

Past Climates Meeting, Symposium and Australasian-INTIMATE workshop 15th-17th May 2009 Te Papa

The meeting was divided into one day Symposium of keynote addresses and public lectures and two days of workshops, including an Australasian-INTIMATE meeting.

Past Climates Symposium: 15 May, 2009

The Past Climates Symposium brought together world leading researchers in modern and past climate change, and the public at New Zealand's National Museum, Te Papa Tongarewa. Lectures presented by invited international and local speakers, were centred on our understanding of past climates in New Zealand, Australia and Antarctica, the causes and effects of climate change in the Southern Hemisphere and the relationships with global climate change.

The keynote lecture, presented by Chris Turney, provided an overview of the history and importance of understanding past climate and its relevance to modern climate change. This was followed by a well illustrated presentation by Peter Huybers on the variability of solar insolation and the degree of synchronicity/asynchronicity in climate change signatures expected at different latitudes and between the hemispheres as a result of changes in obliquity and precession orbital parameters.

These talks provided the general framework for the subsequent talks by Nancy Bertler on ice records from Antarctica, Lionel Carter and Tim Barrows on marine records from the South Pacific and Southern Ocean, terrestrial records by Matt McGlone on pollen from the subantarctic islands, and Anthony Fowler on kauri tree ring records from northern New Zealand.

Wally Broecker completed the session with discussion of the prospect of changes in rainfall patterns across a warmer world by comparing paleo-lake records from temperate regions of northern and southern America.

The symposium culminated in the Antarctic Research Centres (Victoria University of Wellington) annual S.T. Lee Lecture in Antarctic studies presented by George Denton. His talk, entitled *Antarctica and the Ice Age Puzzle*, focussed on the role of Antarctica and the Southern Ocean in recent global ice ages, particularly the last glacial termination and the switch from a glacial climate to the interglacial conditions of today. The discussion, including evidence from southern New Zealand and South America, solidified the idea that determining the origin of this warming event lies at the heart of solving the ice age puzzle.

The one day symposium incorporated the Ice-core, MARine and TERrestrial themes of the INTIMATE program and was well attended by approximately 180 delegates including scientists, students, public and media representatives, whose field of interest was not necessarily related to paleoclimate research. The presentations provided an overview of our current knowledge of past climate change in the Southern Hemisphere. The symposium also set the scene for the following two day INTIMATE workshop which provided a more in-depth view on paleoclimate research. A discussion session, chaired by Professor Peter Barrett, offered opportunity to ask outstanding questions to the speakers, including identifying what in their opinions were the most important insights paleoclimate research had provided for understanding future climate change and what directions were needed in the future. Lionel Carter used a contraction of a Donald Rumsfeld quote to sum up the symposium and encapsulate future directions **“there are known knowns, there are known unknowns, but there are also unknown unknowns”**. His suggestion was that the paleoclimate community can only work on the known unknowns and hope that the unknown unknowns are not as important.

The entire day of talks, including George Denton's well attended public lecture (approximately 300 people), were filmed and are available for viewing at <http://www.paleoclimate.org.nz/pastclimates/>.

Past Climates Australasian-INTIMATE Workshop: 16-17th May, 2009

At the two-day workshop scientists from New Zealand, Australia, USA, Canada, France, UK, and South America presented and discussed the latest research on the mechanisms and drivers of late Quaternary climate change in Australasia and the Southern Hemisphere. The general themes that provided the framework for the workshops and discussions included

- Last glaciation and termination- abrupt climate change
- Interconnections, Southern Hemisphere comparisons
- Geochronology
- Drivers and climates of the Southern Hemisphere

