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Identification of moisture sources for extreme precipitation events in Europe simulated with a mesoscale model

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Extreme precipitation events have led to disastrous floods in central Europe in recent years. Still, important aspects of the atmospheric hydrological cycle remain unknown, making the forecasting of such events a major challenge. Even though particular cyclone tracks are known to be frequently associated with heavy precipitation (Vb Wetterlagen), additional preconditions of the atmosphere and land surface are required to create a major flood event. An important issue of such extreme precipitation events are the water vapour sources that contribute to a flood. In this study, we aim to increase the understanding of the dynamics of certain extreme precipitation events in central Europe. In particular, our aim is to assess the contribution of moisture from different water basins and the role of feedback mechanisms of the land surface (precipitation recycling) to flood events.

So-called water vapour tracers have been implemented in the CHRM regional climate model, a hydrostatic mesoscale model with a horizontal resolution of typically 25-50 km. Thereby marked water vapour allows for identifying the contribution of different evaporation areas to precipitation without disturbing the model physics, as would be the case in more standard dry/moist model sensitivity studies. In two case studies with extreme precipitation in central Europe (Elbe flood, August 2002 and Swiss flood, August 2005) water vapour tracers were released from the major European water basins, such as the Atlantic, the eastern, central, and western Mediterranean, the Black Sea, and the land surface area. Reanalysis and analysis data from ECMWF were used as initial and boundary conditions. The relative contribution of the different moisture sources to the extreme precipitation are compared both in magnitude and temporal

sequence.

CHRM is able to successfully simulate both flood events. First comparisons between the devastating Elbe flood from August 2002 and the recent Swiss floods from August 2005 show, despite similar weather patterns, remarkable differences in the moisture source characteristics. In both simulations, the Mediterranean is the major source region of moisture, but land areas also show notable contributions. This highlights the importance of pre-conditions of the atmosphere and land surface for major flood events. Limitations of the water vapour tagging methodology mainly concern the quality of advection numerics and parametrisations of hydrologic processes in the model. Nevertheless, run-time processed water vapour tracers in mesoscale models offer important new possibilities to quantitatively investigate key aspects of the model-simulated atmospheric hydrological cycle.