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Interactive comment on "Efficiency of immersion mode ice nucleation on surrogates of mineral dust" *by* C. Marcolli et al.

C. Marcolli et al.

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We thank Ulrich Schurath for his encouraging and constructive comments:

I congratulate the authors to this interesting paper which provides - to me for the first time - convincing experimental evidence for what I always suspected: heterogeneous nucleation on immersed IN like ATD (and on other insoluble polymorphous particles including soot, I presume) occurs on surface sites which cover a wide range of activities, occupy a vanishingly small fraction of the surface area, and therefore are far from representative of the bulk surface properties. It should be noted that ice nucleation on mineral dust is not comparable to droplet freezing induced by surface films of long-chain alcohols which form heterogeneous substrates with long-range 2-D crystal structures, as described in a very recent paper in J. Phys. Chem. C by Zobrist et al.. Applying the contact angle concept to ice nucleation at such films might make sense,

but it is of little value as long as there is no other technique by which the contact angle can be measured independently. To my surprise, the authors apply the contact angle concept to ATD as well, although this material is a conglomerate of complex microminerals with nearly continuously varying stoichiometries and surface structures. Fig 6 can be used to convert the log-normal distribution function of the contact angle alpha into an occurrence probability distribution function of the parameter f(het) in equation (4). However, the distribution function of f(het) could also be directly derived from the experimental data by fitting the DSC heat flux model to the thermograms, and does not require the prior introduction of the questionable contact angle concept. It would be interesting to see the corresponding occurrence probability distribution function!

Response: By using the contact angle as fitting parameter, we did not want to imply that ice nucleation indeed occurred via a critical nucleus with the corresponding contact angle. We will consider using fhet as fitting parameter in future studies. An occurrence probability function directly for fhet would have a similar form as the one for the contact angle because for the relevant contact angle ranges the dependence of fhet on the contact angle is almost linear.

p. 9694, sentence beginning line 13: According to my understanding the first term in Eq. (1) represents a frequency factor, known from transition state theory, times the probability of water molecules to sit on top of the diffusion barrier between liquid water and ice, while the second term describes the number of critical embryos per cc which exist in pseudo-equilibrium with the H2O monomers either in the bulk liquid (homogeneous nucleation), or (in case of Eq. 4) at the surface of the immersed IN (heterogeneous nucleation). The half-sentence "at the nucleus/water interface" in line 15 should therefore be dropped. Right?

Response: Right. We delete this half-sentence in the revised manuscript.

p. 9700 (lines 17-21) is indeed a repetition of information contained in the last paragraph on p. 9697. However, while on p. 9697 the cooling rate is said to increase to

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ca. 1.7 K per minute, the corresponding number quoted on p. 9700 is ca. 2.7 K per minute. Please check!

Response: We avoid the repetition in the revised manuscript. The 1.7 K per minute refers to the recorded DSC cooling rate, the 2.7 K per minute to the model calculation. This agreement is satisfactory considering the simple model assumption that we used to achieve it.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 9687, 2007.