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Dynamical analysis of large-scale 100-year precipitation events over Central European river catchments and their differences to less extreme events

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Extreme, large-scale precipitation events can lead to extreme river floodings which are one of the most dangerous weather events for society when occurring in highly populated areas. However, the largest impacts are caused by very rare events with return periods on the order of 100 years. To do a quantitative and robust analysis of daily 100-year precipitation events, observational time series are typically too short. Therefore, an approach is applied here in which operational ensemble prediction data from the ECMWF are used to generate a large pool of simulated, but realistic daily precipitation events (corresponding to 1200 years of data) from which several 100-year events can be analysed. For five different major Central European river catchments, composite analyses show that 100-year precipitation events in all catchments are typically associated with an upper-level trough moving into Central Europe 24h to 48h before the occurrence of the events. During the 24h before the events, details in the progression of the trough and the location of the associated surface cyclone determine in which catchment extreme precipitation occurs. A comparison to composite analyses of less extreme precipitation events shows that dynamical mechanisms such as an amplified mid-tropospheric trough/cut off are more important for an intensification of precipitation events in the Danube and Oder catchments while in the Elbe, Rhine and Weser/Ems catchments thermodynamical mechanisms such as a larger moisture flux are more important. The question how a warmer climate will affect the dynamical processes of such extreme precipitation events will be investigated in a follow-up study.