Geoscientific
Model Development
Discussions

Interactive comment on "An investigation into the performance of three cloud droplet activation parameterisations" *by* E. Simpson et al.

Anonymous Referee #2

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In this work three cloud condensation nuclei (CCN) activation parameterisations are tested against a detailed parcel model for a wide set of cloud formation conditions. The authors find that including effects of giant CCN improves the performance of cloud formation parameterisations, although in general they tend to overestimate the fraction of activated aerosol when a significant fraction of large particles is present.

In general this is a well-written paper and its results are relevant for the atmospheric community. Although CCN activation parameterisations are quite developed, still more evaluation is needed to test the limits of commonly used assumptions. The only general comment I have is that the authors are too superficial in the description of the differences between the parameterisations. Instead of mere description of their results, the authors should explain the differences among the parameterisations in terms of the as-

sumptions behind each approach. With that issue resolved I'd recommend this paper for publication in GMD.

1 Specific Comments

Page 1318, Line 8. Ghan et al. (2011) performed systematic comparison of several parameterisations. Other works cited by the authors have done so as well. Thus the statement that this is the "first systematic evaluation" is unsupported.

Page 1318, Line 12 and below. "Large" and "small" are too vague. Please be more specific on what specific values these statements refer too. Also in a sentence explain better what do you mean by infinite time and how it affects the performance of the parameterisations

Page 1318, Line 18. Since the parameterisations only differ in the way the approximate the maximum supersaturation, this statement is equivalent to say that this is due to difference in the parameterisations. Please be more specific.

Page 1320, Line 14. Correct "performance".

Page 1320, Line 24. Correct "numerical".

Page 1320, Line 26. Better say "benchmark for comparison" instead of "ground truth".

Page 1322, Lines 3-5. Say that ARG is written in terms of dimensionless parameters.

Page 1322, Line 19. Define dP/dt.

Page 1324, Line 18. Correct "artifact".

Page 1325, Section 3.2. This description seems somehow superficial. The differences may be understood in terms of the differences in the assumptions behind eacg parameterisation. It also looks like the parameterisations fail most of the time and except for some FN GCCN cases, none is able to reproduce the parcel model for $d > 100$ nm. Is this contrary to what is presented in other works?

Page 1326, Line 8. Figure S8 provides valuable information and maybe should not be supplemental. Similarly for Figure S6 later on.

Page 1326, Line 10-15. Can this be understood in terms of the approximations made for each parameterisation?

Page 1326, Line 16. Why does the correction in FN GCCN work well in this case but it does not in the single-mode experiment?

Page 1327, Section 3.4. It does not seem completely random that all the monomodal cases result in overestimation whereas all the bimodal cases result in underestimation. What is the origin of these systematic differences?

Page 1327, Section 3.5. Since the FN GCCN parameterisation performs better, the authors should recommend including the effects of unactivated large particles in cloud

models.

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