Influence of SO\textsubscript{2} on nucleation, growth rates and yield of secondary organic aerosols

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Binary nucleation of sulphuric acid and water was observed to occur in laboratory experiments at atmospherically relevant concentrations (Berndt et al., 2005). In addition, laboratory experiments show that the nucleation of sulphuric acid is considerably enhanced in the presence of organic acids due to the formation of a stable aromatic acid-sulphuric acid complex, which reduces the nucleation barrier (Zhang et al., 2004). Several laboratory studies have examined the role of acidic aerosols in enhancing the uptake of carbonyl compounds through acid catalyzed reactions (Jang et al., 2003) and the influence on the SOA yield (Kleindienst et al., 2006).

A laboratory study was carried out to investigate the secondary organic aerosol formation of 1,3,5-trimethylbenzene (TMB) in the presence of SO\textsubscript{2}. Several experiments were carried out using SO\textsubscript{2} concentrations between 0.2 and 20 ppb for TMB concentrations of 150, 300, 600 and 1200 ppb, while keeping all the other parameters constant. Aerosol size distributions were measured using a twin SMPS system. The first is a nano SMPS composed of a short DMA column and a TSI UWCPC, while the second one consisted of a long DMA column and a TSI 3022CPC. This combination of instruments provided measurements of the size distributions over the size range from 4 to 700 nm diameter. VOC concentrations were measured using a Proton Transfer Reaction-Mass Spectrometer (PTRMS) while organic acids and SO\textsubscript{2} concentrations were measured using a wet effluent diffusion denuder/aerosol collector (WEDD/AC) connected to IC-MS. The particle chemical composition was measured using an Aerosol Time Of Flight Mass Spectrometer (ATOFMS, TSI, USA).

The empirical particle nucleation and growth rates were determined using only the aerosol size distribution as input, using the recently developed inverse modelling procedure PARGAN (Particle Growth and Nucleation) (Verheggen and Mozurkewich, 2006). Growth rates were determined by regression analysis of the General Dynamic Equation. The empirical growth rates were then used to estimate the time of nucleation for particles in each size bin, defined as the time when their diameter surpassed 1 nm. Their number density at the time and size of nucleation were determined by integrating the particle losses that occurred in the time interval between nucleation and measurement. The nucleation rate was then given by the rate at which particles grow past the critical cluster size, assumed to be 1 nm.

Figure 1 demonstrates the effect of SO\textsubscript{2} on nucleation. With higher initial SO\textsubscript{2} concentrations the maximum particle number concentration is increased from 800 to ~1.1x10\textsuperscript{5} particles/cm\textsuperscript{3} (0 to 20 ppb SO\textsubscript{2}), while there is only a minor influence of 1,3,5-TMB on the maximum number concentration.

Figure 1 shows the effect of SO\textsubscript{2}/sulphuric acid as well as TMB concentrations. The effect of SO\textsubscript{2} on the SOA yield and SOA composition, as measured with ATOFMS, will be discussed.


