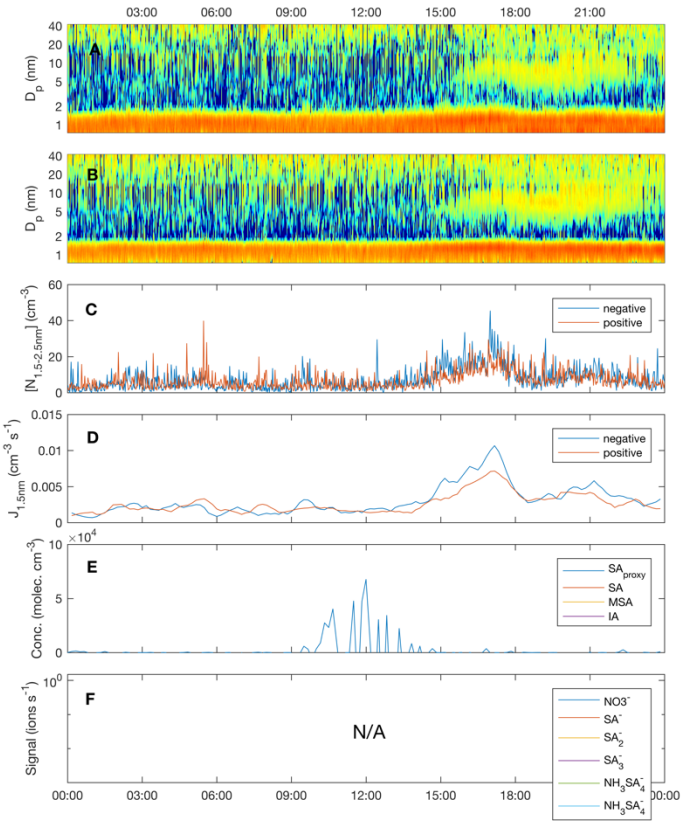

Figure S9. Size distribution of negative (a) and positive (b) clusters and particles, concentration of freshly nucleated, charged 1.5-2.5 nm clusters (c), formation rate of negative and positive 1.5 nm clusters (d) measured concentrations of sulphuric acid (H_2SO_4), methane sulphonic acid (MSA) and iodic acid (HIO_3) as well as sulphuric acid concentration estimated by proxy calculation (e) on 3rd December 2020. Data on and ion clusters is not available. Nucleation rates are calculated, consistently with rest of the analyzed days, from the change in concentration $N_{1.5\text{-}2.5nm}$ between 1.5 and 2.5 nm ion clusters. Though the calculation yields non-zero values, from surface plots it is obvious that no growth from cluster sizes to stable particles can be observed. I.e. at least ion-induced nucleation does not occur in situ in proximity of SMEAR. H_2SO_4, MSA and HIO_3 concentrations were below detection limit of CI-APi-TOF – i.e. no signal was distinguishable from the instrument background. Since [SO_2] and UVB radiation are close zero, also calculated H_2SO_4 is negligible and no explanation for formation pathway of observed small particles can be derived from the data. Particles are obviously formed elsewhere and advected to the station or mixed from upper layers of the atmosphere. During the transportation the signs of the particle precursor have been lost.

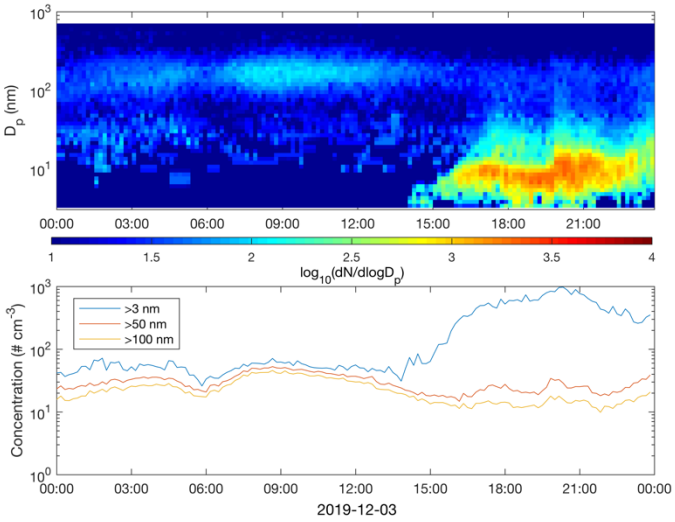

Figure S10. Particle size distribution and concentrations of particles larger than 3 nm, 50 nm and 100 nm recorded by DMPS 3rd December, 2019.