**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.

Anonymous Referee #1

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[12pt, a4paper]article

1 General comments

The paper gives an elaborate parameterization for cloud droplet activation taking into account large CCN which may experience limited growth and in addition couples very easily to existing parameterizations, alleviating its implementation. Scientifically, the topic is of large interest and significance, as the parameterization directly influences cloud microphysics.

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).

2 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.

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

- **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).

- **the number concentrations**: (p. 10)
  For both N_1 and N_2 the values have been chosen rather high (like a 'polluted' case). Does this have any significance? Does anything change for a 'clean' case?

- **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?

    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.

- **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.

- **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.

3 Technical corrections

In the following only corrections concerning grammar or orthography are suggested. The page (p.) and the line (l.) are specified before giving the suggested correction.

- p. 4, l. 1: "... growth, but **an** application of this ..."

- p. 4, l. 2: "... In this work a different ...", without comma after '*work*'.

- p. 4, l. 13: "... at s$_{max}$. **The s**upersaturation in ..."

- p. 4, l. 16 - p. 5, l. 2: Try to make two sentences. Would make it more legible.

- p. 6, l. 3: "... 1998), which yields"

- p. 6, l. 7: "... of air, **and** D'_v is ..."

- p. 7, l. 12-13: Reformulate sentence. Proposed:
  "Alternatively, Eq. (5) can be written in terms of the mean droplet diameter ..."

- p. 8, l. 11-13: Begin the sentence "The following ... " on a new line.

- p. 10, l. 1: "... range of updraft **velocities** and ..."

- p. 10, l. 11: "... ($< 0.01\,\mu m$) **and/or giant CCN (i.e., dust and sea salt;** $> 1\,\mu m$**)** ..."

- p. 10, l. 19: "vate**.** At this ...", point missing at end of sentence.

- p. 10, l. 24: "... parcel model occur **(depicted by circles)**; which ..."

- p. 10, l. 26: "... and the parcel model **(depicted by triangles)**."

- p. 11, l. 9: Begin the sentence "A second sensitivity test ..." on a new line.

- p. 11, l. 21: "sectional and lognormal versions of ...", without the second '*and*'.

- p. 14, l. 1 of Fig. caption: "Maximum supersaturation (left) and aerosol activation fraction (right) for ...", turn around the sequence, i.e. list from left to right.

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