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High resolution climatology
- towards climate change services

Synoptic climatology of rain from cutoff lows compared to other systems such as cold-frontal systems in fine-scale climate change model projections

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Evaluation and analysis of synoptic climatology is useful for quantifying the uncertainties in the simulation of rainfall processes by climate models, and then to determine the drivers behind projected changes to rainfall. The frequency of different rain-bearing system types was examined in fine-scale dynamically downscaled global climate model (GCM) simulations using software that automates expert knowledge of these phenomena. The incidence and rain produced by these systems in the downscaled GCMs is evaluated in comparison to NCEP reanalysis datasets, and changes in these types and the rain they bring is examined over the 21st century.

The study site is Tasmania, the island in southeast Australia. Tasmania has a temperate maritime climate and complex rainfall distribution and variability across its small area. A complex suite of large-scale remote drivers influences rainfall variability in Tasmania, and these vary with location and season. These drivers affect the rainfall in any location through a change in the frequency or nature of the dominant synoptic systems. Rain bearing systems relevant to Tasmania can be placed into three categories: cutoff lows, cold frontal systems and other. Cutoff lows are significantly associated with blocking in the region, and are an especially important source of rain to the northeast of Tasmania. Onshore cold frontal systems contribute a large proportion of the >3000 mm annual rainfall over the western district of Tasmania. The 'other' category includes those systems within pre- and postfrontal airstreams. An automated analysis package, 'synview', has been developed by CAWCR to detect and attribute cutoff systems from other types in reanalysis or model data. The synview algorithms are a synthesis of knowledge gained from considerable manual analysis.

The synoptic climatology was evaluated in a set of six fine-scale ($\sim$10 km grid) dynamically downscaled GCM projections of Tasmanian climate to 2100. These simulations are run at a finer spatial scale than coarse scale GCMs, and therefore improve the resolution of cutoff lows. These fine-scale simulations also show an improved rainfall distribution through a more finely resolved topography and land-ocean boundary. However, we outline limitations of the simulations to reproduce the synoptic climatology of the recent climate when assessed against reanalysis. We conclude that fine-scale dynamical downscaling better accounts for synoptic climatology over Tasmania than coarse scale GCM simulations, but there are still notable limitations. We advocate that an explicit check of the synoptic climatology in model simulations provides useful information about the errors and uncertainties involved in climate modelling. We also find that an analysis of changes to the synoptic climatology in model simulations can help identify the drivers behind changes to rainfall and better inform the use of model projections.