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A stochastic rainfall model for the assessment of regional water resource systems under changed climatic condition

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Abstract. A stochastic model is developed for the synthesis of daily precipitation using conditioning by weather types. Daily precipitation statistics at multiple sites within the region of Yorkshire, UK, are linked to objective Lamb weather types (LWTs) and used to split the region into three distinct precipitation sub-regions. Using a variance minimisation criterion, the 27 LWTs are clustered into three physically realistic groups or 'states'. A semi-Markov chain model is used to synthesise long sequences of weather states, maintaining the observed persistence and transition probabilities. The Neyman-Scott Rectangular Pulses (NSRP) model is then fitted for each weather state, using a defined summer and winter period. The combined model reproduces key aspects of the historic precipitation regime at temporal resolutions down to the hourly level.
Long synthetic precipitation series are useful in the sensitivity analysis of water resource systems under current and changed climatic conditions. This methodology enables investigation of the impact of variations in weather type persistence or frequency. In addition, rainfall model statistics can be altered to simulate instances of increased intensity or proportion of dry days for example, for individual weather groups. The input of such data into a water resource model, simulating potential atmospheric circulation changes, will provide a valuable tool for future planning of water resource systems. The ability of the model to operate at an hourly level also allows its use in a wider range of hydrological impact studies, e.g. variations in river flows, flood risk estimation etc.

Keywords: water resources; climate change; impacts; stochastic rainfall model; Lamb weather types

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