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The significance of spatial rainfall representation for flood runoff estimation

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In the context of flood management in the UK, the sensitivity of simulated flood runoff to the representation of observed spatial rainfall is evaluated. The study is based on 15 years of radar data, 16 raingauges and 12 flow stations from the 1000km^2 Upper Catchment of the River Lee in the Thames region. Event-based, semi-distributed hydrological rainfall-runoff modelling is undertaken, in which alternative rainfall descriptors (raingauge networks of various density, radar data) are considered and their effects on simulated runoff are evaluated as a function of: 1) rainfall type, selecting events representing extreme, and more typical frontal and convective rainfall; 2) catchment type, on natural and artificially urbanised basins; and 3) catchment scale, at scales ranging from 80 to 1000 km^2. An index of spatial variability is defined, based on the difference between the reference rainfall (as defined by the full raingauge network) and alternative rainfall descriptors. A modified Nash-Sutcliffe Efficiency criterion measures the performance of the simulated runoff with respect to reference simulated runoff. Results show a complex picture. The dominant effect is the spatial variability of the rainfall. No clear pattern emerges as a function of catchment scale, or response time, except that the impact of spatial variability is damped at the whole catchment scale of 1000km^2. The sensitivity to spatial rainfall is enhanced on urbanised catchments. This paper concludes with specific guidance concerning the importance of spatial rainfall for flood estimation and the spatial resolution requirements for rainfall at different catchment scales.