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# Model sensitivity studies regarding the role of the retention coefficient for the scavenging and redistribution of highly soluble trace gases by deep convective cloud systems

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Abstract. The role of the retention coefficient (i.e. the fraction of a dissolved trace gas which is retained in hydrometeors during freezing) for the scavenging and redistribution of highly soluble trace gases by deep convective cloud systems is investigated using a modified version of the Weather Research and Forecasting (WRF) model. Results from cloud system resolving model runs (in which deep convection is initiated by small random perturbations in association with so-called "large scale forcings (LSF)") for a tropical oceanic (TOGA COARE) and a mid-latitude continental case (ARM) are compared to two runs in which bubbles are used to initiate deep convection (STERAO, ARM). In the LSF runs, scavenging is found to almost entirely prevent a highly soluble tracer initially located in the lowest 1.5 km of the troposphere from reaching the upper troposphere, independent of the retention coefficient. The release of gases from freezing hydrometeors leads to mixing ratio increases in the upper troposphere comparable to those calculated for insoluble trace gases only in the two runs in which bubbles are used to initiate deep convection. A comparison of the two ARM runs indicates that using bubbles to initiate deep convection may result in an overestimate of the influence of the retention coefficient on the vertical transport of highly soluble tracers. It is, however, found that the retention coefficient plays an important role for the scavenging and redistribution of highly soluble trace gases with a (chemical) source in the free troposphere and also for trace gases for which even relatively inefficient transport may be important. The large difference between LSF and bubble runs is attributed to differences in dynamics and microphysics in the inflow regions of the storms. The dependence of the results on the model setup indicates the need for additional model studies with a more realistic initiation of deep convection, e.g., considering effects of orography in a nested model setup.

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