

## ***Interactive comment on “Atmospheric homogeneous nucleation of H<sub>2</sub>SO<sub>4</sub> and H<sub>2</sub>O” by D. R. Benson et al.***

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Received and published: 12 January 2011

Benson et al. present laboratory measurements of the binary homogeneous nucleation of H<sub>2</sub>SO<sub>4</sub> and H<sub>2</sub>O which are quite important for understanding the binary homogeneous nucleation of H<sub>2</sub>SO<sub>4</sub> and H<sub>2</sub>O in the atmosphere. However, I am somewhat dissatisfied about the present study. In their previous studies Benson et al. discussed measurements and showed very interesting results on the binary homogeneous nucleation, but here solely laboratory measurements are shown and the entire study is rather a technical than a scientific one.

First of all I am wondering why Benson et al. do not use any atmospheric measurements together with their laboratory measurements? Further, it is not clear what

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the goal of this study is and what is new compared to previous studies, e.g. there has just a few months earlier a study on laboratory measurements of the nucleation of sulfuric acid and water in ACPD being published by Brus et al. (2010). It would be worth if Benson et al. would discuss what the differences between their study and the study by Brus et al. (2010) are.

Benson et al. state that their measurements of nucleation are made for atmospheric relevant conditions. However, the sulfuric acid concentrations used in this study are only representative for clean air. Air masses in the boundary layer are quite often polluted and thus polluted conditions should be also considered under atmospheric relevant conditions. Measurements have shown that in polluted air  $\text{H}_2\text{SO}_4$  concentrations can reach up to  $10^8 \text{ cm}^{-3}$  (Weber et al., 2001, Berresheim et al., 2002, Bardouki et al., 2003; Weber et al., 2003, Mauldin et al., 2002).

Further, covering atmospheric relevant conditions would also mean to perform the laboratory measurements under different temperatures and humidities relevant for the atmosphere as it was done by e.g. Brus et al. (2010) and not just at one temperatures as it was done by Benson et al. This is rather a snapshot and only represents certain conditions in the atmosphere and not a set of atmospheric relevant conditions.

Some detailed comments on the manuscript text:

*P29052, L2:* As stated above clean air sulfuric acid concentrations and only one temperature do not represent all atmospheric relevant conditions. Different temperatures, relative humidities and higher sulfuric acid mixing ratios should be taken into account. As stated above measurements of  $\text{H}_2\text{SO}_4$  show that concentrations can reach up to  $10^8 \text{ cm}^{-3}$ . Further, the binary homogeneous nucleation is strongly dependent on temperature and humidity and different values applied for the measurement surely will change the results.

*Abstract in general:* It should be more clearly pointed out what the goal of this study is what the differences concerning previous studies are and what is new in this study compared to previous studies.

*P29052, L8:* I am not convinced of this statement. I do not believe that only getting a higher slope in the nucleation rate vs.  $\text{H}_2\text{SO}_4$  is an indicator for the need of ternary aerosol precursor to reduce the slope in the atmosphere. This should be discussed more clearly and probably compared with atmospheric measurements. How does you know that this slope difference is not caused by errors in the measurements?

*Another general question:* Dynamical effects in the boundary layer can also strongly affect the nucleation of sulfuric acid and water. Can such processes be treated in laboratory measurements? If yes, how is it done?

*P29053, I5:* That nucleation is a non-linear process has been known since at least a decade, thus the reference of Lee et al. (2003) is here not adequate or should, if cited, be cited with adding e.g. The non-linear behaviour goes back to publications by Easter and Peters (1994), Bigg et al. (1997) and Nilsson and Kulmala (1998). I not know sure which is the correct references, but this fact is known since that time the mentioned publications were published or even earlier than that.

*P29063, I6:* Binary homogeneous nucleation is not that often occurring in the boundary layer. As was stated by Weber et al. (1999) observations of particle formation can be well explained by the binary homogeneous nucleation of  $\text{H}_2\text{SO}_4$  and  $\text{H}_2\text{O}$  above 4 km.

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