

4TH AUS2K WORKSHOP REPORT

Australasian palaeoclimate of the last 2000 years: Inter-comparison of climate field reconstruction methodologies, modeling, and data synthesis approaches

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The aim of the 4th Aus2k workshop (27–29 October 2015, held in Auckland) was to review progress made by the PAGES Aus2k working group, and to identify research from the Australasian research community that will contribute to Phase 2 of the PAGES 2k Network. Nineteen palaeoclimatologists from New Zealand and Australia attended the workshop at the National Institute of Water and Atmospheric Research (NIWA) in Auckland. There was an increased representation of lake sediment and speleothem specialists at the meeting, adding to the recent consolidation of non-annually resolved data from Australasia. From the outset, the highly multidisciplinary group generated very insightful and collegial discussions, setting the tone for a highly productive workshop.

Day one of the workshop showcased recent research developments in data synthesis, climate modelling and new record development. Helen McGregor discussed the recent low-resolution sea surface temperature synthesis generated by the PAGES Ocean2k group (McGregor et al., 2015). A composite of 57 records reveals a long-term cooling trend during the pre-industrial Common Era, with climate modelling identifying volcanic eruptions as the

most likely driver. Nerilie Abram presented a PAGES2k Consortium paper currently in revision, examining the onset of Industrial-era warming across the oceans and continents. Warming begins later in the Southern Hemisphere than in the Northern Hemisphere, potentially due to delayed warming in the tropics. Mandy Freund presented a new Australian precipitation field reconstruction spanning the last millennium. This was identified as one of the region's contributions that will go towards the planned global PAGES 2k special issue of *Climate of the Past*.

Hamish McGowan presented a promising 2100-year temperature reconstruction using a speleothem from the Snowy Mountain region of New South Wales, showing that there is good coherence with major hemispheric and global climatic events. Chris Moy linked high-accumulation lake records from southern South America and the NZ sub-Antarctic Auckland Islands to changes in the Southern Hemisphere westerly winds, demonstrating strong millennial-scale variability throughout the Holocene. Ben Henley presented results of an Interdecadal Pacific Oscillation reconstruction spanning the period from 1600 CE to present using a new Tripole Mode

Index (Henley et al., 2015), and considered its possible links to global temperature variations.

Of significance for bridging the gap between proxy data and climate model simulations, Steven Phipps presented preliminary Australasian climate field reconstructions generated by assimilating Southern Hemisphere records into a new 25-member ensemble of CSIRO Mk3L model simulations. Duncan Ackerley presented plans to run a suite of simulations of the last millennium using the Australian Centre for Water and Climate Research's (CAWCR) ACCESS model. He also invited suggestions for new experiments, highlighting growing interest in palaeoclimatology from the broader climate science community in Australia.

The morning session of day two focused on an update on the new Australasian database of low-resolution records, synoptic typing data synthesis techniques being used by the Aus2k group (Lorrey et al., 2013; Browning and Goodwin, 2015). A lively discussion led by Ian Goodwin considered the development of guidelines for future record collection in our sector of the Southern Hemisphere, framed around understanding regional

and hemispheric climate dynamics. Within this session, Bronwyn Dixon described the new Australasian 'low-resolution' database, which includes 536 low-resolution records from Australia and Indonesia. The highest quality records in the database were identified and their age models were recalibrated using BACON. Preliminary results using a Monte Carlo EOF method previously applied to east African data (Anchukaitis and Tierney, 2012) were also presented. Stuart Browning gave an extremely thought-provoking presentation on a new 1000-year climate reanalysis called 'PalaeoR'. This product was generated using a novel data assimilation technique and has been made freely available to the research community (<http://climatefutures.mq.edu.au/research/themes/marine/paleor/>). The follow-on presentation by Drew Lorrey showcased the NIWA Past Interpretation of Climate Tool (PICT; <http://pict.niwa.co.nz>), which applies modern analogues to understand past circulation changes using collections of proxy data. Initially developed for New Zealand, the tool is now being expanded to include other regions and a wider range of climatic variables.

The afternoon session of day two focused on an update of progress developing lake sediment records from Lake Ohau in New Zealand by Marcus Vandergoes. The Southern Annular Mode has a strong influence on rainfall in the lake catchment, giving the potential to develop a record of changes in Southern Hemisphere circulation spanning the past 17,000 years. Krystyna Saunders presented an update on the application of high-resolution hyper-spectral scanning techniques to Rebecca Lagoon in Tasmania. She has generated the first high-resolution, quantitative reconstruction of Tasmanian rainfall



Figure 1: Members of the Aus2k group visiting the Cascades Kauri Park, Auckland, New Zealand. (Photo credit: Drew Lorrey)

to be based on lake records, with the reconstruction identifying the start of the 19th century as being one of the driest periods of the last 2,000 years. There was also an interactive group poster session that highlighted progress on the climatic interpretation of Western Australian speleothem records from Pauline Treble; a new borehole temperature reconstruction for eastern Australia by Suman Asadusjjaman, only the third attempted for the Australian continent; an array of sedimentary charcoal records from the Pacific Island region spanning the western Solomon Islands to western Polynesia by Matthew Prebble; and a new high-resolution Southern Hemisphere westerly wind reconstruction using sub-Antarctic lake sediments being developed by Krystyna Saunders.

Day three was primarily focused on extensive discussion of the development of regional 'best practice' standards for proxy metadata reporting to be compatible with the LiPD framework (McKay and Emile-Geay, 2015). The group watched a pre-recorded presentation on LiPD given by Julien Emile-Geay, then discussed examples in the literature for existing geochronology protocols and ideas for new record collection. Drew Lorrey agreed to coordinate the further development of a metadata template that will form the basis of a journal article on this critical topic, with the intention that it will assist the next generation of palaeoscientists in reporting and collecting material from our region. The group also discussed a group contribution in assessing different data-model assimilation methods being employed in the Aus2k region and how they can inform future palaeoclimate record collection, with Ian Goodwin volunteering to lead this project.

The workshop wrapped up by identifying two contributions on regional hydroclimate synthesis papers, led by Early Career Researchers Mandy Freund and Bronwyn Dixon, for the planned PAGES 2k network-wide special issue of *Climate of the Past*. The group also generated a proposed table of contents for a regional special issue of the same journal to showcase the diversity of new research being developed by the Aus2k community. The proposed submission timeframe is expected to span around September 2016 to March 2017. Please contact a member of the steering committee if you are interested in contributing your research as part of the group's legacy to the 2k network.

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Duncan Ackerley, Monash University; Suman Asadusjjaman, University of Canberra; Stuart Browning, Macquarie University; Bronwyn Dixon, University of Melbourne; Mandy Freund, University of Melbourne; Ian Goodwin, Macquarie University; Hamish McGowan, University of Queensland; Helen McGregor, University of Wollongong; Chris Moy, University of Otago; Matthew Prebble, Australia National University; Pauline Treble, Australian Nuclear Science and Technology Organisation (ANSTO); and Marcus Vandergoes, GNS Science.

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