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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Parameterizing ice nucleation rates for cloud modeling using contact angle and activation energy derived from laboratory data" *by* J.-P. Chen et al.

Anonymous Referee #1

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General comments:

The work by Chen et al "Parameterizing ice nucleation rates for cloud modelling using contact angle and activation energy derived from laboratory data" use published data from laboratory measurements of ice nucleation to determine thermodynamic parameters of ice nuclei (IN). If classical nucleation theory is sufficient to describe ice nucleation, the thermodynamic values determined in this paper can be used in models to predict ice nucleation.

The paper is generally well written and the procedure to determine apparent contact angle and activation energy is well described. The problems with today's heteroge-

neous ice nucleation parameterizations in modes are well defined in the introduction. The work is original and scientific sound and should be published in APC.

Specific comments and a few suggestions:

Page 14421 line1: Different types of freezing modes are mentioned. However, later in the paper, the use of the term "freezing mode" or "freezing nucleation" is referred to as only immersion freezing mode, and do not include condensation and contact freezing . Somewhere it should be clearly stated that "freezing nucleation", is means "immersion freezing".

Page 14421 line 5: Change "co-called" to "so-called".

Page 11421 line 12: References such as Möhler et al. [2006] and DeMott et al. [1998] could also be included here.

Page 14421 line 13: It is mentioned that the "threshold temperature" formulations and deposition mode formulations are "....not strictly correct either", and base the statement on that theoretical nucleation theory does not support this notion. However, recently published paper by Vali [2008] shows strong support for the modified singular model of heterogeneous immersion freezing nucleation. Maybe you could add something like "....not strictly correct either, if the theoretical nucleation theory can sufficient explain heterogeneous ice nucleation"?

Page 11421 line 15: Include "temperature" in "threshold formulations".

Page 11412: Somewhere in the introduction, the work by Khvorostyanov and Curry [2004] could be mentioned as an example for a heterogeneous ice nucleation parameterization, based on classical nucleation theory, that can be used in models.

Page 14424 line 1: Möhler et al. [2006] gives the nucleation rate in their paper for a given dS_i/dt. They note that the formation of new ice crystals quickly stops after reaching a maximum S_i (ice supersaturation), and new ice is not formed (even if a large fraction of the dust particles have not frozen yet). Thus even if enough time is

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given, more ice is not nucleated. How can this observation be incorporated into the classical nucleation theory where ice seem to still form, only given a specific length of time?

Page 14429, line 18: Replace "it" with "f" in the sentence "it is also a function of....." (it is confusing what "it" refers to here.

Page 14432, line 4: State that the wetting coefficient and contact angle is within the term "f" in equation (14) for clarification.

Page 14437 equation21: Change the Greek letter for proportionality coefficient since this is also used in equation 10, but with a different meaning.

Tables: I suggest, for easy comparison, to keep the different types of IN in the same order as in table 2 and 4. Also, use the same order and naming in table 6 and 7 as in table 2 and 4.

Table 5: First value for m is wrong. With a contact angle of 109.2, m = -0.328 (not -0.279)

DeMott, P.J., D.C. Rogers, S.M. Kreidenweis, Y.L. Chen, C.H. Twohy, D. Baumgardner, A.J. Heymsfield, and K.R. Chan (1998), The role of heterogeneous freezing nucleation in upper tropospheric clouds: Inferences from SUCCESS, Geophys. Res. Lett., 25, 1387-1390

Khvorostyanov, V.I., and J.A. Curry (2004), The theory of ice nucleation by heterogeneous freezing of deliquescent mixed CCN. Part I: Critical radius, energy, and nucleation rate, J. Atmos. Sci., 61, 2676-2691

Möhler, O., P.R. Field, P. Connolly, S. Benz, H. Saathoff, M. Schnaiter, R. Wagner, R. Cotton, M. Kramer, A. Mangold, and A.J. Heymsfield (2006), Efficiency of the deposition mode ice nucleation on mineral dust particles, Atmos. Chem. Phys., 6, 3007-3021

Vali, G. (2008), Repeatability and randomness in heterogeneous freezing nucleation,

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Atmos. Chem. Phys., 8, 5017-5031

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 14419, 2008.

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