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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Thermodynamic derivation of the energy of activation for ice nucleation" *by* D. Barahona

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I appreciate the comments made by the reviewer; they will be addressed in depth in a later response. However I feel that comments on the appropriateness of this work for the scope of ACP must be addressed before further discussion takes place. In essence, this work provides an improved description of a parameter widely used in atmospheric models to describe ice cloud formation. As such it should not be dismissed as a mere theoretical exercise. Since the representation of ice nucleation in cloud models is still under development the manuscript is relevant for the atmospheric community and within the scope of ACP. Detailed responses are given below.

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Interactive Discussion

Discussion Paper

Reviewer: The paper is interesting, but not easy to digest. I actually don't think it is a good fit for ACP, as the considerations are rather basic physics and physical chemistry than atmospheric physics.

Response: Ice nucleation theory has found widespread application in the modeling of the formation of ice clouds. However most experimental and modeling studies in atmospheric sciences still use theoretical descriptions developed several decades ago. One of the reasons is precisely that theoretical developments remain hidden from the atmospheric community and only discussed in journals specialized in fundamental physics, even though they are very relevant for cloud modeling. The focus of this work is not the development of new fundamental physics as the reviewer suggests, but instead the application of recent ideas to the description of ice formation. ACP provides a multidisciplinary forum where such theoretical advances can be discussed within the context of atmospheric modeling. This is exactly the gist of the manuscript and therefore is clearly within the scope of ACP.

Reviewer: The paper emphasizes the advantages of the new model for temperatures down to 190 K, but this is hardly of relevance for homogeneous freezing of water in the atmosphere.

Response: The reviewer is mistaken in stating that freezing at 190 K is not relevant for the atmosphere. Away from convective systems most cirrus clouds form by the freezing of haze particles (liquid solution droplets) instead of pure water droplets, and typically at low temperature. It is likely that clouds near the tropical tropopause are formed mostly by this mechanism. This is already mentioned in several places in the paper and will be further emphasized in the revision to avoid confusion.

Reviewer: Of the listed references, only three cited papers have been published in ACP, and two of them are by the author himself. In my opinion this paper would have found a more suitable readership if it had been submitted e.g. to JPC or PCCP.

ACPD
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Response: The paper cites about 22 papers from either journals specialized in atmospheric research (e.g. Atmospheric Environment, Journal of Geophysical Research, ACP) or high impact journals oriented towards a wide audience(e.g., Nature, Proceedings of the National Academy of Sciences). Moreover, the majority of citations (even those from journals specialized in physical chemistry) come from groups well known within the atmospheric community. This shows that the manuscript is indeed ascribed within an atmospheric context instead of fundamental physical chemistry as the reviewer suggests. ACP is a relatively young journal which explains that few references from ACP where included.

Reviewer: If it remains in ACP, it should be revised such that it becomes more accessible for this audience, including experimentalists working on laboratory measurements of homogeneous freezing or modellers interested in the parameterization of these processes for models of the atmosphere.

Response: The paper will be revisited to further emphasize its atmospheric relevance. Most of the laboratory results and parameterizations used in atmospheric models have already been discussed and compared against the results of this work (see Fig. 4). The classical nucleation theory is widely used in cloud models, and an improved description of a very uncertain parameter of the theory (i.e., the activation energy) is clearly of interest to atmospheric modellers. This point has made been several times in the paper and will be further emphasized in the revision. If any citation was ommited I'll gladly include it in the discussion.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 18151, 2015.