

# ***Interactive comment on* “Parameterizing the competition between homogeneous and heterogeneous freezing in cirrus cloud formation – monodisperse ice nuclei” by D. Barahona and A. Nenes**

**Anonymous Referee #1**

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General comments:

A parameterization to compute ice crystal number and size resulting from aerosol-induced ice nucleation is presented. Ice formation due to homogeneous and heterogeneous freezing is considered. An analytical expression for the critical ice nuclei number concentration suppressing homogeneous freezing is provided. The parameterization is evaluated by comparison with the results of a detailed parcel model. This reveals a very small average error of the parameterization.

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Ice microphysical calculations in large-scale atmospheric models currently suffer from large uncertainties which partly result from poor representations of aerosol-induced cirrus formation. This hampers a proper simulation of the radiative effects of cirrus clouds and is, therefore, a source of uncertainties in current climate predictions. The parameterization discussed in the manuscript is an important contribution to reduce such uncertainties. Therefore, the paper addresses a very relevant topic which is clearly within the scope of ACP.

The overall presentation of the parameterization is clear and well structured. The methods developed by the authors are clearly outlined. Their operational capabilities are demonstrated by several applications and comparisons with the results of other studies. I would recommend publication after some modifications outlined below.

Specific comments:

1) The authors state that Kärcher et al. (2006) consider either pure heterogeneous or pure homogeneous freezing. This is not correct. Also Kärcher et al. consider the competition between the two mechanisms and explicitly calculate the effect of heterogeneous freezing on the occurrence and microphysical properties (number, size) of ice crystals frozen homogeneously. The authors should clarify this in the manuscript. They should motivate their study by discussing the new aspects compared to the parameterization by Kärcher et al. In the present version of the manuscript the improvements or different approaches with regard to Kärcher et al. are not clearly highlighted.

2) The authors extensively discuss the calculation of the limiting number of ice nuclei that would prevent homogeneous nucleation. What is the intention? The parameterization includes not only cases where homogeneous nucleation is suppressed. Cases where homogeneous nucleation occurs with the number of homogeneously frozen crystals reduced due to the presence of ice nuclei are also relevant. The authors should balance the discussion in order to include also the other cases.

3) The authors compare their results with the outcome of other studies, particularly

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Gierens (2003) and Liu and Penner (2005). Nevertheless, comparisons with the Kärcher et al. (2006) study are missing. The work of Kärcher et al. and the present study have very similar objectives. Therefore, the authors should also include discussions of the results of Kärcher et al. in the manuscript.

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