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

Anonymous Referee #1

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Review of Petters and Kreidenweis for ACPD

This paper presents a new formulation of the water uptake of aerosol particles, which uses a single parameter for both the subsaturated and supersaturated regimes. This representation has some very useful additive properties, and eliminates the need to measure or estimate multiple parameters (Van’t Hoff factor, molecular weight, surface tension...) for the specific organic species present on a particle. If this simplification is verified to hold for many ambient particle types within acceptable error bounds, this new representation may prove extremely useful to regional and global models that simulate aerosol and cloud processes and their climate forcings. The paper is well written, but perhaps too short. I recommend it for publication in ACP after the following issues are addressed.

- Relating the proposed approach to other single-parameter hygroscopicity representations is very important. It seems that the strengths of the present paper lie in the explicit combination of the sub and supersaturated regimes and on the evaluation of the approach with many recent experimental datasets. This point has already been brought up in detail by Svenningsson and Swietlicki.

- Perhaps the strongest advantage of the proposed simple approach is that it can be used to parameterize the relationship between the organic composition and its hygroscopic properties for field data. Many "chemical effects" on CCN have been proposed and/or verified in the laboratory with simple mixtures, that could in principle result in large changes in the number of activated droplets. However it is not clear that these effects are ever important in the atmosphere. The k-Kohler theory proposed here can be used with field determinations of aerosol composition to derive values of kappa which are appropriate to various types/groups of bulk organic species. Several techniques are starting to routinely determine the groups of bulk organic species present in ambient aerosols, such as functional groups from FTIR [Maria et al., 2003], HOA and OOA from the AMS [Zhang et al., 2005], or various categories from WSOC-NMR [Fuzzi et al., 2001]. The approach presented here allows the linear mixing of the kappas from each organic group. If the values of kappa derived through this method are shown to work for varying mixtures the same organic groups as measured in different environments, the combinations of these techniques will provide a very important shortcut for the representation of organic hygroscopicity and activation in models. This exercise would also allow the detection of deviations where such a parameterization is insufficient. I suggest that this possibility is referred to in the paper.

- The abstract (line 13) states "We confirm the general applicability..." of this approach. It seems that this is slightly overstated, and that the remaining uncertainties are better captured in the conclusions section. Since the paper is short and since many people

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will only read the abstract, I recommend explaining the current limitations and future tests in more detail in this section.

- P 8441: at a recent conference I saw a report of non-linear mixing effects appear when mixing a surface active (HULIS) and a non-surface active (ammonium sulfate) component. It seems that this type of effect would not be captured by the k-Kohler theory.

- P 8439 / line 6: what is referred to here as "sphere equivalent diameter" is typically referred to as "volume equivalent diameter" (D_{ve}) in the aerosol literature, see e.g. DeCarlo et al. [2004].

- P 8443, line 2: the observation that size is more important than chemistry for CCN activation was first given by Junge and McLaren (1971) and further explored by Fitzgerald (1973). The former paper should also be acknowledged here. (By the way this was a long time before the recent re-discovery of this result by Dusek et al!)

References

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