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Title: Joint estimation of extreme precipitation aggregates at different spatial scales through mixture modelling and conditional methods

Abstract:
River flooding is not typically caused by extreme rainfall at a single location in space, rather it is caused by extreme values of precipitation aggregates, e.g., total volume of rain that falls with a spatial region. Parsimonious and effective models for the extremes of precipitation aggregates that can capture their joint behaviour at different spatial resolutions must be built with knowledge of the underlying spatial process. Extreme precipitation is driven by a mixture of processes acting at different scales and intensities, and the specific process that drives the extremal behaviour of the aggregate will be dependent on the aggregate resolution; whilst high-intensity, spatially-localised convective events cause extreme high-resolution spatial aggregates, the contribution of low-intensity, large-scale fronts is likely to increase with the scale of the aggregate. Thus, to jointly model low- and high-resolution spatial aggregates, we require a model that can capture both convective and frontal events. We propose a framework for modelling extreme precipitation using conditional methods and model the underlying spatial process as a mixture of two components with different marginal and dependence models that are able to capture the extremal behaviour of convective and frontal rainfall. Simulation from our mixture model leads to improved joint inference on extremes of spatial aggregates over multiple regions of different sizes. Labelling observations from mixture components is conducted deterministically, and this and our modelling approach are applied to fine-scale, high-dimensional gridded UK hourly precipitation data.