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Influence of Giant CCN on warm rain processes in the ECHAM5 GCM

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Abstract. Increased Cloud Condensation Nuclei (CCN) load due to anthropogenic activity might lead to non-precipitating clouds because the cloud drops become smaller (for a constant liquid water content) and, therefore, less efficient in rain formation (aerosol indirect effect). Adding giant CCN (GCCN) into such a cloud can initiate precipitation (namely, drizzle) and, therefore, might counteract the aerosol indirect effect.

The effect of GCCN on global climate on warm clouds and precipitation within the ECHAM5 General Circulation Model (GCM) is investigated. Therefore, the newly introduced prognostic rain scheme (Posselt and Lohmann, 2007) is applied so that GCCN are directly activated into rain drops. The ECHAM5 simulations with incorporated GCCN show that precipitation is affected only locally. On the global scale, the precipitation amount does not change. Cloud properties like total water (liquid + rain water) and cloud drop number show a larger sensitivity to GCCN. Depending on the amount of added GCCN, the reduction of total water and cloud drops account for up to 20% compared to the control run without GCCN. Thus, the incorporation of the GCCN accelerate the hydrological cycle so that clouds precipitate faster (but not more) and less condensed water is accumulated in the atmosphere.

An estimate of the anthropogenic aerosol indirect effect on the climate is obtained by comparing simulations for present-day and pre-industrial climate. The introduction of the prognostic rain scheme lowered the anthropogenic aerosol indirect effect significantly compared to the standard ECHAM5 with the diagnostic rain scheme. The incorporation of the GCCN changes the model state, especially the cloud properties like TWP and N_l. The precipitation changes only locally but globally the precipitation is unaffected because it has to equal the global mean evaporation rate. Changing the cloud properties leads to a local reduction of the aerosol indirect effect and, hence, partly compensating for the increased anthropogenic CCN concentrations in that regions. Globally, the aerosol indirect effect is nearly the same for all simulations.

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