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Cloud microphysics and aerosol indirect effects in the global climate model ECHAM5-HAM

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Abstract. The double-moment cloud microphysics scheme from ECHAM4 that predicts both the mass mixing ratios and number concentrations of cloud droplets and ice crystals has been coupled to the size-resolved aerosol scheme ECHAM5-HAM. ECHAM5-HAM predicts the aerosol mass, number concentrations and mixing state. The simulated liquid, ice and total water content and the cloud droplet and ice crystal number concentrations as a function of temperature in stratiform mixed-phase clouds between 0 and −35° C agree much better with aircraft observations in the ECHAM5 simulations. ECHAM5 performs better because more realistic aerosol concentrations are available for cloud droplet nucleation and because the Bergeron-Findeisen process is parameterized as being more efficient.

The total anthropogenic aerosol effect includes the direct, semi-direct and indirect effects and is defined as the difference in the top-of-the-atmosphere net radiation between present-day and pre-industrial times. It amounts to -1.9 W m^{-2} in ECHAM5, when a relative humidity dependent cloud cover scheme and aerosol emissions representative for the years 1750 and 2000 from the AeroCom emission inventory are used. The contribution of the cloud albedo effect amounts to -0.7 W m^{-2}. The total anthropogenic aerosol effect is larger when either a statistical cloud cover scheme or a different aerosol emission inventory are employed because the cloud lifetime effect increases.

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