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UK Rainfall extremes: trends, non-stationarity, and clustering

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The temporal and spatial distribution of heavy rainfall events are major drivers in the development of floods. This work will focus on the time interval between large rainfall events and whether this interval is becoming shorter, leading to clustering of heavy rainfall events and hence greater potential for flooding.

Since precipitation is a direct cause of flooding, characterising the behaviour of rainfall extremes would be a first step toward linking meteorological research to flood management. In particular, establishing whether heavy rainfall events occur in successions (clusters) and identifying any driving mechanisms (e.g. seasonality, atmospheric circulation types) could be of great benefit to public policy, the insurance industry or water resources managers.

Extreme precipitation in many regions globally has been examined in the scientific literature using several measures, from the frequency or intensity of events, to the likely probability of occurrence in any year (return level). However, assessments of temporal variability have mostly concentrated on either seasonal or annual frequency estimates, with little attention paid to the time elapsed between distinct precipitation events.

This work aims to understand the statistical properties of the heaviest daily precipitation events per year, in terms of timing, intensity and spatial occurrence across the UK. Specifically, it focuses on the following questions:
1. Is the time interval between these events changing more than would be expected under natural variability?
2. Can the seasonality be characterised, and hence help determine whether events are occurring with greater frequency/intensity within a year?
3. Do extreme events naturally occur at random or do they exhibit temporal clustering, possibly in relation to seasonality or other patterns?
4. How are extreme rainfall events affected by large-scale climatic patterns (e.g. North Atlantic Oscillation, Scandinavian Pattern) or by local climatic variables (e.g. sea level pressure, temperature)?