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A new direction for Antarctic ice cores: reconstructing Pacific decadal variability and Australian drought history from the Law Dome ice core.

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Decadal scale SST oscillations in the Pacific significantly influence rainfall variability and drought risk across and beyond the Pacific region. Understanding long-term decadal SST behavior in the Pacific is necessary to assess past and future climate, particularly drought risk. However, short instrumental records through much of the Pacific region, in particular the South Pacific, make such assessments difficult. A new reconstruction of Pacific decadal variability covering the last millennium has been produced from the Law Dome ice core, a high snow accumulation site in East Antarctica. The Law Dome ice core samples (at sub-annual resolution) a broad mid-latitude swathe of the Indian and South West Pacific region. This region exhibits wind speed and direction anomalies that are coherent with the phase of the Interdecadal Pacific Oscillation (IPO), an index measuring the decadal-scale Pacific SST state. This is the first millennial length IPO reconstruction and is based on the annual accumulation (snowfall) and sub-annual sea salt (wind proxy) records from Law Dome.

To demonstrate the versatility of this new IPO reconstruction, we used it to explore drought history in eastern Australia, a region where drought risk is elevated during IPO positive phases. To do this, we super-imposed the 1000 year IPO reconstruction on a Law Dome proxy for eastern Australian rainfall (previously shown to represent rainfall with high significance during IPO positive phases ($r = 0.406–0.677$, $p < 0.0001–0.01$). Eight 'mega-droughts' (dry periods >5 years duration) were identified over the last millennium. Six mega-droughts occurred between AD 1000-1320 including one 39 y drought (AD 1174–1212). Water resources and infrastructure planning in Australia has been based on very limited statistical certainty around drought risk due to the short ($\sim$100 year) instrumental record and lack of rainfall proxies. This study shows that, similar to SW North America, Australia also experienced mega-droughts during the medieval period. Knowledge of the occurrence, duration and frequency of such mega-droughts will greatly improve drought risk assessment in Australia. Importantly, this new IPO reconstruction will help with assessing climate risk over the longer term in the wider Pacific Basin, particularly in the data-sparse Southern Hemisphere. In addition, the hydrological application of producing an annually dated drought record to calculate long-term drought risk represents a new use of Antarctic ice core records.