On the drivers of inter-annual and decadal rainfall variability in Queensland, Australia

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Over the past century, Queensland has experienced considerable inter-annual and decadal rainfall variability. While the connection with the El Niño-Southern Oscillation (ENSO) has been extensively studied, the effects of other large-scale climate patterns (e.g., the Southern Annular Mode) and local synoptic variability remain uncertain. Drivers of regional rainfall variations are also poorly understood, but here are shown to be as important as state-wide variations for understanding and predicting Queensland's hydroclimate. Empirical orthogonal teleconnection (EOT) analysis is used to decompose gridded, seasonal-total Queensland rainfall for 1900-2008 into patterns of spatially coherent variability (EOTs). Regressions of EOTs onto atmospheric fields from the 20th Century Reanalysis reveal the drivers of state-wide and regional rainfall anomalies, as well decadal variations in the drivers' strengths. The leading, state-wide EOTs in summer, winter and spring are correlated with ENSO, while the leading autumn pattern is linked to variations in the late-season monsoon. The second and third EOTs describe regional rainfall anomalies associated with local circulation patterns, particularly onshore winds and Tasman Sea blocking; tropical cyclones strongly control summer rainfall in the Cape York Peninsula. The EOTs focused in southeast Queensland show coherent multidecadal variability but are unrelated to large-scale climate drivers, suggesting internal variability in that region's synoptic patterns. Local tropical and extra-tropical circulation patterns are shown to explain as much or more variance in Queensland rainfall than ENSO. Understanding how these local patterns may change in a warmer world will be critical to providing accurate predictions of the impacts of climate change in Queensland.