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Atmospheric Chemistry and Physics Discussions

Interactive comment on "A single parameter representation of hygroscopic growth and cloud condensation nucleus activity" *by* M. D. Petters and S. M. Kreidenweis

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Petters and Kreidenweis present a single-parameter (kappa) representation of hygroscopicity, to be used for both hygroscopic growth at sub-saturation and in descriptions of water activity during cloud drop activation. We very much appreciate all contributions on this subject and think that a simple parameterization is an essential prerequisite for using hygroscopicity in assessing direct and indirect effects of aerosols on climate. It is also useful for lung deposition studies.

We have studied previous papers on this subject from the Kreidenweis group and always found them inspiring. The present paper is a good example of their high-quality

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work.

We would however encourage the authors to help the readers by discussing how their parameter relates to previously used single-parameter representations of hygroscopicity.

In many papers (among those Svenningsson et al.,1992;1997;,1994; Pitchford and McMurry,1994; Swietlicki et al.,1999;Aalto and Kulmala,2000;Hämeri et al.,2001; Lehmann et al.,2005; Mertes et al.,2005; Massling et al.,2005) the parameter epsilon has been used: epsilon being defined as the volume fraction of a model salt in a dry particle consisting of the model salt and an insoluble core and having the same hygroscopic growth as the actual particle. Normally ammonium sulfate has been used as the model salt. A linear relation between kappa and epsilon can be found. When ammonium sulfate is used as the model salt for epsilon the result simply is kappa= epsilon * 0.53.

A problem with epsilon is that it is often referred to as “soluble fraction” and this can easily be misunderstood as a statement that there should be a fraction 1- epsilon that is not water soluble and that the only compound that is important for the hygroscopicity is the model salt. We want to point out that this is a misinterpretation of epsilon: the concept of a model salt and an insoluble core is only a model for hygroscopicity. In order to avoid this misinterpretation, Rissler et al. (2006) and Rissler (2005) suggested a new parameter (by chance also denoted kappa), defined as the number of soluble moles of ions or non-dissociating molecules per unit volume of dry particles. Rissler’s kappa would typically have values ranging from a few thousand moles per cubic meter of dry particle volume to 40400 moles per cubic meter (pure ammonium sulphate with i = 3).

The parameter epsilon has also been used to link hygroscopicity at sub-saturation to cloud and fog droplet activation (e.g. Svenningsson et al. 1992). Still there is a need of more studies testing the applicability of such a simple model. We thus find the analysis

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that Petters and Kreidenweis present in figure 5 very interesting and encouraging.

Epsilon is originally adopted from the work by Fitzgerald (1975). In 1982 Fitzgerald et al. suggested a single hygroscopicity parameter (Bc) based on relations between dry particle size and critical supersaturation. This parameter is very similar to kappa as suggested by Petters and Kreidenweis.

Kreidenweis et al. (2005) suggested a more complex hygroscopicity representation, with three parameters (their equation 17). Simplifying this parameterization by letting b=c=0 would give a representation identical to the one suggested in the present paper by Petters and Kreidenweis.

We do not have a strong opinion about which of these parameters (epsilon, kappa (Rissler et al. 2006), kappa (Petters and Kreidenweis 2006),or Bc) to use, since they all are similar and depend linearly on each other. We hope that the future will bring us many interesting discussions with the authors!

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