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Decadal oscillations and extreme value distribution of river peak flows in the Meuse catchment

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In flood risk management, flood probabilities are often quantified through Generalized Pareto distributions of river peak flows. One of the main underlying assumptions is that all data points need to originate from one single underlying distribution (i.i.d. assumption). However, this hypothesis, although generally assumed to be correct for variables such as river peak flows, remains somehow questionable: flooding might indeed be caused by different hydrological and/or meteorological conditions. This study confirms these findings from previous research by showing a clear indication of the link between atmospheric conditions and flooding for the Meuse river in The Netherlands: decadal oscillations of river peak flows can (at least partially) be attributed to the occurrence of westerly weather types.

The study further proposes a method to take this correlation between atmospheric conditions and river peak flows into account when calibrating an extreme value distribution for river peak flows. Rather than calibrating one single distribution to the data and potentially violating the i.i.d. assumption, weather type depending extreme value distributions are derived and composed. The study shows that, for the Meuse river in The Netherlands, such approach results in a more accurate extreme value distribution, especially with regards to extrapolations. Comparison of the proposed method with a traditional extreme value analysis approach and an alternative model-based approach for the same case study shows strong differences in the peak flow extrapolation. The design-flood for a 1,250 year return period is estimated at 4,800 m3s-1 for the proposed method, compared with 3,450 m3s-1 and 3,900 m3s-1 for the traditional method and a previous study. The methods were validated based on instrumental and documentary flood information of the past 500 years.