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Atmospheric Chemistry and Physics Discussions

# *Interactive comment on* "A single parameter representation of hygroscopic growth and cloud condensation nucleus activity – Part 3: Including surfactant partitioning" *by* M. D. Petters and S. M. Kreidenweis

**Anonymous Referee #2**

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This paper deals with the complex topic of bulk/surface partitioning affecting the cloud activation potential of aerosol particles. The paper is concise whilst seemingly presenting a reformulation of existing tools to understand the role this phenomenon may have. More work is needed in this area, specifically in going away from proxy systems to understand the behavior of atmospherically complex mixtures. Given the wide uptake of the single parameter representation within aerosol-cloud interaction models, the paper is relevant to the wider audience. Before publication however, some general comments need addressing with respect to its uniqueness.



Modelling bulk/surface partitioning is a complex problem. There have been numerous studies in which both iterative and analytical numerical methods have been presented to enable the wider community to probe the sensitivity to this process. From a forward modelling perspective the reader needs some guidance on the clear benefit of this paper when compared to those methods that account for perturbed Raoult and Kelvin contributions to the traditional 'Kohler' curve. The latter methods, which are referenced in this paper, are available for uptake for generalised studies for systems of varying complexity. For investigators that already rely on the single parameter representation, the beauty of that framework is the ability to attempt mitigation of chemical complexity when describing CCN activaion potential. If the framework presented here were to be used by others who rely on empirical representations of 'Kappa', there seems to be an inconsistency. There is no reason why that empirical representation wouldnt already account for partitioning if it was derived from a CCN based measurement. Is this true? On the other hand, if a theoretical representation of 'Kappa' were used, then steps to calculate each 'kappa' value are techniques that one would use in traditional Kohler theory. Reading the end summary, which is very nicely caveated, it should be obvious to the reader if the sole aim of this work is to allow large-scale modellers who currently incorporate Kappa Kohler theory to test the sensitivity to bulk to surface partitioning. Regarding this, the recent study by Prisle et al (2012) shows the potential effect of choosing a detailed bulk/surface partitioning framework over a simplified framework in a global climate model. This is the kind of work that needs performing, on multiple scales, to decipher what level of complexity is required. That study, which should be referenced, showed that existing parameterisations can be used in large-scale models to test the importance of complexity and dictate avenues for future investigations. It further supports the comments made by the authors in this paper that more investigations are needed. As a process level diagnostic tool, the other methods presented in the literature must also be used to look at, for example, non-ideality in both phases, choice of dividing surface etc.

Prisle, N. L., et al. (2012), Surfactant effects in global simulations of cloud droplet activation, Geophys. Res. Lett., 39, L05802, doi:10.1029/2011GL050467.

Minor comments:

Section 3.3, page 22700, line 18: Presume this should be 'practice'.

Page 22701. Line2: Missing a '.' after surfactants.

Page 22688, line 19: Kohler theory assumes all of the solute material is involatile also. Line 20, 'Text book versions'. Please add a reference.

Abstract: Remove the unreferenced reference to 'Raatikainen and Laaksonen'. Suggest either fully referencing or alluding to past work in a more general sense.

Page 22689, line 5: Please re-iterate the conditions (k) for which this approximation is valid.

Section 2.3, page 22696, line 12: Add comma after 'surfactant'.

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Interactive comment on Atmos. Chem. Phys. Discuss., 12, 22687, 2012.