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Regional modelling of tracer transport by tropical convection – Part 1: Sensitivity to convection parameterization

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Abstract. The general objective of this series of papers is to evaluate long duration limited area simulations with idealised tracers as a tool to assess tracer transport in chemistry-transport models (CTMs). In this first paper, we analyse the results of six simulations using different convection closures and parameterizations. The simulations are using the Grell and Dévényi (2002) mass-flux framework for the convection parameterization with different closures (Grell = GR, Arakawa-Shubert = AS, Kain-Fritch = KF, Low omega = LO, Moisture convergence = MC) and an ensemble parameterization (EN) based on the other five closures. The simulations are run for one month during the SCOUT-O3 field campaign lead from Darwin (Australia). They have a 60 km horizontal resolution and a fine vertical resolution in the upper troposphere/lower stratosphere. Meteorological results are compared with satellite products, radiosoundings and SCOUT-O3 aircraft campaign data. They show that the model is generally in good agreement with the measurements with less variability in the model. Except for the precipitation field, the differences between the six simulations are small on average with respect to the differences with the meteorological observations. The comparison with TRMM rainrates shows that the six parameterizations or closures have similar behaviour concerning convection triggering times and locations. However, the 6 simulations provide two different behaviours for rainfall values, with the EN, AS and KF parameterizations (Group 1) modelling better rain fields than LO, MC and GR (Group 2). The vertical distribution of tropospheric tracers is very different for the two groups showing significantly more transport into the TTL for Group 1 related to the larger average values of the upward velocities. Nevertheless the low values for the Group 1 fluxes at and above the cold point level indicate that the model does not simulate significant overshooting. For stratospheric tracers, the differences between the two groups are small indicating that the downward transport from the stratosphere is more related to the turbulent mixing parameterization than to the convection parameterization.

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