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The use of multiple dendrochronological techniques to develop a 200-year drought record for subtropical Southeast Queensland, Australia

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In Australia the majority of tropical and subtropical regions lack any long-term (multi-decadal to centennial scale) instrumental climate records highlighting a need for alternatives such as proxy climate reconstructions. Despite this need, only a limited number of terrestrial proxy sources are available. Tree-rings provide one of the few options for climate reconstructions yet very little dendrochronological investigation has been undertaken as early assessments of tropical Australian species in the 1970s and 1980s indicated most species had short life-spans, poorly preserved timbers, or were compromised by having many ring anomalies. There has also been limited effort into understanding the growth-climate relationships of these trees with only a few studies undertaken targeting specific species that have unfortunately been heavily cleared from the region (eg. *Toona ciliata*). One exception noted in the early species assessment suggested that trees in the *Araucariaceae* family, a common tree family along the tropical Australian east coast, is longer lived than many other species in the region, contains growth rings which are annual in nature, and grows in response to climatic conditions.

Here we describe the results from a stand of *Araucaria cunninghamii* trees located in Lamington National Park, a World Heritage listed rainforest in subtropical Southeast Queensland, Australia (a region known for experiencing extreme hydroclimatic events). Our assessment discovered the presence of false, faint, locally absent, and pinching rings. By combining traditional dendrochronological analysis (eg. crossdating) with more recent techniques such as age validation by bomb-pulse radiocarbon dating and tree-ring density analysis, a robust ring-width chronology from 1805-2014 was developed. Dendrometers installed on four trees at the Lamington site confirmed that tree growth was annual and that moisture sensitivity was driving growth. Further growth-climate analysis indicated that the strongest correlation to the tree-ring chronology was specifically related to drought conditions in the region. The strength of this response was compared to both local and regional spatial areas and to drought indices such as the self-calibrating Palmer Drought Severity Index (scPDSI), the Standardized Precipitation Evaporation Index (SPEI), and the long-term drought conditions shown by the Australian and New Zealand Drought Atlas (ANZDA). The combined analysis led to the development of a 200-year drought reconstruction for the region and demonstrates influences from both the El Niño Southern Oscillation (ENSO) and the Interdecadal Pacific Oscillation (IPO).

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