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Combined effect of storm movement and drainage network configuration on flood peaks

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This presentation reports the combined effect of storm movement and drainage network layout on resulting hydrographs and its implication to flood process and also flood mitigation. First, we investigate, in general terms, the effects of storm movement on the resulting flood peaks, and the underlying process controls. For this purpose, we utilize a broad theoretical framework that uses characteristic time and space scales associated with stationary rainstorms as well as moving rainstorms. For a stationary rainstorm the characteristic timescales that govern the peak response include two intrinsic timescales of a catchment and one extrinsic timescale of a rainstorm. On the other hand, for a moving rainstorm, two additional extrinsic scales are required; the storm travel time and storm size. We show that the relationship between the peak response and the timescales appropriate for a stationary rainstorm can be extended in a straightforward manner to describe the peak response for a moving rainstorm. For moving rainstorms, we show that the augmentation of peak response arises from both effect of overlaying the responses from subcatchments (resonance condition) and effect of increased responses from subcatchments due to increased duration (interdependence), which results in maximum peak response when the moving rainstorm is slower than the channel flow velocity. Second, we show the relation between channel network configurations and hydrograph sensitivity to storm kinematics. For this purpose, Gibbs' model is used to evaluate the network characteristics. The results show that the storm kinematics that produces the maximum peak discharge depends on the network configuration because the resonance condition changes with the network configuration. We show that an "efficient" network layout is more sensitive and results in higher increase in peak response compared to "inefficient" one. These results imply different flood potential risks for river networks depending on network characteristics. In addition, they imply a possibility of an alternative drainage network layout as an effective measure for flood mitigation in urban environments.