

## ***Interactive comment on “Kaolinite particles as ice nuclei: learning from the use of different types of kaolinite and different coatings” by H. Wex et al.***

**Dr Murray (Referee)**

b.j.murray@leeds.ac.uk

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Review of Wex et al. Kaolinite particles as ice nuclei: learning from the use of different types of kaolinite and different coatings

In this article Wex et al. present a study of the effects of coatings of levoglucosan, succinic acid and sulphuric acid on two different kaolinite samples. They show that in the immersion mode only one kaolinite sample is affected by sulphuric acid and neither sample is affected by the other coatings. They also show that nucleation below water saturation is shifted to higher RH for all coatings. The authors then go on to suggest that nucleation of ice by coated particles is simply a form of immersion nucleation in solution droplets. The paper is well presented, the experimental methodology is sound

and once the following comments are addressed I recommend it for publication in ACP.

## Comments

1. Title: The phrase ‘types of kaolinite’ implies the kaolinite mineral was somehow variable. The word kaolinite refers to a mineral with a specific chemical formula and a specific crystal structure, so by definition there is only one kaolinite. But, kaolinite samples from different locations have different impurities. I suggest replacing ‘types of kaolinite’ with ‘kaolinite samples’.

2. I agree with the definitions presented on p30314. They are fairly close to Vali's (1985), which could be cited explicitly. The definition obviously contrasts with the rather rigid definitions presented by Pruppacher and Klett (1997), which could also be stated clearly.

3. p30314 ln 20. Define ‘top soils’. Do you mean fertile soils as well as desert soils?

4. p30314 ln25. The statement about quartz not being a good ice nucleus is not supported by Atkinson et al. (2013) in the immersion mode or Zimmerman in the deposition mode (JGR, VOL. 113, D23204, doi:10.1029/2008JD010655, 2008). In the immersion mode it is far more active than the clay minerals.

5. P30316 ln 27. ‘In general, kaolinite belongs to the group of clays, consists largely of aluminium-silicates...’. This is incorrect. Kaolinite is a clay mineral and is a phyllosilicate. Refer to Deer et al. (An Introduction to Rock forming minerals, Longman, 1966).

6. P30322 ln17. Wheeler and Bertram (Deposition nucleation on mineral dust particles: a case against classical nucleation theory with the assumption of a single contact angle. Atmos. Chem. Phys. 12(2):1189-1201, 2012) should also be cited here. Kaolinite from the clay mineral society (KGa1b) seems to be a special case!

7. P30326. Ln 5: ‘hint towards’. Revise. I suggest something like ‘are consistent with...’

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8. P30330. In 5. In this argument there is an implicit assumption that the succinic acid is deposited as a crystalline material. Yes, if it were crystalline and given the high DRH then it would be strange to see immersion freezing like behaviour. I suspect that the vapour deposition of succinic acid onto kaolinite particles results in an amorphous coating and I'd expect that crystallisation of this amorphous material to be inhibited as it is for other aqueous organic systems (e.g. Price et al. Quantifying water diffusion in high-viscosity and glassy aqueous solutions using a Raman isotope tracer method, *Atmos. Chem. Phys. Discuss.*, 13, 29375-29411, 2013). Also, a citation for the high DRH should be included.

9. P30331, para 1. In this discussion a recent article by Knopf and Alpert needs to be discussed (A water activity based model of heterogeneous ice nucleation kinetics for freezing of water and aqueous solution droplets, *Faraday Discuss.*, 2013, 165, 513, DOI: 10.1039/c3fd00035d). They reach a similar conclusion to the present authors, i.e. that the freezing of solution droplets can be described as immersion freezing by taking into account water activity.

10. P30332, In 26. Atkinson et al. did not 'assume' that K-feldspars are most important, this was a conclusion based on experiments. They used experimental evidence to argue that K-feldspar is the most important mineral in desert dusts for ice nucleation. This finding was recently reinforced by O'Sullivan et al. (Ice nucleation by soil dusts: relative importance of mineral dust and biogenic components, *Atmos. Chem. Phys. Discuss.*, 13, 20275-20317, 2013. doi:10.5194/acpd-13-20275-2013).

11. How do the coatings and hygroscopicity of coated dusts compare to natural dusts?

12. Fig. 6. Say what the vertical black line is in the caption. Can this be distinguished from the other black line by making it dotted or dashed?

13. Fig 7. There is a lot of detail in this plot which makes it difficult to read. Could the sulphuric acid results be presented in different plots to the other coatings?

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Minor comments 1. P30314, ln 4: 1950's

2. P30315, ln 3. 'often blurry' is inappropriate terminology. I suggest something like: 'The difference between condensation and immersion freezing is poorly defined'.

3. P30329. Ln 10. 'redly'. Change to 'red'.

4. Fig. 5. Should SA in the key be SuccA?

5. Fig. 8. Use some colour to distinguish groups of line.

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Interactive comment on Atmos. Chem. Phys. Discuss., 13, 30311, 2013.

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