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## A non-parametric hidden Markov model for climate state identification

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**Abstract.** Hidden Markov models (HMMs) can allow for the varying wet and dry cycles in the climate without the need to simulate supplementary climate variables. The fitting of a parametric HMM relies upon assumptions for the state conditional distributions. It is shown that inappropriate assumptions about state conditional distributions can lead to biased estimates of state transition probabilities. An alternative non-parametric model with a hidden state structure that overcomes this problem is described. It is shown that a two-state non-parametric model produces accurate estimates of both transition probabilities and the state conditional distributions. The non-parametric model can be used directly or as a technique for identifying appropriate state conditional distributions to apply when fitting a parametric HMM. The non-parametric model is fitted to data from ten rainfall stations and four streamflow gauging stations at varying distances inland from the Pacific coast of Australia. Evidence for hydrological persistence, though not mathematical persistence, was identified in both rainfall and streamflow records, with the latter showing hidden states with longer sojourn times. Persistence appears to increase with distance from the coast.

**Keywords:** Hidden Markov models, non-parametric, two-state model, climate states, persistence, probability distributions

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