Australasian Quaternary Association Inc.

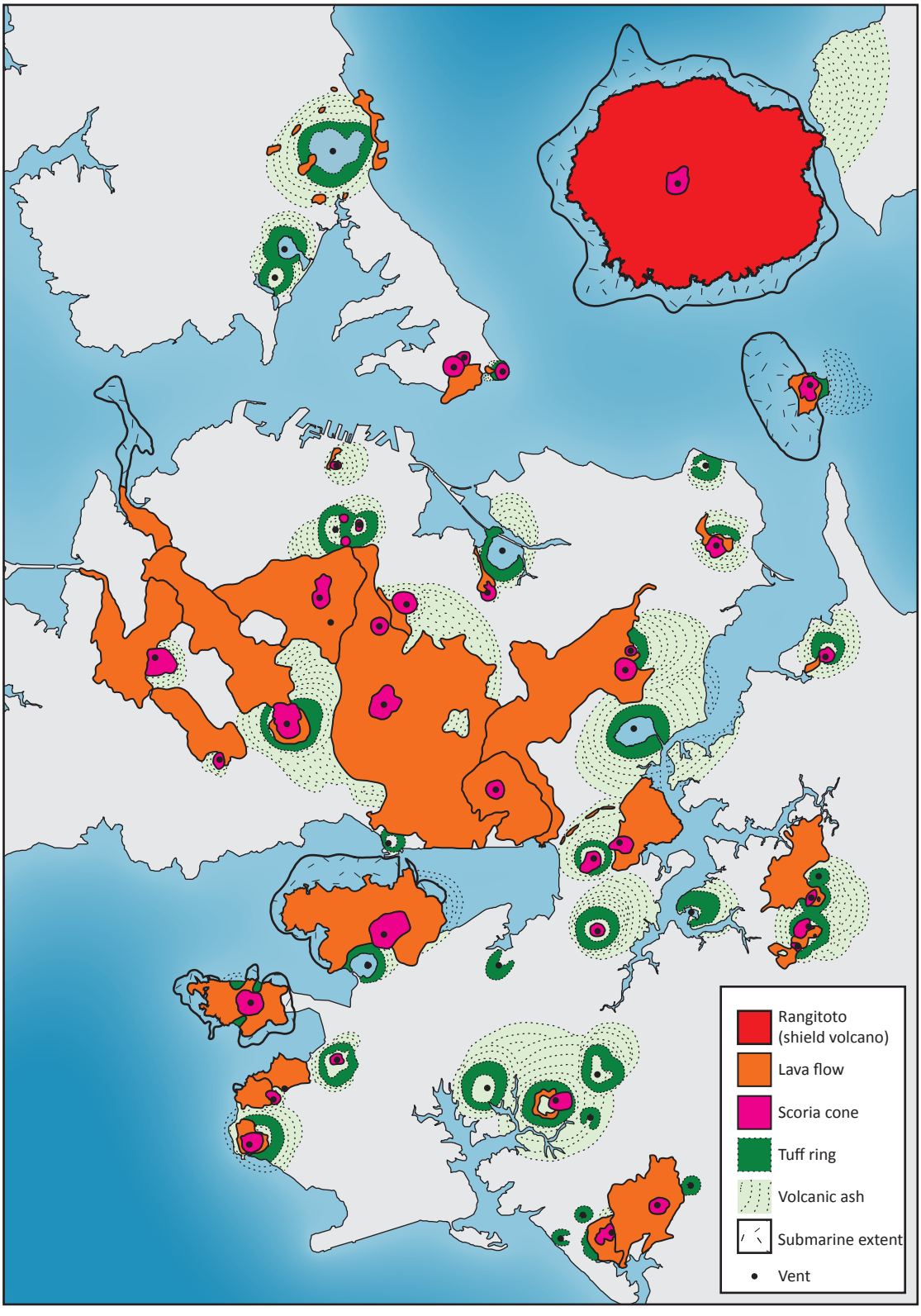
ABN 78 458 664 047
www.aqua.org.au

AQUA

AQUA Biennial Conference

Quaternary Perspectives from the City of Volcanoes

Old Government House, University of Auckland, New Zealand, 5-9 December 2016



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Quaternary Perspectives from the City of Volcanoes

