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Quantifying the hydrometeorological origins and space-time characteristics of trans-basin floods

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Floods that affect many sites simultaneously can pose great challenges in the co-ordination of flood disaster management actions, as well as for the insurance and re-insurance industry, since this type of flooding leads to an accumulation of losses and the risk assessment needs to be extended to a concept representing the spatial risk of flooding. The assessment of the accumulated risk, especially over large domains, requires an analysis of the spatial and temporal coherence of flooding. For that purpose, we have developed a complete and consistent set of trans-basin floods for Germany for the period between 1952 and 2002 based on the analysis of multiple series of mean daily discharge. Each flood is characterised by a specific value for the timing, the location and the magnitude of discharges within the entire river network. To assess the future risk of trans-basin flooding, the responsible mechanisms for flood genesis (atmospheric conditions, runoff generation in the catchment, and routing) need to be identified and quantified in their spatial and temporal characteristics and dependencies.
The events are caused by three atmospheric circulation patterns, i.e. a) cyclonic westerly flow b) blocked westerly flow and c) cut-off lows. Adopting a catchment perspective, for each event type we explicitly show the contributions and space-time dynamics of rainfall, snowmelt, catchment state and routing making use of a spatially distributed river basin model (SWIM). The relative contribution of advection, convection and orographic enhancement to rainfall formation is analysed using reanalysis data (ECMWF ERA-40). We show which combination of processes can potentially lead to trans-basin floods of various magnitudes.