tion, image analysis). It was also suggested to implement a website (to be hosted on the PAGES website) with a metadatabase of existing varved records and a database of images of varves.

Key topics to be addressed at future workshops were also discussed. The next workshop will focus on bridging the gap with other communities that deal with the study of archives of past climate with annual resolution, i.e., ice cores, tree rings, corals, and speleothems. Additionally, models and data assimilation communities will be included. This workshop will be held in the USA (exact place and time to be announced). A third and potentially fourth workshop will focus on establishing standards of best practice for the study of varved sediments, and on specific thematic themes such as events, climate variability, calibration and intersite comparisons.

Anybody interested in varves studies and the VWG can register and contribute to activities by contacting the first author.

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The 1st Australasia 2k regional workshop: Towards data synthesis

Melbourne, Australia, 31 May–2 June 2010

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Australasia spans from the tropics to the sub-Antarctic, and straddles several major oceanographic and atmospheric systems that are of global significance and potentially sensitive to anthropogenic-driven climate change. For instance, northern Australasia is influenced by the Indo–Pacific Warm Pool (Hansen et al., 2006), which is a major source of latent heat and hence drives global atmospheric and oceanic circulation. Towards higher latitudes, the Southern Ocean (south of 45˚S) plays a key role in global climate (Caldeira and Duffy, 2000). Although considerable progress has been made in developing quantitative reconstructions of temperature change for the Northern Hemisphere over the past two millennia (Mann et al., 2009), significantly more work is required in Australasia (and the Southern Hemisphere as a whole) (Nicholls et al., 2006).

The first Australasia 2k (Aus2k) regional network workshop aimed to fill this critical gap in climate science by reviewing annually- to centennially-resolved climate reconstructions for Australasia for the past 2 ka, towards synthesis in the planned PAGES Regional 2k Network synthesis book. 73 scientists from around the world, representing the proxy, modeling and dynamics communities, met to present the latest datasets and interpretations from across the region.

The first day focused on short presentations and posters of single proxies from the full range of natural archives spanning ice, marine and terrestrial records of the past 2 ka. Not surprisingly, tree rings underpin the terrestrial annual resolution record for Australasia (Antarctic ice is great for teleconnections (Fig. 1) but not local variability). However, the majority of well-replicated records are less than 500 years and only Tasmania and NZ have records extending for the full 2 ka (i.e., a classic "fading record problem"). A surprise was the number of "new" species used in tree-ring reconstructions being developed from throughout the region—vital for understanding geographic variability. A good example is the Western Australian

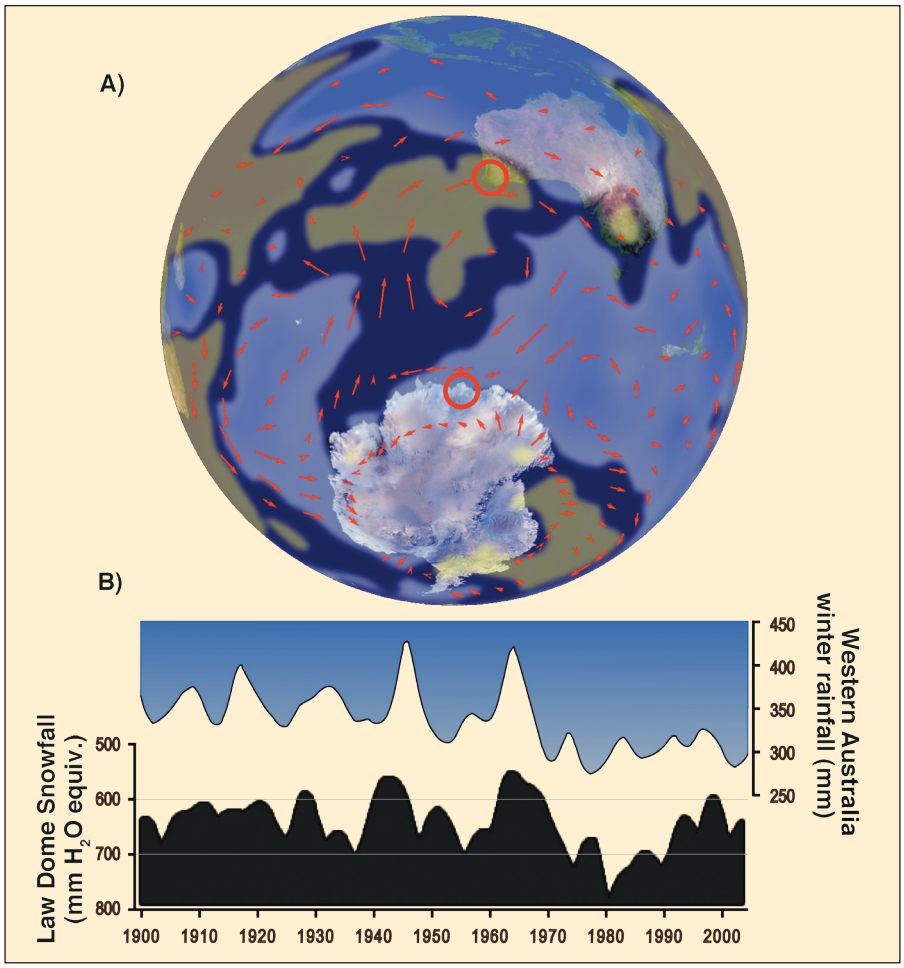

*Figure 1: **A**) Atmospheric water vapor and wind anomalies for years with high precipitation at Law Dome. Blue regions show wet anomalies; tan regions show dry anomalies, which can be seen to extend across southwest Western Australia (SWWA) (Data from NCEP/NCAR reanalysis) (Credit: Tas van Ommen). **B**) Comparison of SWWA winter rainfall (blue) and Law Dome snowfall (black) since the beginning of reliable rainfall data for WA. The two regions are connected via large-scale meridional flow (van Ommen and Morgan, 2010). The positive precipitation anomaly at Law Dome over the past four decades, corresponding to extended drought in SWWA, is the largest such anomaly in 750 years of snowfall data (Credit: Tas van Ommen/Mat Oakes, Australian Antarctic Division).*

