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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Influence of Giant CCN on warm rain processes in the ECHAM5 GCM" *by* R. Posselt and U. Lohmann

R. Posselt and U. Lohmann

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The authors wish to thank the referee for the helpful comments on this manuscript. Below please find the point by point response to your comments.

Due to the revision of the first part of this paper the model changed. Thus, the global simulation were redone which lead to quite significant changes in the results. Thus, some comments about specific numbers and results are redundant. Nevertheless, we tried to follow the suggestions of the reviewer as much as possible.

Reply to "General comments":

- The revised manuscript follows the suggestion by the reviewer and the comparison to the standard ECHAM5-HAM is removed. Control simulation is now the ECHAM5-HAM with the prognostic rain scheme with 30 sub-time (ECHAM5-RAIN, now CTL30). Nevertheless, the revised manuscript also includes a comparison of the prognostic rain scheme for different numbers of sub-time steps (CTL30 vs CTL10). This is done because the first part of this paper only deals with single column simulations and the impact of sub-time step number on the global scale is not investigated there. In order to be able to compare the control simulations with observation, they are tuned so that the radiative balance at top-of-the-atmosphere is within $\pm 1\,W\,m^{-2}$.

- In the revised manuscript, evidences and discussions regarding the feedback to convection and changes in autoconversion and accretion are added.

Reply to "Specific comments":

1. The abstract is revised and shortened.
2. The mentioned paragraph is removed.
3. The numbers/results changed. The ECHAM5-HAM simulation is removed.
4. The references are added.
5. The revised manuscript contains a more detailed statement about the role of GCCN within the rain formation process (enhancing collection process and subsequent initiation of precipitation).
6. This section is revised. As the reviewer suggested, we added a table with the generation mechanisms for sea salt. The last paragraph gives an overview about available sea salt generation function that are used in GCMs (not only ECHAM5). Thus, this paragraph was not moved.

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7. See reply to “General Comments”.
8. In both figures large-scale precipitation is shown. This information was added to the figure caption. The feedback to the convective precipitation cannot be shown in an SCM. The feedback happens due to changes in the large-scale moisture field which is not captured within a SCM.
9. This section was revised and shortened. The ECHAM5-RAIN (now CTL30) is used as reference/control simulation. See also reply to “General Comments”.
10. The presented simulation for the sea salt distribution comparison in Fig.7 (now Fig. 4) is a global mean (taken only over the ocean) from a 1-year simulation. We are aware of the drawbacks of comparing measurements taken at various regions for a limited amount of time with the mean sea salt concentration over the whole ocean from a simulation. Nevertheless, we think that this is useful comparison as it shows that the model is able to reproduce natural sea salt emission and concentrations over the whole size range and for the various wind speed classes (regarding the given limitation/drawbacks). Thus, we decided to keep that figure.
11. This section was rewritten and revised. The SCM studies showed only the (stratiform) precipitation at cloud base. We now also added the precipitation at the surface which show much lower variability. This is caused by evaporation of rain below the cloud base. Furthermore, the strongest increase in the SCM study is connected to very high GCCN concentration ($1\,cm^{-3}$) which are not found in the global simulations.
12. The discussion of stratiform and the feedback to the convective precipitation is revised and extended. Additional evidence is given by showing changes in the large-scale moisture field (as the large-scale moisture convergence is triggering convection) and the changes in CAPE. Furthermore, large-scale moisture convergence also determines the type of convection - either non-precipitating shallow

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cumulus or heavily precipitating deep convection.

13. The whole results section is revised and reordered also due to the changes in the results caused by the redoing of the simulations. Further figures and tables are added to back up the findings and statements.

14. The suggested statements/findings about the connections of SCF to TCC and Reff (NI and TWP) are added.

15. see above (13)

16. The section about the diurnal cycle is removed from the paper.

17. see above (9) and “General Comments”.

18. As the results changed due to the new simulations this whole section is rewritten. The decrease in TWP due to an increase in GCCN are now mainly found in the Northern Hemisphere. The tropics experience an increase in TWP which might be also due to the changes in the moisture fields. The changes in the Southern Hemisphere do not show systematic changes. The increase in GCCN concentration in the Southern Hemisphere are so small compared to the background aerosol that it does not matter.

19. The simulations show that the 10m wind speed increases for part of the southern storm track. The GCCN change the location of this “increase belt”. In the Northern Hemisphere no systematic changes in the wind speed are visible. A figure is added to back up this information.

20. The new simulations are tuned.

21. see above (12)

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22. The results shown are not valid anymore and for the new simulation no numbers are given as the effect is negligible on the global scale.

Reply to "Technical corrections": The technical corrections has been included.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 14767, 2007.

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