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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 #3

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This manuscript provides an extension of the kappa formalism introduced by the same authors in ACP in 2007 (PK07) to account for compounds with limited solubility. An algorithm to calculate critical supersaturations is provided.

The extension of the kappa formalism is relevant to the scientific community and the first part of the manuscript is clearly written and presents comprehensible equations for water uptake at sub- and super-saturation as well as critical supersaturations for cloud droplet formation. I find however that the discussion part of the manuscript should be improved: the notation is not consistent and the choice of parameters should be explained better. I also suggest to include a comparison with experimental data or

example molecules.

Specific comments

Abstract and page 5946: The last sentences of the abstract and corresponding text on page 5946 that only a small part of the atmospheric aerosol fall into the sparingly soluble envelope and these molecules only make up a small fraction of total organic aerosol fraction is not supported by data or literature references in the manuscript.

Introduction Page 5941 Lines 7-10: Some references to previous work (e.g. Rissler et al. 2006) on the idea of a single hygroscopicity parameter to effectively model the ccn activity of atmospheric particles should be included.

Generalized k-Kohler equations

Page 5842 line 10: ..Applying the ZSR assumption and rearranging equation (1).. It seems that Equation (1) should be corrected to equation (2). Also it should be defined that Vs is the sum of the individual Vsi and it should be defined what Vsi is.

Page 5943: line 13: I think it should be Vw/Vs=g3-1 instead of Vw=g3-1,.

Page 5944: the authors assume that surface tension lowering or surfactant partitioning is not an issue and use the surface tension of pure water. This should be stated explicitly in the manuscript.

Discussion and conclusions

The use of symbols and notation should be improved, e.g. in the first part of the manuscript D means droplet diameter, in Figure 3 it means dry particle diameter and it is also used to denote a minimum in the Kohler curve. The use of C and Ci is confusing and should be made consistent. In general the text can be improved by better explaining figures and the choice of kappa and solubility values.

Page 5944: The use of the words sparingly soluble and moderately soluble is confusing. In Figure 3 the words Insoluble, sparingly soluble and soluble are introduced and

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clearly defined. It would be much easier to read the discussion if these terms were defined in the beginning of the discussion. It would strengthen the manuscript if examples of solubilities and kappa values of real molecules from the different solubility classes were given. What type of molecule has k=0.6 and a solubility of 0.02? No such molecule appears in PK07 table 2 as far as I can see. What combinations of kappa values and solubilites are realistic? In mixed particles: would it not be more realistic that the deliquescence (A) is below 100%RH? it could still be C that dominates activation.

Page 5944, line 21: It says that moderately soluble species has C>1 and that this is the case for most inorganic salts. Most inorganic salts would be characterized as fully soluble, but still C would be smaller than 1?

It is said that Kohler curves using equations 9 and 10 are compared to previously complex Kohler curves. Such a comparison is however not made - no Kohler curves from previous work are shown in Figure 1.

The curve k=0.5, C=infinity is not explained in the text, neither is C=1.

It could make the text more clear if figures 1 and 2 were related. The labels A, B and C could have the same meaning (B denotes a Kohler curve minima in figure 1 but a maximum in figure 2).

It should be explained in the text which values of kappa and Ci were studied. I suggest that ABCD in figures 1 and 2 are replaced by other symbols. C and D are used for many things.

Page 5945 Lines 5-10: For mixed particles cloud droplet activation can also be controlled by solubility even though deliquescence is below 100% RH.

If DRH is at supersaturation I think it would be more correct to say that DRH=sc than to say that DRH>sc – if the particles are exposed to the DRH they will grow to cloud droplets, so the critical supersaturation is the DRH.

Figure 3 is a nice illustration. It should be pointed out in the figure caption that the four

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full lines are for single component particles.

References J. Rissler, A. Vestin, E. Swietlicki, G. Fisch, J. Zhou, P. Artaxo, and M. O. Andreae Size distribution and hygroscopic properties of aerosol particles from dry-season biomass burning in Amazonia Atmos. Chem. Phys., 6, 471–491, 2006

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