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Intra-basin hydrological processes during large and extreme flash floods under various hydrometeorological conditions

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Hydrological response is a result of the complex dynamic interactions between spatiotemporal rain and heterogeneous basin properties. This response is maximized under rare hydrometeorological conditions in which short, quazi-stationary, and intense rainstorms interact with catchments, resulting in extreme flash floods. These extreme flash floods provide a unique scenario in which hydrological behaviors that were concealed or not highlighted during less severe events are revealed. This study aims to gain a better understanding of different intra-basin processes and patterns during large stream flow events with a special focus on the extremes.
To achieve this, we developed a fully distributed hydrological model with high spatiotemporal resolution. The model was applied to five small to medium sized catchments (18-70 square kilometers) at the Ramot Menashe region in northern Israel (Mediterranean climate). High resolution (1 square kilometer, 5-min) rain fields measured by the Shacham meteorological radar were calibrated, corrected and used as inputs to the model. Detailed spatial DTM data and maps of landuse and soil were applied to obtain different model parameters. Infiltration, re-infiltration, evaporation, and surface routing were calculated at each model cell.
To account, quantify, and study the comprehensive hydrological basin response we identified runoff contributing areas, i.e. hillslope cells with surface runoff that reaches the stream network. The spatiotemporal evolution of these areas allows the study of the integrated effect of rainfall patterns with basin characteristics. In particular, it allows the identification of conditions in terms of basin characteristics and storm dynamics under which extreme flash floods are generated.
Results show that storm peak discharge is highly dependent on a combination of rain rate and contributing area, point to a strong connection between the landuse and the formation of contributing areas, and provide important insights regarding the occurrence of extreme flash floods.