Glacial geology-geomorphology, geochronology and modelling were major foci of the research presented and reflected the large amount of data resulting from recent research initiatives carried out in Southern New Zealand, Antarctica and South America. Presentations by David Barrell and Joerg Schaefer highlighted the results of New Zealand and international collaborations for constructing detailed geomorphological maps of glacial moraines in the central South Island of New Zealand. The maps provide the basis for comprehensive Last Glacial Maximum (LGM) and Holocene moraine chronologies constructed using ¹⁰Be cosmogenic exposure age dating, which will provide a benchmark for Southern hemisphere comparisons. Reduced error and improved consistency of the ¹⁰Be ages were discussed by Bob Finkel, while a poster by Aaron Putnam outlined the improvement of ¹⁰Be age estimates through the use a refined production rate calculation derived from a well dated New Zealand calibration site. This extensive set of new moraine ages and maps, combined with data on snowline changes, provide excellent ground truthing for glacial modelling work on New Zealand's Southern Alps being undertaken by Andrew Mackintosh and Brian Anderson at Victoria University of Wellington. Additionally, David Fink provided ¹⁰Be and ²⁶Al cosmogenic ages for moraine chronologies in Te Anau, Southern New Zealand and proposed strong links with the timing of change in $\delta^{18}\text{O}$ variability in Antarctic Ice core records. Brenda Hall presented a ¹⁰Be exposure age chronology of changes in the size of the West Antarctic Ice Sheet (WAIS) in the Ross Sea region during the LGM and Holocene. The results suggest that major changes in thickness and rapid retreat occurred in the early Holocene and that these changes are too late to contribute to any global meltwater pulses in the early deglaciation. Other talks by Jamie Shulmeister and Tim Davies discussed the potential of non climatic drivers in glacial systems and the relevance that these mechanisms (e.g., ice collapse and retreat in pro-glacial lake systems, and landslide-driven glacial advances) may have in influencing the historical record.

Related presentations discussed the glacier modelling view on drivers of climate change. Alexandra Giese focused on models using orbital parameters and greenhouse gases to drive changes in the Equilibrium Line Altitude (ELA) of mountain glaciers and suggested that change could not be driven by orbital parameters alone, but rather that greenhouse gases are the dominant driver of both the magnitude of ELA change and its global distribution. Andrew Mackintosh provided a summary of New Zealand glacier modelling experiments used to rank the climate variables that cause glacier fluctuations and quantifying late Quaternary climate change. Glacier sensitivity experiments, validated against modern snowline data indicate that temperature has a larger effect on glacier mass balance than precipitation. Incoming short wave radiation and local insolation are important in glacier energy balance but have not varied sufficiently to cause insolation-forced temperature change and glacier advance (beyond a few km) during the late Quaternary. Supporting posters and maps from these research areas provided a large contribution to the workshop.

One of the ultimate aims of INTIMATE is to correlate Southern and Northern Hemisphere paleoclimate data and address inter-hemispheric teleconnections and lead/lag relationships in the climate system. John Hellstrom addressed this issue using montane speleothem records from New Zealand and Italy. Records show that changes in southern $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ signals preceded those in the north and provide evidence against the classical 65°N

summer insolation forcing of global glaciations and possibly a stronger role of the Southern Hemisphere. Paul Williams presented additional speleothem records of western New Zealand and identified that these records have distinct Southern Hemisphere paleoclimate signatures and that many climate events are offset or of greater magnitude than their Northern Hemisphere counterparts.

A range of talks were presented on research from Australasia and the Southern Ocean under the themes Southern Hemisphere comparisons and abrupt climate change. Speleothem, alluvial and lake sedimentary records discussed by Mark Quigley, Lynda Petherick and Raphael Wust provide detailed histories of late Quaternary rainfall change with wet periods identified during the deglaciation and Holocene allowing insights into variations in the summer monsoon, the source of precipitation and shifting of the Intertropical Convergence Zone (ITCZ), and ENSO activity. Gerald Nanson and Tim Cohen discussed Australia's hydrological history derived from lake shoreline, fluvial and alluvial records. Marked differences in past water levels between these records from 50 and 90 ka and through to the Holocene provide important background for understanding human arrival on the continent and the resulting demise of the Australian megafauna.

A number of talks focussed on ocean and atmosphere relationships. Advances in geochemical fingerprinting of airborne dust sources from Australia were presented by Patrick De Deckker. Dust forecast modelling showed that Australian dust is being transported to New Zealand, Antarctica and Patagonia and can be identified in marine and ice cores. Future research will offer key insights into past atmospheric circulation in the southern mid to high latitudes. Hinrich Schaefer outlined research into the role of the Southern Ocean in varying CO₂ exchange between the ocean and the atmosphere. Analysis of δ¹³C from a high resolution ice core at Berkner Island, Antarctica suggests that the carbon source is predominantly marine, thus identifying the key role of Southern Ocean ventilation and shifts in the westerly wind belts in CO₂ exchange.

Additional presentations addressed signals of seasonality in paleoclimate records. Liz Sikes investigated marine alkenones and foraminifera Mg/Ca paleo-temperature data from an eastern New Zealand sediment core, and provided evidence for increased seasonality during the Last Glacial Maximum (LGM) and Antarctic Cold Reversal (ACR). Chironomid data presented by Les Cwynar from Tasmanian lake records also provided evidence of summer temperature changes during the deglaciation. In these records there is no marked signal of an ACR temperature change but differences between the chironomid and pollen temperature reconstructions are considered indicative of seasonal variations and higher spring temperatures.

