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Atmospheric
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Interactive comment on “Reformulating atmospheric aerosol thermodynamics and hygroscopic growth into haze and clouds” *by* S. Metzger and J. Lelieveld

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We thank Dr. Ghan for his questions about the applicability of our model to droplet formation. This is a good point we would like to clarify.

1) We agree that the dynamic nature of droplet formation needs to be considered on small scales. Therefore, we do not state that our method substitutes cloud dynamics and microphysics computations. Instead, our approach should be coupled to cloud models, as stated on pages 854, 886, 889. We will bring this point out more strongly in the revised manuscript.

2) Our method can be used to compute the initial cloud droplet size distribution, assuming that the aerosol water mass depends on both the aerosol hygroscopicity and on the

available water vapor mass (as proposed). The further development of the droplet size distribution largely depends on the cloud dynamics and microphysics. The large-scale dynamics determines both the initial temperature and moisture conditions, used as input to our model. At present cloud models typically use the Köhler equation to compute the initial cloud droplet spectrum.

3) Since our method does not require or relies on supersaturation calculations, we bypass the problems involved in the statements: "We know from parcel modeling that the droplet formation process is a highly dynamic process, in which supersaturation initially grows in updrafts until condensation on droplets is strong enough to overcome supersaturation production by adiabatic expansion." and "Droplets forming on larger particles (diameter$>$0.1 micron) are not in equilibrium with the supersaturation, as growth lags behind the equilibrium size."

To which extent the droplet growth lags behind the equilibrium size is ultimately limited by the available water vapor mass and accounted for by our method.

Also, the statement that "... droplets form in updrafts that are explicitly resolved only in models with grid sizes less than 1 km" is again only appropriate for parameterizations that depend on the maximum supersaturation. Our method does not.

4) Our results show that our method enables explicit computations of large-scale hazes and clouds, including cloud cover, the initial cloud water and cloud ice, being useful for climate modeling.

5) Meanwhile we applied our concept to the most recent version of the weather forecast model (COSMO LM) of the German Weather Service (DWD), i.e. the Limited area Model operated for short-term forecasts (LMK). The aerosol-cloud coupling is based on a new cloud cover routine that allows calculating - computationally as efficient as the original cloud cover scheme - the area fraction of a grid box covered by stratiform and convective (subgrid-scale condensing) clouds - entirely based on this work. Our new cloud cover routine is further coupled to the LMK cloud microphysics parameter-

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izations. First results (to be presented separately) indicate a strong cloud response to aerosol loadings. These preliminary results are quite striking and encouraging because LMK, used as a weather forecast model, is operated at a rather high horizontal resolution (2.8 km), it includes a prognostic treatment of cloud water, and shows the same strong cloud response to aerosol loadings as our GCM (presented in this work).

On page 852, line 14 should include the sign for "greater or equal". This is a typo introduced after reading the galley proofs. It will be corrected in the revision.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 849, 2007.

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