Towards an Australasian climate reconstruction for the past two millennia

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In 1988, the World Meteorological Organization and the United Nations Environment Program established the Intergovernmental Panel on Climate Change (IPCC) to assess our understanding of the scientific basis of risk of climate change and opportunities for adaptation and mitigation. Unfortunately, relatively widespread instrumental measurements only extend back to the mid-19th century. In spite of this, there exists a wealth of indicators of past climate that show that rapid changes have taken place. Annually resolved climate proxies, such as tree rings, corals, lake sediments and historical climate datasets have been major contributors to such studies; typically, past surface temperatures have been inferred by calibrating to instrumental temperature data using statistical relationships.

A suite of global, hemispheric and continent-wide reconstructions have emerged during the last decade (e.g., Mann et al., 1998, 1999; Jones et al., 2001; Cook et al., 2004; Moberg et al., 2005; Hegerl et al., 2006) and were prominently synthesized in the IPCC AR4 (Jansen et al., 2007). Reconstructions generally agree that present-day northern hemisphere temperatures exceed those of the last 2 millennia. On the other hand, they differ considerably in details of climate history and sensitivity.

Although some criticism has been leveled at the reconstructions, the essential results have also recently been supported by a panel of the US National Academy of Sciences (National Research Council, 2006). It was noted, however, that more must be done to reduce uncertainties in periods before 400 years ago and in the southern hemisphere. Furthermore, the NRC report and the IPCC AR4 alike demand regional-scale reconstructions of climate variables other than temperature. Some attempts to increase the representativeness of paleoclimate reconstructions have been made. For instance, the dependence on annually and decadally resolved datasets has not always captured variability on multi-centennial timescales. By combining low- and high-resolution proxies (which capture long- and short-term change, respectively) and using a wavelet transform technique, Moberg et al. (2005) demonstrated relatively large multi-centennial variability. Pollack et al. (2006) also reported a borehole temperature reconstruction for the Australian regions (Fig. 1). Although this shows the same broad pattern observed in the northern hemisphere, the precise timing and detail of change was not possible to resolve with this method.

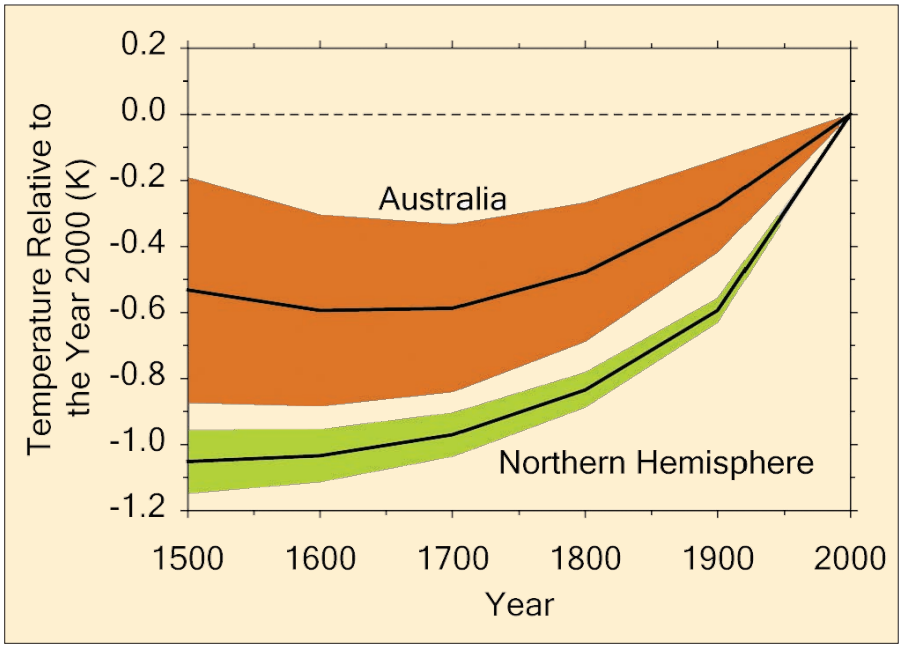

Figure 1: Comparison of Australian borehole temperature reconstruction to northern hemisphere borehole reconstruction (modified from Pollack et al., 2006).

The Australasian region straddles several major atmospheric and oceanic boundaries (many of which are interconnected), which have the potential to be highly sensitive under a variety of future climate change scenarios. These include the Australian Monsoon, the Interdecadal Pacific Oscillation, El Niño-Southern Oscillation (ENSO), and the East Australian Current. In some Australian locations, meteorological records extend back to AD 1840 but are most common only from the beginning of the 20th century (Nicholls et al., 2006). In an attempt to extend the climate record beyond the historical period, we have established a PAGES-endorsed Working Group to develop a reconstruction for the past two millennia in Australia.

20 published datasets have now been identified, including coral calcification, $\delta^{18}O$ and $\delta^{13}C$, tree-ring widths and ice core $\delta^{18}O$. Due to the limited number of sites and their variable length, it has so far proved problematic to integrate the reconstructed temperature series into a robust Australasian average. As an alternative, we are following the approach recently reported by Osborn and Briffa (2006), whereby proxies with positive correlations to temperature are compared to identify hemispheric-scale climate anomalies. Of the 20 datasets, only 10 have proved to have a significant positive correlation with temperature. The results are currently being prepared for publication but suggest that temperatures over Australasia at the end of the 20th century were unusually high compared to the past 550 years. Future work is now focusing on expanding the network of temperature datasets, extending the records further back in time and developing a comprehensive series of quantified moisture-sensitive proxies.

References

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For full references please consult:
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