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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Comprehensively accounting for the effect of giant CCN in cloud droplet activation parameterizations" *by* D. Barahona et al.

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Response to Reviewer # 1

We thank the reviewer for the thoughtful and supportive comments. Our responses to specific comments follow.

General comments

The paper is well structured and comprehensively grants insight into the new parameterization. The results concentrate solely on the influence of the parameterization on the aerosol activated fraction and are compared to parcel model

results, keeping to the microphysical aspects of aerosol particles. In a larger scope, it would be interesting to test the influence of the new parameterization on cloud evolution, hence in a regional or global climate model as an outlook.

We have included an outlook of the application of the parameterization in regional and global climate models.

Specific comments

Concerning ***the abstract***: $(p.2)$

1.As dust, i.e. mineral dust, is an insoluble aerosol and its ability to act as CCN is strongly coupled to it being coated ('aged'), this would be worth mentioning (throughout the paper).

2. The abstract does not mention anything about the obtained results. It is suggested to add a sentence or two at the end concerning the final results.

The suggestions have been incorporated in the abstract

entrainment*: (p. 10) In the simulations entrainment has not been considered (e = 0). Why? What changes for e>0 ?*

This is a very good point. Varying e is a way of changing s_{max}; this is considered unnecessary since s_{max} is changed by varying V,N_a. Thus, equivalent conditions to those of strong entrainment were covered in the study when runs were made assuming weak updrafts. This is made clear in section 4.

ammonium sulfate*: (p. 10) All simulations are done assuming the aerosol particles to be pure ammonium sulfate (please correct if statement is wrong). As sea salt may not change the model results significantly, dust however might have an altering effect. Therefore, is it possible to do simulations taking this issue into account? Else, this should be mentioned in the text (e.g. conclusions).*

We have addressed this point by modifying the definition of B in Eq. (7) accounting for soluble fraction less than unity. To exemplify the case where inert dust is coated by ammonium sulfate, further sensitivity test were carried out assuming a soluble fraction of 0.4. The results are presented in Figure 2.

the number concentrations*: (p. 10) For both* $N1$*and* $N2$*the values have been chosen rather high (like a 'polluted' case). Does this have any significance? Does anything change for a "clean" case?*

N_1 and N_2 were chosen as conditions were an overestimation in s_{max} would have a large impact on the activated aerosol fraction (i.e., a numerous nucleation mode). To address the reviewers concern, we have also tested "clean" conditions, i.e., N_1=100 cm^{-3} and N_2 = 50 cm^{-3}.

Figure 1*: (p. 10/14) 1. In Fig. 1 of the aerosol activation fraction there seems to be an outlying triangle at (38% Activation Parameterization, 12% Activation Parcel Model). Why is the error for that case so much larger than the surrounding ones?*

We thank the reviewer for pointing this out. The discrepancy comes from the discretization of the aerosol size distribution in the numerical model (assumed to be 50 bins per mode). We repeated the simulations using 75 bins and the discrepancy disappeared.

2. (More a remark:) In Fig. 1 of maximum supersaturation, one can hardly see the triangles of the colours green to violet. Maybe one would be able to see more if the range of the colourbar were reduced. Else, one could mention this in the text.

Good point. The limits of the color bar have been reduced to emphasize the range of diameters were large CCN effects become important.

the sensitivity tests*: (p. 10-11) To underline the conclusions of the sensitivity studies the addition of a second figure is suggested, where on the y-axis the ratio '(% Activation Parameterization)/(% Activation Parcel Model)' and on the x-axis the number concentration, N, could be depicted. In addition the updraft velocity, V, could be shown in colour code. Obviously, the colour coded variable can be interchanged with the variable on the x-axis.*

Done. The suggested plots have been included in Figure 2.

the conclusions*: (p. 11-12) As only little is said about the use of such a parameterization in climate models, it is suggested to add a sentence or two at the end of the conclusions as an outlook concerning the use of such a parameterization in a regional or global model and where (geographically and/or in terms of cloud type) it might have the largest impact.*

Good point. Done.

Technical corrections

All technical corrections have been incorporated.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 24717, 2009.