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Coupling FLEXPART to the regional scale numerical weather prediction model COSMO: Implementation, evaluation and first results

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The Lagrangian particle dispersion model FLEXPART is a well-known and robust research tool used by many atmospheric scientists worldwide. In its standard version FLEXPART was developed for the use with global or limited area input files from the European Centre for Medium Range Weather Forecast (ECMWF). Further versions exist for input from the NCEP (National Centers for Environmental Prediction) GFS (Global Forecasting System) model and for regional scale input from the MM5 model and its successor WRF. In Europe several national weather services and research groups develop and operate the non-hydrostatic limited-area atmospheric model COSMO (Consortium for Small-scale Modeling). At MeteoSwiss COSMO is operationally run with data assimilation on two grids with approximately 7 km x 7 km and 2 km x 2 km horizontal resolution centered over Switzerland This offers the exceptional opportunity of studying atmospheric transport over complex terrain on an long-term basis.

To this end, we have developed a new version of FLEXPART that is offline coupled to COSMO output (FLEXPART-COSMO hereafter) and supports output from multiple COSMO nests. The version features several new developments as compared to the standard version. Most importantly, particles are internally referenced against the native vertical coordinate system used in COSMO and not, as in standard FLEXPART, in a terrain following z-system. This eliminates the need for an additional interpolation step. A new flux deaccumulation scheme was introduced that removes the need for additional preprocessing of the input files. In addition to the existing Emmanuel based convection parameterisation, a convection parameterisation based on the Tiedtke scheme, which is identical to the one implemented in COSMO itself, was introduced. A possibility for offline nesting of a FLEXPART-COSMO run into a FLEXPART-ECMWF run for backward simulations was developed that only requires minor modifications on the FLEXPART-ECMWF version and allows particles to leave the limited COSMO domain. On the technical side, we added an OpenMP shared-memory parallelisation to the model, which also allows for asynchronous reading of input data.

Here we present results from several model performance tests under different conditions and compare these with results from standard FLEXPART simulations using nested ECMWF input. This analysis will contain evaluation of deposition fields, comparison of convection schemes and performance analysis of the parallel version. Furthermore, a series of forward-backward simulations were conducted in order to test the robustness of model results independent of the integration direction. Finally, selected examples from recent applications of the model to transport of radioactive and conservative tracers and for in-situ measurement characterisation will be presented.