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Global anthropogenic aerosol effects on convective clouds in ECHAM5-HAM

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Abstract. Aerosols affect the climate system by changing cloud characteristics in many ways. They act as cloud condensation and ice nuclei and may have an influence on the hydrological cycle. Here we investigate aerosol effects on convective clouds by extending the double-moment cloud microphysics scheme developed for stratiform clouds, which is coupled to the HAM double-moment aerosol scheme, to convective clouds in the ECHAM5 general circulation model. This enables us to investigate whether more, and smaller cloud droplets suppress the warm rain formation in the lower parts of convective clouds and thus release more latent heat upon freezing, which would then result in more vigorous convection and more precipitation. In ECHAM5, including aerosol effects in large-scale and convective clouds (simulation ECHAM5-conv) reduces the sensitivity of the liquid water path increase with increasing aerosol optical depth in better agreement with observations and large-eddy simulation studies. In simulation ECHAM5-conv with increases in greenhouse gas and aerosol emissions since pre-industrial times, the geographical distribution of the changes in precipitation better matches the observed increase in precipitation than neglecting microphysics in convective clouds. In this simulation the convective precipitation increases the most suggesting that the convection has indeed become more vigorous.

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