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Roles of hillslope processes and river network routing in the hydrologic response to spatially variable rainfall fields

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This work introduces a new framework to analyze the relevance of hillslope with respect to channel processes in the generation of the hydrologic response to spatially variable rainfall fields for flood events. The dependence between rainfall spatial organization, the geomorphic features of channels and hillslopes, and the basin response is analyzed by extending the concept of 'Spatial moments of catchment rainfall' to the hillslope system. Observational and modeling analyses based on six extreme flash floods occurred in various European regions in the period 2002-2007 are used to illustrate the development of the analytical framework. We found that increased hillslope residence time reduces the sensitivity of the flood response to rainfall space-time organization. We derive a simple expression which quantifies the sensitivity of the flood response to rainfall space-time organization as a function of the overall spatial moments and of the geomorphologic and dynamic parameters characterizing the river routing and the hillslope residence time.