Characterization of the Temporal Clustering of Flood Events across the Central United States in terms of Climate States

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The central United States is a region of the country that has been plagued by frequent catastrophic flooding (e.g., flood events of 1993, 2008, 2013, and 2014), with large economic and social repercussions (e.g., fatalities, agricultural losses, flood losses, water quality issues). The goal of this study is to examine whether it is possible to describe the occurrence of flood events at the sub-seasonal scale in terms of variations in the climate system.
Daily streamflow time series from 774 USGS stream gage stations over the central United States (defined here to include North Dakota, South Dakota, Nebraska, Kansas, Missouri, Iowa, Minnesota, Wisconsin, Illinois, West Virginia, Kentucky, Ohio, Indiana, and Michigan) with a record of at least 50 years and ending no earlier than 2011 are used for this study. We use a peak-over-threshold (POT) approach to identify flood peaks so that we have, on average two events per year. We model the occurrence/non-occurrence of a flood event over time using regression models based on Cox processes. Cox processes are widely used in biostatistics and can be viewed as a generalization of Poisson processes. Rather than assuming that flood events occur independently of the occurrence of previous events (as in Poisson processes), Cox processes allow us to account for the potential presence of temporal clustering, which manifests itself in an alternation of quiet and active periods. Here we model the occurrence/non-occurrence of flood events using two climate indices as climate time-varying covariates: the North Atlantic Oscillation (NAO) and the Pacific-North American pattern (PNA). The results of this study show that NAO and/or PNA can explain the temporal clustering in flood occurrences in over 90% of the stream gage stations we considered. Analyses of the sensitivity of the results to different average numbers of flood events per year (from one to five) are also performed and lead to the same conclusions. The findings of this work highlight that variations in the climate system play a critical role in explaining the occurrence of flood events at the sub-seasonal scale over the central United States.