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Machine learning-based typing of flood hydrographs to characterize extreme events

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Extreme floods are characterized as hydrologic events with exceptionally high peak flows and/or volumes. Such events result from extraordinary meteorological conditions. However, the occurrence of similar meteorological conditions does not necessarily lead to the emergence of a similar flood event. Vice versa, extreme events occur in some regions under ordinary weather conditions. The key question is how do these extreme events develop? What are the driving factors that compound flood events from ordinary events to extreme events?
We addressed these questions with the analysis of flood hydrographs. Since several dominant processes within a catchment define the shape of the resulting hydrograph, we aimed to search for similarities in flood generation processes by these analyses. Our intention was to analyse whether extreme event hydrographs inhibit similar hydrograph shapes with other hydrological events or if they offer a unique shape. Therefore, a large data set as well as a classification into flood types (considering the hydrograph shape) was required. For ten catchments in mid- and southern Germany, the five highest flood events per year within a period of 13 years were separated. For each data set we performed an unsupervised classification to receive an unbiased definition of the occurring flood types. The classification procedure included the calculation of flow signatures drawn from the spectral decomposition of the flood hydrographs by means of the Fourier Transformation.
The specified event clusters for each catchment were compared with statistical tests and by variance analyses of the most important flood characteristics. It can be shown that the applied methodology offers a hydrological relevant classification where each cluster represents an unique combination of flood characteristics. A detailed analysis of the assignment of extreme floods answers the question whether these events define their own flood type. An comparison with meteorological conditions address the emergence of certain flood types and gives an outlook on further applications.