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Assessing trends in rainfall and its remote drivers in climate change projections: the difficult test case of Tasmania

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Tasmania is a challenging and rigorous test case for studies attempting to understand and project changes to rainfall. Tasmania is the island to the southeast of Australia, positioned in the roaring 40s of the Southern Ocean with a temperate maritime climate. Tasmania is topographically complex featuring rugged mountain ranges, a high plateau and lowland plains. Tasmanian rainfall distribution and variability is spatially complex, varying from high rainfall (>3000 mm) in a strong seasonal cycle near the west coast, to low rainfall (∼600 mm) with no seasonal cycle on the east coast. A complex suite of large-scale climatic features drives rainfall in Tasmania. The effects of these drivers vary with location and season. Global-scale modelling indicates that Tasmania lies on the boundary between zones of increasing and decreasing rainfall into the future.

We have produced fine-scale (∼10 km) model projections of Tasmanian climate to 2100 that retain global-scale features present in global climate models using a process of dynamical downscaling. We use these model projections to examine changes to rainfall in Tasmania to 2100. Whilst annual rainfall for the whole state shows no marked changes to 2100 in the projections, changes for the regional districts and for the four seasons are much larger. These changes include a steady decrease in rainfall in the highlands, an increase in summer and autumn rain on the east coast and a significant change in the seasonality of rainfall in the west coast region after 2050.

The use of fine-scale dynamical downscaling modelling allows us to examine projected changes at individual districts within the state, and examine the relevant mechanisms involved at all spatial scales. This includes processes at the hemispheric scale relevant to the region, such as dominant pressure patterns, Hadley Circulation, and the Southern Annular Mode (SAM). It also includes processes at the regional scale such as atmospheric blocking, significant synoptic events (such as cutoff lows), and processes at the fine scale such as the effect of topography.

For the case of the west coast, the projected rainfall trends can be linked to the plausible continuation of current trends to the Hadley Circulation, the high phase of SAM and atmospheric blocking that alter the dominant westerly flow. In contrast, changes to rainfall near the east coast are dependent on a change in the frequency and character of low pressure systems in the in the Tasman Sea resulting in a mean low pressure anomaly driving an onshore circulation.