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Climate patterns in South-east Australia: the Last Interglacial vs the last 2K

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Geologic archives from speleothems give us the opportunity to investigate past climates and their differences and similarities to present and future (projected) climates. We present the analysis of two stalagmites from the Yarrangobilly Caves in the Kosciuszko National Park, Australia, a marginal alpine setting believed to be susceptible to the impacts of global warming.

Stalagmite JC001 grew consistently from ~6500 BP to 2013, and previous work indicated that this speleothem was likely to comprise a palaeo-climate proxy record that accurately reflects local hydroclimate (Campbell et al., 2017). Stalagmite GC001 grew between ~123,525 BP and ~102,000 BP, with a growth hiatus between ~117,000 BP and ~107,000 BP. JC001 was analysed for $\delta^{13}C$, $\delta^{18}O$, and a range of trace elements (Ca, Ba, U, Mg, Sr), while GC001 was analysed for a range of trace elements (Ca, Ba, U, Mg, Sr). The Last Interglacial is of interest as global mean temperatures were ~2˚C warmer than present, and as such it may serve as a useful analogue for future climate change (Capron et al., 2014; McCulloch & Esat, 2000).

Stable isotope analysis (δ18O and δ13C) was conducted by acid digestion using an individual vial acid drop ThemoScientific Kiel IV carbonate device interfaced to ThermoScientific MAT-253 dual-inlet isotope ratio mass spectrometer at the University of California, Santa Cruz, USA and Nanjing University, Nanjing, China. Trace element analysis was undertaken using a Varian 820 – MS ICP and separate laser ablation unit. Ablation was done with a rectangular laser spot (340 μm x 50 μm) and a laser pulse repetition frequency of 10 Hz. Ablation paths were cleaned with the laser prior to analysis. The mass spectrometry was conducted with a dwell time of 50 000 μs.

The wavelet transform was computed to investigate periodicities in the proxy data, and shifts in these periodicities over time. Data were interpolated to ensure regular spacing and were detrended using Loess smoothing (Cleveland et al., 1990).

Both stalagmites show significant periodicity (0.95 significance level) in the order of 4-16 years and ~64 years, although there are periods of inactivity in both. Periodicity of ~60 years is common in the global climate system and is similar to the penta-decadal (50–70 yr) cycle of the Pacific Decadal Oscillation. Results indicate that this signal dominated the south-eastern Australian climate signal during the lead up to the height of the LIG (~120,000 BP), as well as during the last 2K years.

Periodicity of ~4-16 years is similar to that of the El Niño-Southern Oscillation, which has strong correlations with climatic variability in Australia. Results show that ENSO or ENSO-like variability occurred during the LIG, consistent with Hughen et al., 1999 and Kukla et al., 2002, and that this periodicity has consistently occurred during the last 2,000 years. Results indicate that ENSO and PDO-like periodicities are likely to persist as global mean temperature increases due to anthropogenic climate change.