**Atmospheric
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Discussions**

Interactive comment on "Simulating aerosol microphysics with the ECHAM/MADE GCM – Part I: Model description and comparison with observations" by A. Lauer et al.

A. Lauer et al.

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Response to anonymous referee #1

We thank the anonymous referee #1 for carefully reading through our manuscript and helping us to improve our paper with his/her comments.

We agree with the referee, that the abstract should give some more details on the model and its limitations. Thus, we included the following lines:

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Since the current study is focusing on the submicrometer aerosol, a coarse mode is not being simulated. The model is run in a passive mode, i.e. no feedbacks between the MADE aerosols and clouds or radiation are considered yet. This allows the investigation of the effect of aerosol dynamics, not interfered by feedbacks of the altered aerosols on clouds, radiation, and on the model dynamics.

To give some more details about aerosol activation and the handling of interstitial aerosol, we added two paragraphs to section "2.2.6 Wet deposition and clouds" (formerly section "2.2.5 Deposition", "wet deposition"):

Due to the large uncertainties related to aerosol alteration in clouds, we do not consider any aerosol dynamical processes of the interstitial aerosol, i.e. all aerosol dynamics such as coagulation or condensation are only calculated for the cloud free part of the grid box. We only consider the interaction of aerosols with cloud particles.

After the description of the calculation of the scavenging coefficients in the subsection "warm clouds", we included the second paragraph mentioned above:

Finally, the number of activated aerosol particles is obtained by multiplying the accumulation mode number concentration by the scavenging ratio $F_{0,l}^*$. The remaining interstitial particles within the cloud are assumed to be unchanged by wet deposition.

In order to give some more details on the uptake of water and how the modal approach takes into account the growth of the aerosol particles, we extended section "2.2.4 Aerosol chemistry" by the following lines:

The aerosol liquid water content depends on the chemical composition of the aerosol and the ambient relative humidity. Aerosol water is treated just as all other chemical components. Thus an increase in aerosol water results in an increase of the total aerosol mass. With the particle number concentration remaining constant in case of water uptake, the modal mean diameter of the corresponding aerosol mode increases.

We agree with the referee, that a bit more discussion about the limitations of the aerosol module due to the assumptions of fixed standard deviations and perfect internal mixtures within the modes would give further insights to the reader. Therefore we added the following two paragraphs to the model description in section "2.2.1 Basic ideas":

The standard deviation of typical atmospheric aerosol ranges between approximately 1.2 and 2.2 (Jaenicke, 1993). Typical variations of σ_g are less than those of the two other parameters of the log-normal distribution d_g and N. Thus, the use of fixed σ_g allows for reducing the overall computational expenses without loosing too much accuracy.

The assumption of a perfect internal mixture within the different size modes is a simplification, which reduces the computational burden significantly. In general, the degree of internal mixture depends on the residence time of the aerosol in the atmosphere. In polluted continental regions, the characteristic time of the transformation from external to internal mixture is short (in the order of hours) (Reas, 2000). This time scale is comparable to the time needed for the emitted particles to disperse into the large volume covered by the large-scale model grid boxes. However, under clean conditions or in case of strong nucleation, the assumption of an internal mixture introduces some uncertainties to the predicted aerosol properties. This can be of particular relevance when considering optical properties and radiative effects of aerosols.

The referee suggested to include a preliminary assessment on why we think our new model is better than existing ones. Actually, we don't think our model is the best one. In our opinion, for the prediction of currently highly uncertain parameters such as aerosol properties, additional, independent models can contribute to estimate these uncertainties. Thus, we inserted the following lines into the introduction:

Current uncertainties in predicting aerosol properties and aerosol related effects on global climate can be estimated, if results obtained with a particular model are compared to simulations performed with other global aerosol models. ECHAM4/MADE can contribute to such model ensembles to make further progress.

The typos mentioned by the referee have been removed.

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