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From Causative Mechanisms of Extreme Events to a Place-based Assessment of Flash Flood Hazard and Vulnerability in the Continental United States

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Flash floods impose extensive damage and disruption to societies, and they are among the deadliest natural hazards worldwide. Flooding is an on-going global-scale socio-economic risk that is likely to increase in the future under climate change and human development. This risk has led to a variety of studies on the natural and anthropogenic causes of floods. Also, the massive socioeconomic impacts engendered by extreme floods is clear motivation for improved understanding of flood drivers. This presentation is two-fold: first, I demonstrate a machine learning approach to perform clustering of reanalysis data to identify synoptic-scale atmospheric circulation patterns associated with extreme floods across the Continental United States (CONUS). We subsequently assess the flood characteristics (e.g., frequency, spatial domain, event size, and seasonality) specific to each circulation pattern. Focusing on atmospheric circulation patterns leading to extreme rainfall, which is a major factor in nearly all except snowmelt-driven extreme floods, can be especially used to inform continental-scale modeling and forecasting effort. Considering that flash flood is mainly initiated by intense rainfall, and due to its rapid onset, taking action for effective response is challenging. Therefore, building resilience to flash floods require understanding of the socio-economic characteristics of the societies and their vulnerability to these extreme events. The second part of this presentation provides a comprehensive assessment of socio-economic vulnerability (SEV) to flash floods, investigates the main characteristics of flash flood hazard and accordingly a SEV index is developed at the county level across the CONUS. The coincidence of SEV and flash flood hazard are investigated to identify the critical and non-critical regions. The results indicate the resemblance and heterogeneity of flash flood spatial clustering and vulnerability of the regions over the CONUS. We show how identifying these spatial patterns will assist policy makers reach informed and effective decisions for planning and allocating resources.