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Continuous rainfall simulation: A regionalised non-parametric approach

Seth Westra, Ashish Sharma, and Rajeshwar Mehrotra
Water Research Centre, Univeristy of New South Wales, Sydney, Australia (s.westra@unsw.edu.au / +61 2 9385 6139)

This paper presents a framework for the semi-parametric simulation of rainfall at multiple timescales from sub-hourly through to annual and longer, at both gauged and ungauged locations. The continuous simulation algorithm includes a modified Markov model to simulate daily rainfall occurrences, using both previous-day rainfall to account for day-to-day dependence and aggregate prior (e.g. 365-day) rainfall to account for low-frequency persistence, with daily rainfall amounts simulated using a kernel density estimate of the true precipitation distribution. Sub-daily rainfall sequences are obtained through disaggregation, using a conditional method of fragments logic in which the fragments are obtained from the observational record conditional to the daily rainfall amount, and the previous- and next-day wetness states.

This model has been regionalised to any location, regardless of the availability of either daily or sub-daily rainfall records at the location of interest, by substituting information from nearby rain gauges. To enable the substitution of sub-daily rainfall at nearby locations, it is necessary to identify locations with 'similar' daily to sub-daily scaling characteristics. We use a two-sample, two-dimensional Kolmogorov-Smirnov test to identify whether the daily to sub-daily scaling at any of 232 gauged locations considered in our study are statistically similar, followed by a logistic regression to determine the influence of the covariates of latitude, longitude, elevation and distance to coast on the probability that the daily to sub-daily scaling at any two stations will be similar.

The model is tested at five locations in different climate zones around Australia where recorded daily and sub-daily data is available for model evaluation, and results indicate good model performance across a range of metrics, including in preserving the probability distribution of extremes and the antecedent moisture prior to the storm event as would be required for applications in flood estimation.