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Spatiotemporal estimation of rainfall using sequential Gaussian simulation

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Rainfall is typically estimated at unsampled locations using information in either the spatial domain, or in the temporal domain. To estimate rainfall at several locations simultaneously within a region, the former is usually preferred. The simulation method presented here utilises information in the space and time domain to estimate monthly rainfall grids for the United Kingdom over a period of 8 years. Observed rainfall time series were regarded as the sum of a deterministic temporal trend and a stochastic residual component. The parameters of the temporal trend components established at the rain gauges were interpolated in space, accounting for their auto- and cross-correlation, as well as for relationships with ancillary spatial variables. Stochastic simulation was then employed to generate alternative realizations of the spatiotemporal residual component, which were added to the deterministic one to yield realizations of rainfall (after distributional corrections). In total, 40 simulations of rainfall were generated for each month. The simulation approach is fundamentally different to deterministic interpolation as it priorities global statistics, such as the histogram and the spatial dependence structure, over local accuracy. Particularly in situations when the rainfall is under-sampled, the simulation approach provides a useful alternative to deterministic interpolation, as it does not rely heavily on local samples and gives a population of estimates at each grid cell location that can be queried with respect to its distribution properties and used to visualise spatial uncertainty.