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Uncertainties in atmospheric chemistry modelling due to convection parameterisations and subsequent scavenging

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Abstract. Moist convection in global modelling contributes significantly to the transport of energy, momentum, water and trace gases and aerosols within the troposphere. Since convective clouds are on a scale too small to be resolved in a global model their effects have to be parameterised. However, the whole process of moist convection and especially its parameterisations are associated with uncertainties. In contrast to previous studies on the impact of convection on trace gases, which had commonly neglected the convective transport for some or all compounds, we investigate this issue by examining simulations with five different convection schemes. This permits an uncertainty analysis due to the process formulation, without the inconsistencies inherent in entirely neglecting deep convection or convective tracer transport for one or more tracers.

Both the simulated mass fluxes and tracer distributions are analysed. Investigating the distributions of compounds with different characteristics, e.g., lifetime, chemical reactivity, solubility and source distributions, some differences can be attributed directly to the transport of these compounds, whereas others are more related to indirect effects, such as the transport of precursors, chemical reactivity in certain regions, and sink processes.

The model simulation data are compared with the average regional profiles of several measurement campaigns, and in detail with two campaigns in fall and winter 2005 in Suriname and Australia, respectively.

The shorter-lived a compound is, the larger the differences and consequently the uncertainty due to the convection parameterisation are, as long as it is not completely controlled by local production that is independent of convection and its impacts (e.g. water vapour changes). Whereas for long-lived compounds like CO or O_3 the mean differences between the simulations are less than 25%), differences for short-lived compounds reach up to ±100% with different convection schemes.

A rating of an overall "best" performing scheme is difficult, since the optimal performance depends on the region and compound.

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