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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 2: Including solubility" *by* M. D. Petters and S. M. Kreidenweis

Anonymous Referee #2

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General Comments The submitted manuscript presents a method for modeling the cloud activation of a particle. The method, which was previously introduced by the authors, uses a single tunable parameter which represents the overall hygroscopicity of a particle (kappa). In this current contribution, the single parameter method is adapted to include solubility of a particle with a complex composition. The method uses the solubility (here defined as the volume of solute dissolved into a volume of water) of each component of the particle to derive the dissolved fraction of the solute. This enables the isolation of components that are completely solubility (ie, the dissolved volume fraction equals one) and sparingly soluble components (ie, the dissolved volume fraction is less than one). Then two equations, the Kohler equation (which includes the hygroscopicity parameter kappa) and the equation for kappa (which is the sum of each component's solubility) are solved numerically to find the critical supersaturation.

This method is used to calculate Kohler curves and predict deliquescence behavior for hypothetical single-component and two-component particles of varying hygroscopicity and solubility. Figure two shows the effect of adding a small amount (1-5%) of an infinitely soluble component to a particle consisting of sparingly soluble material. The decrease in the dry activation diameter with increasing fraction of soluble component (for a given supersaturation) relates well to the expected result.

The authors also suggest that it may be sufficient to classify the components of particles as either infinitely soluble or completely insoluble. This simplification has the potential to be an important tool for predicting the cloud activation of atmospheric aerosols. Although the scope of this contribution is limited to the development of the method, I look forward to the application of the method to experimental data.

Specific Comments The authors contend that because only a few solutes have solubilities in the sparingly soluble region, atmospheric CCN activity can be modeled by classifying components into either completely soluble or insoluble. However, not all organic species have identified, and therefore, not all solubilities are known. Can you elaborate on this point, that is, do we know enough about atmospheric organics for this simplification to be effective?

The figure captions, especially for figure 1, are lean on helpful details and explanation. Although these can be found in the text, I suggest including an explanation of points A, B, C, etc. the captions for both figure 1 and figure 2.

For figure 3, for the dashed line representing a particle with a 5%, it is curious that the dry diameter chosen was not the same as the pure particle curves (ie 80 nm instead of 70 nm). Although very little change in this curve is expected with a change of diameter of 10 nm, a comparison of the same size particles is a more direction comparison of the behaviors.

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Technical Details p. 5940 line 5-6: suggest rewrite for clarity, either "...to successfully model complex, multicomponent particle types." or "...to successfully model complex, multicomponent types of particles." p. 5942 line 15: rearranging Eq (2), not Eq (1).

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 5939, 2008.

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Interactive Comment