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Towards parameterising evaporation fluxes of artificial water vapour tracers in a mesoscale model with a Lagrangian stochastic model

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Typical bulk schemes for parameterising evaporation fluxes of water vapour used in many mesoscale models introduce severe artifacts when applied to water vapour tracers. For example, an artifical tracer that evaporates from a limited surface area of the ocean experiences unphysically high condensation fluxes when advected over a land surface where no tracer evaporates. Using the flux calculated from the total water vapour gradient in the boundary layer results in a underestimation of evaporation and condensation fluxes, as only a net flux is provided by the flux-gradient approximation.

Here we develop an alternative approach for parameterising tagged tracer fluxes in the numerical weather prediction model COSMO based on a Lagrangian random flight model that solves the Langevin equation. Based on stochastic velocity fluctuations given by the turbulence characteristics under a certain stability regime, Lagrangian particles representing the tracer are displaced vertically. Vertical fluxes are then diagnosed from the model state.

We present the model setup and validation, as well as a comparison of water vapour and tracer fluxes calculated from bulk schemes based on the flux-gradient approximation to the estimates from the random flight model. A possible solution to integrate the computationally intense Lagrangian calculations efficiently into the COSMO model is proposed and discussed.