Old Government House, University of Auckland, New Zealand
5-9 December 2016

Local organising committee
Drew Lorrey, Petra Pearce, John-Mark Woolley,
Paul Augustinus, David Lowe, Kat Holt, Marcus Vandergoes

Photo credit: Kevin Sowden

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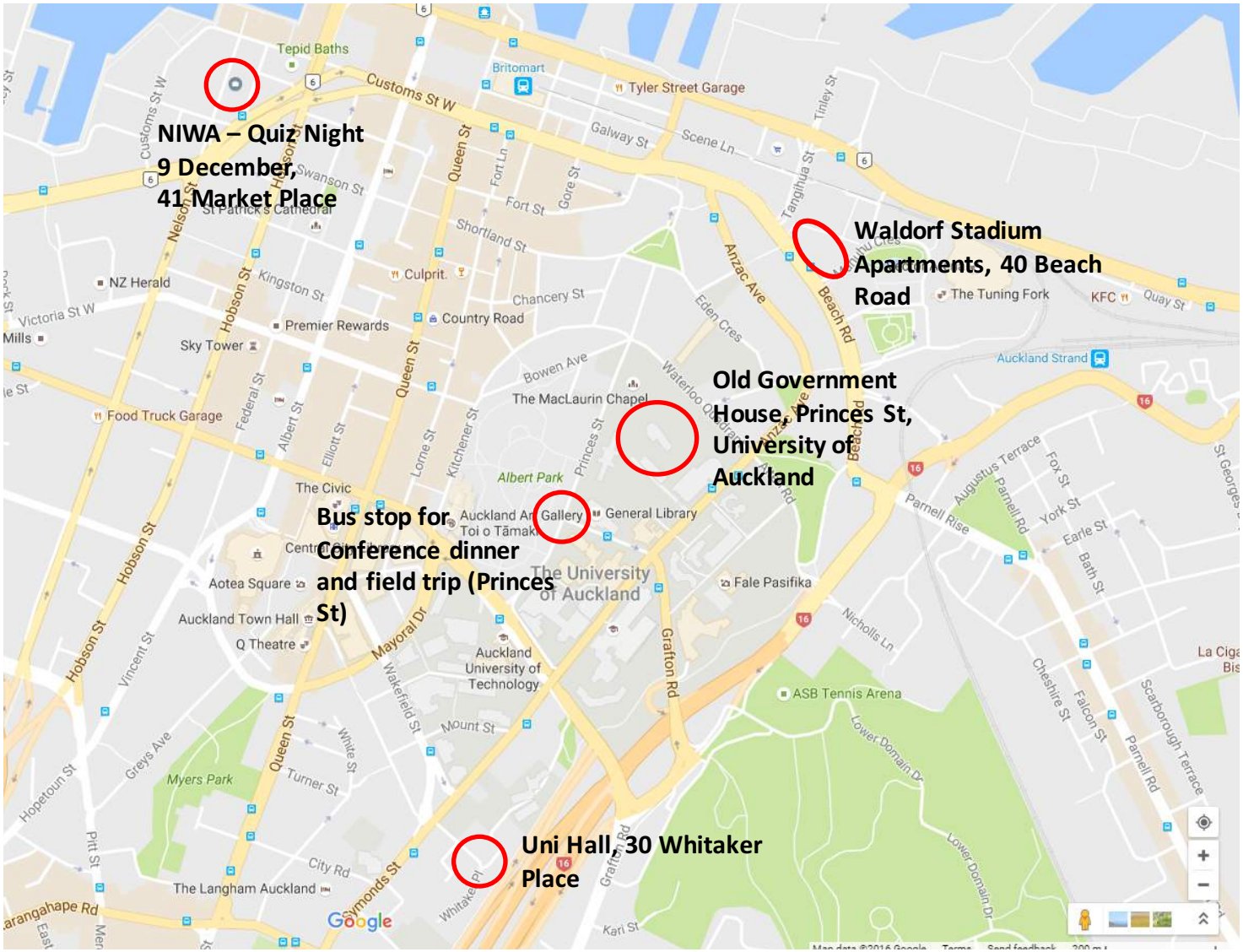

