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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Technical Note: Analytical formulae for the critical supersaturations and droplet diameters of CCN containing insoluble material" *by* H. Kokkola et al.

H. Kokkola et al.

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We thank the Editor for his comments on the manuscript. Here are our replies to the specific points in the Editor comment.

1. The authors state in the abstract that formulas for critical supersaturation and diameter is provided, but only an expression for critical diameter is given. True, it is just a matter of substituting Equation (5) into (1), but it would be very nice to have an explicit expression for critical supersaturation.

We will include the explicit equation for the critical supersaturation in the revised manuscript.

2. As the soluble fraction decreases, does the critical supersaturation approach the Kelvin limit $A/D_{p,0}$?

The solution does approach the Kelvin limit, but approaches it "slowly". The Kelvin limit is a good approximation only when the soluble fraction is less than 10^{-5}.

3. Related to the point above, one of the authors have recently published a paper in ACP on adsorption activation (Sorjamaa and Laaksonen, 2007) which describes the CCN behavior of insoluble material that adsorbs water. At which point should the current work be used vs. adsorption activation?

The main difference is that in the adsorption activation, it is assumed that no water soluble material is present in the CCN, and thus the aqueous layer consits of pure water, whereas in the current treatment, it is assumed that the nucleus contains both insoluble and soluble material, whereby the aqueous layer is a solution rather than pure water. Of course, the two theories should merge when the amount of soluble matter becomes negligibly small, but this consideration is out of the scope of the present manuscript. We will nonetheless mention this issue in the revised manuscript.

4. Khvorostyanov and Curry (2007) have also discussed the issue of insoluble aerosol and extensions of classical Köhler theory to account for it. Can the authors comment on how the two studies complement each other?

Khvorostyanov and Curry (2007) also give the expression for the critical supersaturation and radius when insoluble material is present, but they use approximation in the derivation of the critical radii. Furthermore, their Equation for the critical radius (Equation (30)) is applicable only for particles with extremely small soluble fraction and shows relative error of more than 0.02 in the critical supersaturation when soluble fraction is less than 10^{-5} for 50 nm particles with NaCl as the soluble compound. For more accurate results, the approximation of the critical radius defined by Khvorostyanov and Curry (2007) should be replaced by the analytical expression given in our manuscript.

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5. line 5, page 17969: write $B/D_p^3 - D_{p,0}^3$ *as* $\frac{B}{D_p^3 - D_{p,0}^3}$

We will make this change in the revised manuscript.

References

Sorjamaa R, Laaksonen A, The effect of H2O adsorption on cloud-drop activation of insoluble particles: a theoretical framework, ACP, 6175-6180, 2007

Khvorostyanov VI and Curry JA, Refinements to the Kohler's theory of aerosol equilibrium radii, size spectra, and droplet activation: Effects of humidity and insoluble fraction, JGR, 112, 2007

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 17967, 2007.