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The applicability to large catchments of spatial-temporal rainfall modelling with point processes: case study of East Anglia, UK

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Many studies have illustrated the importance of the space-time structure of rainfall patterns, which is found significant in a wide range of scientific and engineering applications. It motivates the development of stochastic rainfall modelling. Point process models which are based on the physical process of precipitation are one of the tools used to achieve a continuous simulation of the time series. However, whether such models can replicate enough of the space-time dependency structure for hydrological applications in large catchments is unclear. This research aims to investigate the applicability of the current point process models on the basin response over a large-scale catchment.

A case study was undertaken in a large catchment in the UK (about 19000 km2), where floods and several drought events were observed in the 11-year historical record. A dense network of rain gauges was used for the model calibration over the region. We employed a spatial-temporal rainfall model based on Neyman-Scott rectangular pulses, where storm types and the defined storm extent were taken into consideration.

In the first part of the study, the model is validated, which shows that it can capture and reproduce the summary statistics and extreme event. However, it is found inadequate in reproducing the relationship between the point rainfall and areal rainfall (Areal Reduction Factors) and its performance deteriorates with increasing catchment size. In the second part, we use the gridded synthetic rainfall field as input, together with other hydrological and climate datasets, to drive a fully integrated catchment model (MIKE-SHE). Through the comparison with the response based on weather radar record, the effect of using the synthetic spatial rainfall field on runoff estimation, at large-catchment scale is evaluated.