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Interactive comment on "Modelling sea salt aerosol and its direct and indirect effects on climate" *by* X. Ma et al.

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We thank the reviewer for the thoughtful comments.

It is currently not clear how strongly global-scale aerosol indirect effects are affected by competing effects of different types of aerosol. Owing to large differences in aerosol and cloud properties between different oceanic regions, these effects can be expected to be variable.

As mentioned in the manuscript, O'Dowd et al.(1999) proposed a parameterization of CDNC as a function of a linear combination of number concentrations of sulphate and sea salt particles for global models. Their parameterization produced good agreement with results of detailed microphysics calculations. This approach also neglects competing effects of different types of aerosol.

We agree that the use of an empirical parameterization does not account for competing effects of different types of aerosols. It does not appear to be straightforward to account for competition in the context of empirical relationships. More advanced methods, such as first-principle based parameterizations (e.g. Nenes and Seinfeld, 2003) can be expected to be much more realistic in that regard if combined with realistic parameterizations for aerosol and cloud processes. First-principle based parameterizations are currently being tested in a number of GCMs and may be expected to replace the relatively simple parameterizations that are used in current operational global climate models in the future. However, substantial scientific questions still need to be addressed before reliable estimates of aerosol indirect effects will become available based on these new parameterizations. For example, large uncertainties still exist with regard to the representation of aerosol size distributions in GCMs. Relevant cloud dynamical processes are still poorly represented in GCMs. We are currently developing a new first-principle based approach (von Salzen et al., 2007) which we are planning to use to test empirical parameterizations in the future.

The empirical parameterization in the current study represents an improvement compared to other empirical parameterizations of CDNC which are usually only based on sulphate. However, we agree that effects of other types of aerosols are potentially also important.

Mircea et al. (2002) investigated the effect of organic aerosol on CCN for different conditions and found only weak impacts of organic aerosol on CCN for marine conditions. Another study by O'Dowd et al. (2004) shows that the competition of organic with inorganics is strongly dependent on the mixing state and updraft velocity. The results give evidence for potentially large effects for externally mixed aerosol. However, effects of organic aerosol on CDNC are relatively small for low updraft velocity and internal mixture with inorganic species.

Sources of organic aerosol are expected to be small compared to sources of sea salt and sulphate aerosol over large oceanic regions, including the southern ocean

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for which sea salt aerosol indirect effects are particularly strong according to the results of our simulations. An omission of the effects of organic aerosol on CDNC in the GCM therefore appears to be acceptable for a first order estimate of sea salt indirect forcing. We are planning to revisit this issue using a first principle-based approach for activation in the future.

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