Advances in ¹⁴C chronology and age model analytical techniques were also a key theme of the workshop. David Lowe presented an overview of the Bayesian analytical technique Bpeat. He outlined the application of this analysis to construct robust age models and refine key marker horizons such as tephras from highly resolved ¹⁴C chronologies. Considerable effort has also recently been invested to improve the radiocarbon calibration dataset. Presentations by Alan Hogg and Quan Hua on the radiocarbon dating of over 250 samples from kauri and huon pine outlined significant improvements to the ¹⁴C calibration curve, particularly in determining the detail of offset for the Southern Hemisphere radiocarbon curve and bridging the gap in the INTCAL04 calibration data during Younger Dryas time.

A second public lecture presented by Wally Broecker on the evening of May 16th was well attended by 140 people. The talk entitled “**What should we do with fossil fuel CO₂?**” provided considerable food for thought about using technology to reduce the ever rising levels of CO₂ in the atmosphere and then either sequestration by burying the CO₂ in the ground or in the deep oceans or reacting it with MgCO₃. He ended the lecture by commenting that the next 50 years will be interesting for global warming research and that “it is going to be an interesting time to see how our experiment in global warming pans out”.

The symposium and public lectures generated a high level of public and media interest. Several radio interviews (George Denton and Wally Broecker) and a newspaper article (Wally Broecker) can be accessed at.

http://www.nzherald.co.nz/environment/news/article.cfm?c_id=39&objectid=10572877

George Denton Radio NZ interview

<http://www.radionz.co.nz/national/programmes/ourchangingworld/20090507>

Wally Broecker Radio NZ interview

<http://www.radionz.co.nz/national/programmes/ourchangingworld/20090528>

Australasian INTIMATE discussion

Peter Almond, co-convenor of Australasian INTIMATE began discussion by providing a historical summary of the project since its inception in 2004. He outlined its initial goals and successes including, posters and publications of a New Zealand based Climate Event Stratigraphy (CES) from 30-8 ka using high resolution and fragmentary records; a major review of New Zealand tephrochronology 30-8 ka; and efforts to provide a synthesis CES across Australia.

A major focus of the discussion was to outline directions for the future (Australasian INTIMATE Phase 2). Key goals were to encourage the Australian paleoclimate community to develop a more refined CES and link the Australasian paleoclimate data to existing climate modelling initiatives and international focus groups. One approach identified to link paleo data to climate modelling is the use of regional climate regime classification to reconstruct climate modes for past time slices. This approach enables comparison with modern synoptic climate patterns and modelled scenarios. The methodology will be applied initially to New Zealand proxy climate data and, based on a subdivision of New Zealand into six climate zones, will reconstruct regional climate variability and likely synoptic patterns for key time slices between 30-8 ka.

The application of the approach to broader Australasian based reconstructions was outlined by Andrew Lorrey (co-convenor of AUS-INTIMATE) as one way paleoenvironmental chronologies from New Zealand and Australia could be integrated. Lorrey reiterated that previously, proxies have either been interpreted in a local, regional or global context, and in many cases, individual proxies have been directly compared with reference to specific events or changes. However, little work has been undertaken to exploit in-phase or contrasting signals for Australia and New Zealand archives to reconstruct past South Pacific, trans-Tasman, or Australasian circulation modes. Many patterns observed in palaeo data are reminiscent of (but not exclusive to) what occurs during different ENSO modes, IPO, or ENSO interacting with the SAM. These patterns can be linked via climatological studies to synoptic type frequency changes and larger scale adjustments in hemispheric-scale circulation characteristics. The unique changes and their known precipitation and temperature outcomes for New Zealand and Australia means the set of possible circulation anomalies for the entire Tasman sector for any given time slice can potentially be narrowed down by corroborating New Zealand and Australian palaeoclimate patterns.

These directions along with ideas discussed to develop a refined Australian CES were endorsed by the attending Australasian delegates to be presented to other members of the Australian community at the 7th International Conference of the International Association of Geomorphologists in Melbourne 2009.