rainfall reconstruction from *Callitris* tree-rings. After the presentations, there was an open discussion of common themes and the challenges facing the groups working in the region. Key issues raised during this session included the strategic sampling of key lake sequences before they are lost to the current drought in Australia, proposed development of sub-regional reconstructions, determining the stability of teleconnections over time, clarifying the seasonality of the signal preserved within different proxies, the challenge of calibration against contemporary climate given recent land use changes, and the extension of records both forwards and backwards in time. Furthermore, several presentations reported asynchronous temporal and spatial temperature and precipitation trends when compared to those in the Northern Hemisphere over much of the past 2 ka, raising the question of whether the use of such terms as the "Medieval Warm Period/Anomaly" and the "Little Ice Age" are appropriate when referring to the Australasian region. Further work is needed to gain a consensus on this issue. Presentations also highlighted that more effort is needed to develop proxies from this region if we are to get good enough resolution to comment on the past millennium with adequate spatial coverage.

On the second day, presentations and posters focusing on multiproxy reconstructions and modeling work across the region were given and their policy relevance discussed. A broader discussion then took place on how the data might be most effectively collected. After exploring a range of options, it was agreed that the community would collate only published (or directly publishable) data (using both raw and quantified analyses) from each of the different archives, with a full estimate of the uncertainties included and an agreement that objective criteria for the final selection of records must be developed prior to the generation of final reconstructions (in consultation with other regional 2k groups). Qualitative, lower resolution data will also be utilized as an independent check on reconstructed high resolution variability. On the third day, these issues were explored in greater detail and individuals were identified who would lead the collection of data from each proxy group by mid April 2011.

As a starting point, the group was encouraged to develop an Aus2k metadatabase hosted on the PAGES Aus2k website (http://www.pages.unibe.ch/science/2k/aus2k/index.html), to develop an inventory of records that are currently available and/or being actively developed in the Australasian region. Following the meeting, a small-scale proposal was submitted to the Australian Government to fund a research fellow, who will develop a quantitative database of the records listed on the website. This will allow all members of Aus2k to access the database and develop the suite of climate reconstructions needed for the region. Qualitative, lower resolution data will also be utilized as an independent check on reconstructed high resolution variability (Fig 1).

The second Aus2k workshop will be hosted by Pauline Grierson and take place in the first half of 2011 (most likely in Perth). This workshop will focus on combining the collated datasets to generate reconstructions of different climate variables for the Australasian region and identify future reconstruction needs to capture the full 2k period.

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The nitrogen cycle in the ocean, past and present

1st NICOPP Workshop, Montreal, Canada, 14-16 May 2010

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Some three decades after the first measurements of nitrogen isotopes ($\delta^{15}N$) were made in the marine environment, 27 nitrogen enthusiasts from nine nations congregated on the verdant flanks of Mount Royal, in Montreal. This meeting represented the first for the PAGES Working Group "Nitrogen cycle in the ocean, past and present" (NICOPP). Over three days, this group discussed recent findings, summarized the state of knowledge, and highlighted outstanding challenges related to the use of sedimentary $\delta^{15}N$ as a tracer of the marine nitrogen cycle. From a series of stimulating talks and enthusiastic discussions, three overarching topics emerged.

Seeing the big picture

While some areas of the ocean are dominated by either water column denitrification, nitrate utilization, or N_2 fixation (Fig. 1), overlap between these processes can produce complex spatial patterns in nitrogen isotopes, apparent in simulations with coupled ocean-biogeochemistry models. As a result, isolated sediment records can be deceiving, as any one is likely to be a time-varying amalgam of all three processes. However, when assembled, records show coherent changes over time even in complex regions, with clear relationships to their oceanographic contexts, allowing the multiple processes to be disentangled. Accordingly, it was resolved by the NICOPP Working Group to amass a global database of all available bulk sediment N isotope measurements, to help move beyond the ambiguity of isolated wiggly lines.

The devil's in the details

There has been considerable concern, over the decades, regarding just what N isotopes in marine sediments represent. The hopeful interpretation is that bulk combustible nitrogen, an easily measured quantity, represents the isotopic composition of the integrated marine organic export flux. However, isotopic alteration during sinking and burial, and contributions from terrestrial nitrogen, have been shown to modify the bulk isotope record in some environments. To account for these secondary influences, measurements are being made in a growing number of sedimentary fractions and specific compounds. These include the organic nitrogen trapped within microfossils, corals, chlorophyll and amino acids, as well as inorganic nitrogen. The results, so far, reveal new dimensions of complexity, as these individual components can vary with species assemblages, growth conditions, and trophic structures; yet, they often parallel