The role of sulphuric acid in the formation of atmospheric particles based on a long-term explicit modelling approach

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The role of atmospheric aerosols is perhaps the largest unknown concerning our climate and greenhouse warming. New particle formation has been observed at almost all sites, where particle size distributions have been measured (Kulmala et al., 2004). Although many field campaigns, laboratory experiments and new modelling approaches have led to increased understanding, detailed mechanisms responsible for the formation of new particles in the troposphere have still not been completely elucidated. One of the most controversial topics is the role or importance of sulphuric acid in the formation process.

In this study we present results achieved by SOSA (Boy et al., 2011). This model was developed at the University of Helsinki. The meteorology is based on a 1-D version of the model SCADIS (Sogachev et al., 2002) and the Model for Emissions of Gases and Aerosols in Nature (MEGAN) is used to simulate the emission of organic vapours from the biosphere (Guenther et al., 2006). The gas phase chemistry is solved with the Kinetic Pre-Processor (KPP) in combination with the Master Chemical Mechanism from the University of Leeds. It is a parallelized model operating on a high-performance super-cluster at the CSC - IT Centre for Science in Finland, which gives the possibility to run detailed processes in chemistry, aerosol dynamic and meteorology over long periods with reasonable model runtime.

We will present different model results for 10 years of simulations (2003-2012) and comparison with measurements. Our aim is to demonstrate the role of sulphuric acid when considering the question: What are the crucial molecules for new particle formation in the atmosphere?

One possible way to get some hints to solve this question is the use of long-term comparisons between different parameters simulated with the new model SOSA and the frequency of particle formation events (Boy et al., 2002). In this context we calculated different combinations of parameters like e.g. RP-1:

$$RP-1=\frac{[H_2SO_4]}{CS}$$

This equation gives the concentration of sulphuric acid divided by the condensation sink of the pre-existing aerosols. Figure 1 presents the number of event days in three different classes (Boy et al., 2002) and the amount of days per month where the daytime (9-15) mean value exceed the mean value by 0, 10, 25 %, respectively.

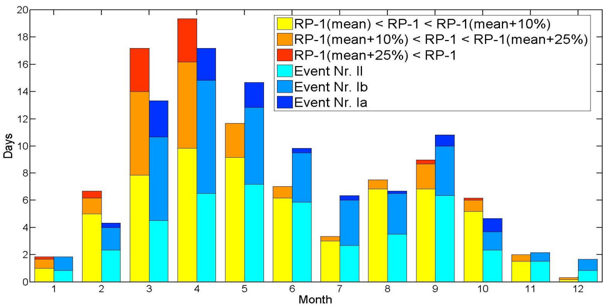

Figure 1: Monthly trend for RP-1 and observed frequency of nucleation event days

The figure shows a clear correlation in monthly distribution between sulphuric acid and nucleation event frequency. Including the monoterpenes, temperature and water vapour into the equation shifts the distribution more towards the summer months but also decrease the amount of days during the second observed event peak in autumn.

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