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Global cloud and precipitation chemistry and wet deposition: tropospheric model simulations with ECHAM5 / MESSy1

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Abstract. The representation of cloud and precipitation chemistry and subsequent wet deposition of trace constituents in global atmospheric chemistry models is associated with large uncertainties. To improve the simulated trace gas distributions we apply the new submodel SCAV, which includes detailed cloud and precipitation chemistry and present results of the atmospheric chemistry general circulation model ECHAM5/MESSy1. A good agreement with observed wet deposition fluxes for species causing acid rain is obtained. The new scheme enables prognostic calculations of the pH of clouds and precipitation, and these results are also in accordance with observations. We address the influence of detailed cloud and precipitation chemistry on trace constituents based on sensitivity simulations. The results confirm previous results from regional scale and box models, and we extend the analysis to the role of aqueous phase chemistry on the global scale. Some species are directly affected through multiphase removal processes, and many also indirectly through changes in oxidant concentrations, which in turn have an impact on the species lifetime. While the overall effect on tropospheric ozone is relatively small (<10%), regional effects on O_3 can reach ≈20%, and several important compounds (e.g., H_2O_2, HCHO) are substantially depleted by clouds and precipitation.

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