Geosci. Model Dev. Discuss.,
https://doi.org/10.5194/gmd-2020-50-RC3, 2020

Geoscientific Model Development Discussions

Interactive comment on "A new parameterization of ice heterogeneous nucleation coupled to aerosol chemistry in WRF-Chem model version 3.5.1: evaluation through the ISDAC measurements" *by* Setigui Aboubacar Keita et al.

Anonymous Referee #3

Received and published: 31 July 2020

This paper by Keita et al. introduces a new parameterization in one of the microphysical scheme of the WRF-Chem model to better represent the impact of the degree of acidity in clouds on the nucleation rate and cloud microphysical properties. To validate this method, it uses in-situ measurements in Arctic clouds made by an aircraft, which is always a difficult thing to do. This is a challenging goal, which must be addressed with thoroughness. I'm afraid it is not the case in the present version of the paper. The presentation is poor (lack of clarity, long paragraphs) and there is a lack a proofreading (mistakes in equations, typos). But more importantly, the authors do not discuss the

origin of their parameterization, which is one possibility among others, in an already complex scheme. The results are encouraging but should be described in more detail. I have read really good papers by the same team and they are recognized experts in the field. For some reason, the submitted version of this paper is too preliminary. This paper is definitely useful and contains interesting ideas. It will be of interest to the community, but I would clearly suggest a rewrite by the authors, as well as a second wave of peer review, before publication.

Major comments

First major comment: the rational behind this new parameterization is not clearly presented. Section 2.1.1 (which should be section 2.2) must be rewritten. Why did the authors decide to change the nucleation rate and the contact angle, instead of another method ? Why did they choose this relationship between the neutralized fraction and the contact angle ? How does this new parameterization fit in the Milbrandt and Yau scheme exactly (a diagram would help) ? This section is confusing and incomplete.

Second major comment: The paper clearly lacks proofreading. A lot of well-known and well-established equations contain mistakes.

For example, these equations contain mistakes, and there might be other mistakes that I missed :

Equation 1: velocity is missing in the first term of the right-hand side part of the equation, a dot is missing as well (convergence) ; the third term is d/dz and not d/dt

Equation 4: it is a PDF, therefore, Nx(D) = dn/dD, and writing dNx(D) does not make any sense. Ntx is the total number concentration, and is integrated over D, so it is Ntx and not Ntx(D). In the exponential, both lambda_x and D are to the power of nu_x, not only D, it is therefore (lambda_x D)ˆnu_x.

Equation 5: again, it is a PDF, and it is Nx(D) and not dNx(D).

Equation 6: Ntx and not Ntx(D)

Equation 8 is not consistent I believe; it is not in kg/kg, because of the 1/rho factor.

Equation 11: I don‘t understand where this equation comes from. Please demonstrate.

Equation 16: usually Mwˆ2 also appears in the Gibbs free energy term;

Equation 17: it is not q-qcos(theta) but q-cos(theta)

Minor comments :

l.85: "All symbols for variables and parameters used are listed in Table 1." Where is Table 1 ? It appears to be missing. This probably explains why the numbering of all the other tables is wrong...

l.155: "For condensation-freezing, it can be included in the immersion freezing of coated IN when air is supersaturated with respect to liquid water." This sentence is quite confusing, and this whole paragraph is unclear. How does this new parameterization fit in the Milbrandt and Yau scheme exactly ? Please include a diagram, for example.

Sections 4.2, 4.3, 4.4, 5: these sections are all made of one huge paragraph and are very hard to read.

l.606: the two references to Milbrandt and Yau are the same, and should be Part I and part II;

Figure 6 is very hard to read.

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