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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Depositional ice nucleation on solid ammonium sulfate and glutaric acid particles" *by* K. J. Baustian et al.

Anonymous Referee #1

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Review of Baustian et al.

This is a straightforward account of the heterogeneous ice nucleating ability of solid ammonium sulfate (AS) and glutaric acid (GA) particles. The experimental approach is to deposit particles on a hydrophobic surface, ensure they have crystallized, and then to raise the relative humidity at low temperature. Ice formation is observed both optically with a microscope and spectroscopically with a microscope-FTIR with micron spatial resolution.

Although others have previously observed that solid AS can act as an ice nucleus (IN), this study adds to the literature by presenting new data for GA, contrasting the IN abilities of AS and GA with the same experimental technique, and expanding the temperature range for the AS measurements. Also, the observation technique is quite

elegant with the FTIR spectra providing composition information on the particles that acted as IN, i.e. by evaporating the ice and then observing the underlying particles that provided the nucleation site. The relative humidity and temperature calibrations, performed in part by observing deliquescence of NaCl appear to have been done well. The paper is clearly written.

The weaknesses of the paper are that the onset for ice nucleation is not well defined in terms of the fraction of the total number of particles acting as IN or the total surface area present, and the large size of the solid substrates used (i.e. much bigger than will be present in the atmosphere).

The findings are that a small number (roughly 1 in a 1000) of the solid AS particles are good IN at low ice supersaturations and that GA is not as good an IN as AS. I recommend publication, in part because this paper provides somewhat better measurements of the IN abilities of (large) solid AS particles than have been measured in the past, the new GA measurements, and the novelty of the experimental technique. The atmospheric relevance is hard to be definitive about as yet, given that we do not fully know the phase of ammonium sulfate-containing particles at the low temperatures of the cirrus regime.

I have just a relatively minor suggestions/questions:

1. Introduction. A reference to Knopf and Koop (2006) would be appropriate given that the study also observed the ice nucleating ability of individual ice particles.

2. page 20952. “in the atmosphere as a component of secondary organic aerosol”

3. page 20956. change “respectfully” to “respectively”

4. page 20956. “Thus, it is not possible to quantify the exact experimental surface area or nucleation rates in this study.” It is not clear what this sentence is referring to.

5. page 20958. “These frost point measurements were found to be accurate when checked using calculations from Marti and Mauersberger (1993).” How accurate?

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6. Could the roughness in texture of the solid ammonium sulfate particles be a clue to their being moderately good IN?

7. page 20963. “In all three types of experiments we observed ice nucleation occurring preferentially on just a few particles per sample.” When the ice starts to nucleate presumably the ice supersaturation no longer exists, or at least is lower than it was previously, as the water vapour condenses as ice. Is this the reason that only 1 in a 1000 particles form ice crystals? This point should be made in the paper, i.e. that only the onset of ice nucleation can be measured because of this effect.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 20949, 2009.