Characterization of particle formation in a spruce forest in north east Bavaria

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Keywords: NAIS, nucleation, H2SO4, spruce
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Particle formation is happening all over the world (Kulmala et al., 2007) and influences human health and the global climate. However the processes leading to particle formation are not sufficiently understood until today. The formation and growth rate are essential parameters for the characterization of particle formation events (Kulmala et al., 2012). We tried to characterize particle formation and searched for connections between meteorological parameters and particle formation events.

We conducted particle and meteorological measurements during the summer 2012 in a spruce forest in north east Bavaria to increase the knowledge of particle formation events. For the particle measurements we used a scanning mobility particle spectrometer and a neutral cluster and air ion spectrometer which allows to measure particles down to a diameter of about 2 nm. The data of both instruments was used to generate a combined particle distribution for the calculation of nucleation and growth rates. We estimated the condensation and coagulation sink and parametrized sulphuric acid concentrations from measured sulphur dioxide concentrations and parametrized hydroxide radical concentrations.

We identified 18 event days which could be divided into three classes by their nucleation and growth behaviour. We also used 8 non event days without a rise in ultra fine particle concentration for comparison with the meteorological parameters. The overall growth rates were between 0 and 5.5 nmh^{-1}, the nucleation rates mostly under 10 $cm^{-3}s^{-1}$. We observed the highest relative humidity on non event days which is in good agreement with observations made by Boy and Kulmala (2002) who proposed that low water concentrations in the atmosphere favour nucleation events. Drops of the precursor sulphur dioxide concentration often during changes of wind direction or a decrease of radiation due to clouds often led to an interruption of the particle formation events. Correlations between air temperature and growth indicate an influence of oxidation products of volatile organic compounds (VOC) on particle growth. Particle formation occurred mainly on days with easterly winds. One reason for this finding could be wast forested areas in the east of the research area providing large amounts of precursor VOCs needed for the growth of the particles. Furthermore, rise of sulphur dioxide concentrations, a precursor for sulphuric acid, was often connected to easterly winds. The results of the correlation between sulphuric acid concentrations and nucleation rates are consistent with the homogenous binary nucleation of two sulphuric acid molecules. There was a clear connection between the rise of sulphuric acid concentrations and the rise of ultra fine particle concentration with a time delay of about 1.5 hours (c.f. Fig.1). In contrast we observed that the influence of sulphuric acid on the growth is under 7 % (c.f. Tab.1).

In summary our study emphasizes the influence of sulphuric acid on the nucleation and hints at the importance of VOC for the further growth of the newly formed clusters.

Table 1: Growth [nm/h] calculated from the geometric mean (observed growth), explained by the condensation of sulphuric acid (explained growth), in per cent on 5 event days

Day	Observed growth	Explained growth	[%]
24.07.	1.5	0.05	3
12.08.	4.6	0.06	1
13.08.	1.2	0.09	7
14.08.	1.8	0.11	6
15.08.	3.4	0.08	2

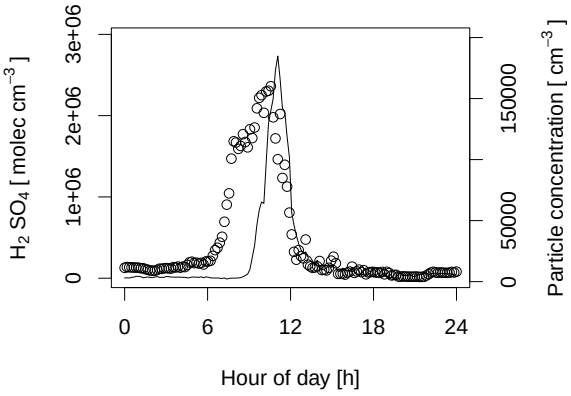

Figure 1: Mean sulphuric acid concentrations (dots) and ultra-fine particle concentrations (lines) on Class I event days

Many thanks to Andreas Held for the support with the study and the funding and special thanks to Wolfram Birmili (IfT Leipzig) for providing the NAIS.

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