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An intercomparison of Lagrangian methods to diagnose evaporation regions of water vapour and precipitation

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The identification of regions where water evaporated from the surface, so called moisture sources, for precipitation or atmospheric water vapour is currently receiving increased attention. Water source information provides insight into the dynamical coupling between surface evaporation, moisture transport, and precipitation, which is an important ingredient for the occurrence of precipitation extremes. Recently, several diagnostics based on backward trajectories have been proposed in the literature to identify the moisture sources for precipitation, each with own specific assumptions and simplifications. A direct comparison between these different methods has so far not been carried out.

Here we present results from an intercomparison of three recently proposed Lagrangian moisture source diagnostics. The ECMWF ERA-Interim data are used as a common dataset. Three-dimensional kinematic backward-trajectories have been calculated using the LAGRANTO model and the Lagrangian particle dispersion model FLEXPART with and without parameterised convection. The different methods are compared for a mid-latitude case, the Elbe flood of August 2002, and a low-latitude case, the Pakistan floods of 2010, to test the influence of convective moisture transport on the diagnostics. Evaporation fields from ERA-Interim as well as the HOAPS data set are used to evaluate the physical plausibility of the identified moisture source regions.

The results demonstrate that the methods differ substantially with respect to the distance of the identified moisture sources for specific events, while the spatial location is relatively consistent. The representation of vertical motion in the trajectory calculation is a decisive factor for all methods. Based on the comparison with simulated and observed evaporation fields, a critical discussion of the underlying assumptions of the various methods is provided.