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Hygroscopic properties of ultrafine aerosol particles in the boreal forest: diurnal variation, solubility and the influence of sulfuric acid

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Abstract. The hygroscopic growth of aerosol particles present in a boreal forest was measured at a relative humidity of 88%. Simultaneously the gas phase concentration of sulfuric acid, a very hygroscopic compound, was monitored. The focus was mainly on days with new particle formation by nucleation. The measured hygroscopic growth factors (GF) correlated positively with the gaseous phase sulfuric acid concentrations. The smaller the particles, the stronger the correlation, with $r=0.20$ for 50 nm and $r=0.50$ for 10 nm particles. The increase in GF due to condensing sulfuric acid is expected to be larger for particles with initially smaller masses. During new particle formation, the changes in solubility of the new particles were calculated during their growth to Aitken mode sizes. As the modal diameter increased, the solubility of the particles decreased. This indicated that the initial particle growth was due to more hygroscopic compounds, whereas the later growth during the evening and night was mainly caused by less hygroscopic or even hydrophobic compounds. For all the measured sizes, a diurnal variation in GF was observed both during days with and without particle formation. The GF was lowest at around midnight, with a mean value of 1.12–1.24 depending on particle size and if new particle formation occurred during the day, and increased to 1.25–1.34 around noon. This can be tentatively explained by day- and nighttime gas-phase chemistry; different vapors will be present depending on the time of day, and through condensation these compounds will alter the hygroscopic properties of the particles in different ways.

▣ Final Revised Paper (PDF, 1504 KB)   ▣ Discussion Paper (ACPD)

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