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Storm and catchment controls on extreme flood genesis: a methodological framework

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What makes an extreme storm an extreme flood? A methodological framework is described for investigating the shaping mechanisms of an extreme flood from storms of differing kind and catchments of varying form. Extreme storms of convective, orographic and frontal origin are chosen from historical records and characterised in terms of return period for their critical rainfall depth and duration and other storm properties. The flood response over a catchment is assessed for flood peak return period and modelled using lumped and distributed approaches. Areal rainfall estimates for catchment and grid-square areas, used as model input, are obtained by multiquadric interpolation methods applied to raingauge data alone and in combination with weather radar data. Shortcomings of stage-discharge ratings affecting implied model performance are taken into account. A rainfall transformation tool is applied to historical storms to change their speed and direction of movement and their magnitude and shape to create artificial storms of greater return period. The flood response is investigated for catchments co-located with the storm and, by invoking storm transposition, to other catchments of different form. An example is presented of a fast-moving extreme convective storm that fails to produce an extreme flash flood. When transposed to another catchment, reduced in speed and re-orientated to align with the river network, a modelled extreme flood response results. The more extreme response obtained from the distributed rainfall-runoff model, relative to the lumped one, serves to highlight the potential value of distributed models in forecasting unusual extreme storms. Animated images of flood forecasts with area-wide coverage, obtained from the distributed model, provide insight into the space-time shaping of the flood by the catchment form. This has particular relevance to flood warning for ungauged locations.