NIWA – Quiz Night
9 December,
41 Market Place
Waldorf Stadium Apartments, 40 Beach Road
Old Government House, Princes St, University of Auckland
Bus stop for Conference dinner and field trip (Princes St)
Uni Hall, 30 Whitaker Place
Tepid Baths
Britomart
Tyler Street Garage
Customs St W
Galway St
Scene Ln
Tinley St
Tangihua St
Queen St
Fort Ln
Gore St
Fort St
Shortland St
Swanson St
St Patrick's Cathedral
Nelson St
Hobson St
Kingston St
Culprit
Chancery St
Anzac Ave
Eden Cres
Beach Rd
The Tuning Fork
KFC
Quay St
Auckland Strand
NZ Herald
Victoria St W
Mills
Premier Rewards
Country Road
Sky Tower
Food Truck Garage
Federal St
Albert St
Elliott St
Bowen Ave
The MacLaurin Chapel
Princes St
Albert Park
The Civic
Lorne St
Kitchener St
Auckland Art Gallery Toi o Tāmaki
General Library
Aotea Square
Auckland Town Hall
Q Theatre
Vincent St
Mayoral Dr
Wakefield St
The University of Auckland
Fale Pasifika
Nicholls Ln
Grafton Rd
Auckland University of Technology
ASB Tennis Arena
Lower Domain Dr
Mount St
White St
Turner St
Myers Park
Greys Ave
Hopetoun St
Pitt St
City Rd
The Langham Auckland
Symonds St
Karangahape Rd
Whitaker Pl
Karl St
Parnell Rise
Augustus Terrace
Parnell Rd
Fox St
York St
Earle St
Bath St
Cheshire St
Falcon St
Scarborough Terrace
Google

Time/date	Sunday 4 December	Monday 5 December	Tuesday 6 December	Wednesday 7 December	Thursday 8 December	Friday 9 December
8.00 am		Registration	Registration		Registration	
8.30 am						Registration
8.50 am		**Millennial Scale Climate Variability.** Convenors: Shaun Eaves, Helen Bostock	**Human-Environment Interactions.** Convenors: Craig Woodward, Krystyna Saunders, Ethan Cochrane		**Coastal dynamics and processes.** Convenors: Craig Sloss, Patrick Moss, Lynda Petherick	**Extending tephras (EXTRAS): Characterising, mapping, dating and applications.** Convenors: David Lowe, Jan Lindsay
9.10 am						
9.30 am						
9.50 am						
10.10 am						
10.30 am		Morning tea	Morning tea		Morning tea	Morning tea
11.00 am		**Australasian peat deposits and their palaeoecological potential.** Convenors: Emily Field, Patrick Moss, Len Martin	**The evolution and impact of ENSO over Australasia** Convenors: Michael-Shawn Fletcher, Michela Mariani, Kristen Beck, Haidee Cadd		**Open.** Convenors: Anthony Dosseto, John Tibby	**Open.** Convenors: Anthony Dosseto, John Tibby
11.20 am						
11.40 am						
12.00 pm					Keynote address: Matt McGlone	
12.20 pm						
12.40 pm		Lunch	Lunch	Mid-conference field trip	Lunch	Lunch
1.00 pm						
1.20 pm						
1.40 pm		Tephras, Coastal Dynamics and Processes, Speleothems	SHAPE, Millennial-scale variability, Australasian peats		**Speleothems.** Convenors: Russell Drysdale, Adam Hartland	Open science, Human-environment interactions, ENSO
2.00 pm						
2.20 pm						
2.40 pm						
3.00 pm		Afternoon tea	Afternoon tea			Afternoon tea
3.20 pm					End of day sessions	
3.30 pm		**SHAPE: Glacial cycles and the LGM.** Convenors: Andrew Lorrey, Steven Phipps, Brian Chase, Maisa Rojas	**Human-Environment Interactions.** Convenors: Craig Woodward, Krystyna Saunders, Ethan Cochrane			**SHAPE: Interglacials and circulation.** Convenors: Andrew Lorrey, Steven Phipps, Brian Chase, Maisa Rojas
3.50 pm						
4.10 pm						
4.30 pm			Keynote address: Atholl Anderson			
4.50 pm	Registration					
5.00 pm	Ice Breaker, Old Government House, University of Auckland		End of day sessions		Bus departs from UoA for conference dinner	
5.10 pm						
5.30 pm		End of day sessions			Conference dinner	End of day sessions
6.00 pm						
6.30 pm		Public science talk: Marcus Vandergoes		Public science talk: Chris Turney		
7.00 pm						Quiz night at NIWA: beer, wine, nibbles
8.00 pm					Keynote address: Phil Shane	
8.15 pm						
8.30 pm					Conference dinner	
9.00 pm						
10.00 pm						

