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Parameterization of convection in a Lagrangian particle dispersion model and its evaluation

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This paper presents the evaluation of a convective parameterization in the Lagrangian particle dispersion model FLEXPART based on meteorological data from the European Centre for Medium-Range Weather Forecasts (ECMWF) as input. The convection scheme designed by Emanuel and Živković-Rothman relies on the grid-scale temperature and humidity of the input data and provides as a by-product a displacement matrix necessary for the vertical convective particle redistribution. It is shown that apart from minor fluctuations caused by the stochastic convective redistribution of the particles the well-mixed criterions is fulfilled in transport simulations including convection. Although for technical reasons the calculation of the convective displacement matrix differs somewhat between the forward and the backward simulations in time, the mean relative difference between the convective mass fluxes in forward simulations and those in backward simulations is below 3% and can therefore be tolerated. A comparison of the convective mass fluxes and the convective precipitation rates with those archived in the ECMWF ERA-40 data reveals that the convection scheme in FLEXPART produces upward mass fluxes and precipitation rates generally smaller by about 25% than those from ECMWF ERA-40. It is concluded from these results that the convection scheme as implemented in FLEXPART is working reasonable, as precipitation in the ECMWF model is known to be overestimated. Tracer transport simulations with and without convection are finally compared with surface and aircraft measurement data from tracer experiments. At the surface we found no substantial differences between the model runs with and without convection. At higher altitudes, however, the model runs with convection produced better agreement with the measurement data in some cases and indifferent results in the others. However, in order

to generalize this finding and to validate properly the convection scheme in FLEXPART, tracer experiments with much more measurements at higher altitudes would be desirable.