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Understanding trans-basin floods

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Trans-basin floods are extreme events occurring on a regional scale and across catchment boundaries. They are the consequence of highly complex and inextricably linked processes involving atmospheric conditions, runoff generation and concentration in the catchment, and in-channel wave propagation. To understand trans-basin floods the dynamics of these processes have to be analysed over a range of temporal scales including preconditioning factors, like monthly anomalies of climatic conditions; initial factors, such as the immediate flood producing weather system or the catchment state on a daily scale and maintaining factors, such as persistent regimes determining the progression of a flood event.

These mechanisms can be understood by analysing past events. Therefore a set of trans-basin events was developed for a period of 51 years (1952-2002) analysing time series of daily mean discharge at 170 gauges of rivers in the central European basins Elbe, Danube, Rhine, Weser and Ems. A novel indicator including both the spatial extent of the event as well as the magnitude of the discharges in the rivers allows comparing events with respect to their severity.

Reanalysis data (i.e. ECMWF ERA-40 and NCEP Reanalysis I) were used to examine the general circulation patterns during the events. Further, a high-quality dataset of daily precipitation for over 2300 stations in Germany was used to trace the water supply of the events on all the three temporal scales. Several atmospheric parameters, such as water vapour content or temperature anomalies, were derived for the affected flooding area to serve as possible indicators common to a majority of the events. The causative general circulation patterns could be grouped into three types with 1) more or less zonally progressing baroclinic disturbances within the planetary frontal zone, 2) zonal flow retarded by a quasi-stationary air mass boundary (blocking situation to the East) and 3) slowly moving cut-off lows with abundant meso-scale frontal precipitation. For the 20 most severe events, all summer floods were associated with atmospheric flows of type 3, whilst all winter events could be attributed to moist westerly flows of types 1 and 2. Several cases in winter also involved melting of significant snow accumulations which served as a crucial source for surface runoff.