The attendance of Jorge Strelin, University of Cordoba, Argentina, provided the opportunity to discuss comparable research initiatives currently being undertaken in South America and build relationships to further facilitate the initiation of a South American INTIMATE group. Australian researchers Jessica Reeves and Tim Cohen were invited with the aim of expanding the Australian INTIMATE convenors group and have now undertaken new roles as co-convenors. We thank INQUA and ANSTO for the financial support for Jorge's, Jessica's and Tim's attendance.

Summary

A range of new data and advances in understanding existing data were presented at the meeting. There were many correlations and overlaps between datasets and new ideas about the variability in seasonality during the last glacial and glacial transition in the Southern Hemisphere. It was also evident that there have been significant improvements in geochronology, with a New Zealand calibration site for ^{10}Be exposure dating and radiocarbon calibration, along with new statistical age modelling techniques.

The detailed mapping and extensive dating of glacial moraines in the South Island certainly dominated the Past Climates workshop. This will provide an important data set to physically model glacier advances and retreats and test hypotheses about their behaviour. Significant advances have also been made in mapping and dating the shorelines of Australia's inland mega lakes and determining the hydrological history since the last interglacial, and the monsoon and ENSO influence on the tropical and subtropical climate of Australia. There were few presentations on marine or ice core records at the meeting, probably a reflection of the comparably lower numbers of researchers currently working in this field in Australia and New Zealand

Thanks to all the international researchers who travelled to the symposium and workshop, especially Professors George Denton and Wally Broecker, and our Australian colleagues who we hope to collaborate with more in the near future. Final thanks to the sponsors GNS Science, the Comer Science and Education Foundation, Victoria University of Wellington, Lincoln University, ANSTO and INQUA, who helped to fund the meeting and make it possible for people to attend.

Report contributors.

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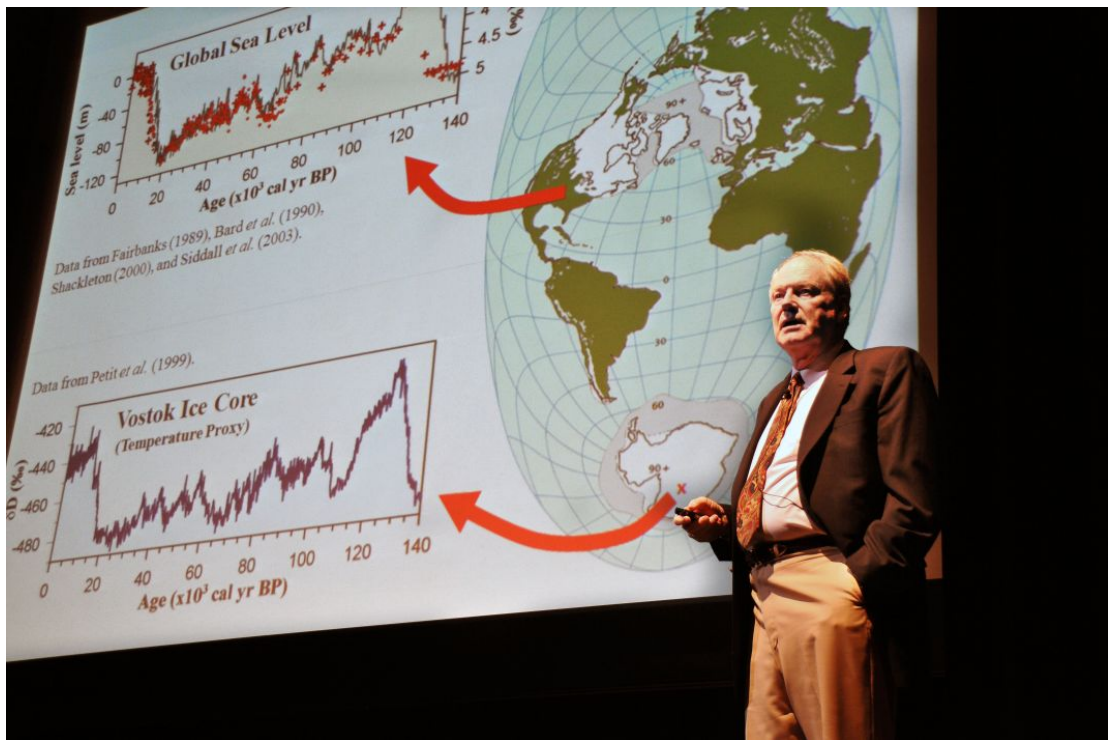
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Conference participants, May 17th. Photo J. Simes



Professor George Denton presenting the annual S. T. Lee Lecture in Antarctic Studies.
Photo M. Low, GNS.