

***Interactive comment on “Experimental study of the role of physicochemical surface processing on the IN ability of mineral dust particles” by D. Niedermeier et al.***

**B. Murray (Referee)**

b.j.murray@leeds.ac.uk

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This is an interesting experimental investigation of the influence of chemical processing on the ice nucleating ability of Arizona Test Dust (ATD). The authors used the LACIS instrument during a campaign in which other instruments were also used which allows an inter-comparison. They find that ice nucleation by ATD is unaffected by heating to 250 K alone. Addition of sulphuric acid results in less efficient ice nucleation above -35°C, but slightly more efficient nucleation below -35°C. On addition of water or heating, the nucleation efficiency of ATD is substantially reduced over the whole temperature range. This is presumably due to the water and heat facilitating a chemical reaction between

C8210

components of ATD and sulphuric acid. Ammonia is found to have a second order effect.

The subject, quality and novelty of this study make it appropriate for ACP and I recommend publication once the following comments have been addressed.

1) P18561, ln 2-4. Why should all the ions of a soluble salt go into solution? Could ions not exchange with other ions on or in the solid or perhaps simply adsorb on the surface. I suspect the bulk of the ions are in the aqueous phase at any one time, but they may also reside on the surface too. Also, clays for example (a component of ATD) are used as heterogeneous catalysts and this implies they interact with solute ions in an aqueous medium. This statement and also the one on page 18574 ln 22 need to be modified accordingly.

2) P 18563, ln 2. Some much more detailed data on the mineralogy of ATD was recently published by Broadley et al. (Atmos. Chem. Phys. Discuss., 11, 22801–22856, 2011), which may help with the interpretation of the results.

3) P 18570, ln 3. replace ‘first’ with ‘high temperature freezing branch’ – and quantify what range of temperatures are being discussed.

4) P 18570, ln 3. ‘vanished completely’. This term is not acceptable. The fice value was simply lower than the detection limit. What is the detection limit?

5) P 18570, ln 5. It is very hard to make out the increase in fice due to H<sub>2</sub>SO<sub>4</sub>. Maybe quote some values in the text with corresponding uncertainties to clarify this.

6) P 18570, ln 18. I do not understand what is meant by ‘missing difference’. This needs to be clarified.

7) P 18571, ln 15-25. The agreement between LACIS and the CFDC is very impressive. After studying the figure I would say that this is somewhat understated here. Based on the figure the values agree to within a factor of two and in all but one case the two measurements are within experimental uncertainty.

C8211

8) P 18572, ln7. Recent work suggests that the pseudo hexagonal lattice match ideas expressed by Pruppacher may not be particularly relevant (at least for kaolinite, which has been described as having a pseudo hexagonal match to ice). Computation work by Hu et al. (Surface Science 601 (2007) 5378–5381) suggests that ice nucleation by kaolinite is probably not due to the pseudo hexagonal lattice of a perfect kaolinite surface. In addition, the idea that amorphous material is a poor ice nucleus has been challenged by recent experiments at the AIDA chamber (Murray, Nature Geoscience, DOI: 10.1038/NGEO817).

9) P 18572, ln18. 'majority of particles features areas.....' I do not understand this sentence.

10) P 18573, ln 11. I think the use of the term 'areas' is unclear. I appreciate that the authors may want to avoid the term 'active site', which I think is wise because it has become associated with the time-independent singular model. However, 'surface area' implies the physical area of a material in units of cm<sup>2</sup>. Broadley et al. used the term nucleation sites and explicitly defined this as either specific active sites (which might be cracks or defects) or crystal faces where a lattice match might be found. The authors also use the term ice active surface features in the abstract, which I think is also much better than 'areas'.

11) P 18573, ln15. Why should the reaction between sulphuric acid and ATD be slow without water – reference?

12) P 18573, ln23. Destroyed by the thermal treatment as well as sulphuric acid.

13) P 18574, ln11. 'effective' doesn't make sense in this context. How about 'have a greater influence'.

14) P 18576, ln 13. "not unlikely" = likely ?

15) P 18576, ln 25. Replace first few words with 'To summarise'

16) P 18577, ln 29 and next page, ln 22. I do not agree with the use of 'destroy' or  
C8212

'vanished completely'. The number went below the detection limit.

17) P 18578, ln 3. Are these calcium and magnesium ions. Include word 'ions'. What does interspersed mean in this context. Where exactly are the ions and why are they accessible for reaction? This is very vague.

18) I found figure 4 quite difficult to see differences between the different experiments when trying to compare different plots. I can think of two possible ways of improving this: 1) plot the change in fice from the untreated ATD case as a function of temperature. 2) plot the untreated ATD case in each plot for reference.

19) Also, label the plots in Figure 4 rather than listing it in the caption. I ended up writing on the plots myself. Use the labels in the caption as labels in the figures.

20) Figure 3. Put a key in the plots. Again, it is very confusing to have to look at the caption to figure out what the symbols mean.

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Interactive comment on Atmos. Chem. Phys. Discuss., 11, 18557, 2011.