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Atmospheric Chemistry and Physics Discussions

Interactive comment on "A laboratory investigation of the ice nucleation efficiency of three types of mineral and soil dust" *by* M. Paramonov et al.

Anonymous Referee #2

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In this study the authors carry deposition and condensation freezing experiments to study the ice nucleation activity of different soil samples collected around the world. The authors study the effect of size and temperature as well as of different treatments applied to the particles. It is found that the active site density correlates well with the Feldspar content of the samples pointing to a mineralogy control of the ice nucleation activity. However the effect of different heating, washing and chemical treatment is not consistent with such a hypothesis. This is an interesting and detailed study of ice nucleation of dust samples relevant for cloud formation. The authors emphasize the limitations of the active site density approach and warn about the assumption of the mineralogy control of the ice nucleation activity of dust samples. The paper is well

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Discussion paper

written and organized. I recommend its publication in ACP after some comments are addressed.

My only general comment deals with the slight but important differences between immersion and condensation freezing. It has been shown in cold stage studies of immersion freezing that slight modifications in the environment around the droplet have large effects on the measured active site density (like for example a droplet evaporating during the experiments). Condensation freezing is by definition a non-equilibrium measurement since the droplets are presumably changing their size during activation. Even for deposition it is likely the water coverage of the particles changes during the ice nucleation measurements. So my question is: how does the water adsorption and eventual droplet activation process affect the ice nucleation measurements? For example by virtue of the Kelvin effect when exposed to a given RHw the 400 nm particles would activate more easily and tend to absorb water more rapidly than the 200 nm particles. This could explain why they apparently look more active, when in reality they may have been exposed to a different thermodynamic environment. Washing may remove some of the soluble material hence the particles may condense and activate more easily, thus leading to an effect on cloud condensation nuclei activity that could be mistaken by an effect on ice nucleation. The authors should comment on how this may affect their measurements.

Technical comments: Page 2, Line 17. Must be “higher” instead of “warmer” temperature.

Page 5, Line 4. Deposition defined as RHw<100% seems ambiguous. I know this is standard practice, but a can dust particle adsorb several monolayers of water at RHw<100 %? How long does it take for a dust particle to reach equilibrium coverage when exposed to a given RHw? Is the residence time of the instrument long enough for it to happen?

Page 8, Eq. 1. Please specify whether this is the surface area per particle or the total

surface area in the population.

Page 9, Line 6. Is the increase in AF consistent with CNT predictions? Although CNT predicts an increase in AF with area it tends to be much more subtle than typically measured.

Page 9, Line 10. This is unexpected since dust is assumed to be a good ice nucleating particle. Is the fact that the maximum AF reaches only 1% due to residence time or particle size? Would it be the higher/lower in the atmosphere?

Page 13, Line 8. Recent work has shown that the dust surface morphology may be more delicate that previously thought. For example, active sites may be susceptible to the addition of very low concentration of ammonium sulfate and other solutes. Thus the heating treatment and the H2O2 hydrolysis seem harsh. Maybe for next experiments enzymatic hydrolysis could be considered to better target organic material.

Page 14, Lines 29-32 (also Page 16, Lines 19-22). The authors make this claim several times. However caution should be taken since immersion and condensation are different and in this particular case may not be completely comparable. The treatments may not only affect the ability of dust to act as ice nucleating particle but also its ability to act as a cloud condensation nuclei (CCN). See my general comment above.

Page 25, Line 23. Is the higher area of Himalayan dust a result of less aggregation or higher porosity?

Page 20, Line 7-10. This is true as long as the treatments do not affect CCN activity.

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