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Projected future changes of very extreme precipitation events over central European river catchments from ensemble climate simulations

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Extreme precipitation events can cause flooding in central European river catchments. Climate simulations show that extreme precipitation, especially towards longer return periods, will intensify in a warmer climate for most parts of Europe. In order to study the mechanisms leading to the intensification of particularly extreme events, we investigate 10-year daily precipitation events over five major central European river catchments in Community Earth System Model Large Ensemble simulations. A statistical evaluation and comparison of large-scale circulation patterns associated with the events with operational ensemble weather prediction data from the ECMWF indicate a realistic representation of the 10-year extreme events in the climate model. Differences in these circulation patterns are analysed between the historical climate of 1990-2000 and a warmer climate at the end of the century (2091-2100). While most events occur in the core summer months (June-August) in the historical climate, there is a broadening of the seasonal distribution with extreme events from May to October in the warmer climate. Precipitation rates increase locally by 5-7%/K, similar to the Clausius-Clapeyron rate, related to significant increases in lower-tropospheric humidity. Averaged over the entire catchments, precipitation still increases, but with lower intensification rates varying between 1.2 and 3.8%/K for the individual catchments. This is due to a combination of thermodynamic and dynamic factors, in particular the shift towards the cold season, associated with smaller temperature increases during the events than expected from the overall warming, and a weakening of vertical motion over parts of the catchments. In future research, the robustness of these findings should be investigated through comparison with other climate simulations.