Social event | Oral presentations | Poster session | Offsite field trip | Keynote speeches | Public science talks

AQUA 2016 Events

Icebreaker function

Sunday 4 December, 5 pm

Old Government House, University of Auckland

Meet your fellow AQUA Conference attendees before the conference begins. Drinks and nibbles will be provided at Old Government House from 5 pm. You may also register and pick up your conference pack at the Icebreaker function.

Public Science Lecture # 1

Monday 5 December, 630 PM

Old Government House, University of Auckland

Lake Ohau Climate History – *Marcus Vandergoes, GNS Science*

Mid-conference field trip

Wednesday 7 December

Buses leave from Princes Street bus stops, near the corner of Alfred Street at the University of Auckland at 9.00 am. Please be prompt!

Admittance onto the bus will be given only for those folks who confirmed their attendance on registration, as it is fully booked. Your name badge will have a ***red dot*** *on it to confirm you signed up for this option.*

A packed lunch with snacks will be provided. Please bring good walking shoes (some terrain will possibly be muddy and slippery), outerwear that is appropriate for inclement weather (i.e. rain coat), sunscreen and a sun hat.

To attend, please ensure you are at the bus departure point on time.

One Tree Hill

The first field trip stop will be at One Tree Hill, which is a prominent volcanic cone that provides widespread scenic views across the Auckland Volcanic Field. It also contains many archaeological sites. We will spend about 1.5 hours at One Tree Hill, where we begin our discussion for the day with a focus on origins and chronology for the Quaternary volcanic features of Auckland. In addition, One Tree Hill has been significantly terraformed by human activities since Polynesians arrived in New Zealand about 800 years ago. Our archaeological

experts will guide us through the context for the cultural features that can be seen at this site and explain to us how they fit within the wider prehistoric record for Oceania.

Cascades Kauri Park

Cascades Kauri Park is in the Waitakere Ranges and consists of some remnant native forest and regenerating forest that would have been typical of parts of Northland and Auckland prior to humans arriving in New Zealand. We will be walking along the Auckland City Loop track, which is a relatively easy walk that takes approximately 1 hour to complete. There will be plenty of opportunity to view birdlife along the way. On the walk, we will hear from researchers based at University of Auckland and NIWA who are conducting tree ring research on kauri. An overview about kauri dendrochronology, dendroclimatology and dendroecology will be provided. This site will also serve as our lunch stop, and we can eat our picnic in the bush while discussing science.

Lake Pupuke

The Lake Pupuke maar is on the north shore of Auckland, and it is a crater lake with a complicated history. This will be the last field trip stop of our day, where Associate Professor Paul Augustinus from the University of Auckland will tell us about the long-term research his group and colleagues have conducted at this site. There will be a specific focus on the record of volcanic eruptions during the late Quaternary recorded in maar sediments, and details about climate changes from prior to the last glacial maximum through the Holocene.

Public Science Lecture # 2

Wednesday 7 December, 630 PM

Old Government House, University of Auckland

Back to the Future *– Chris Turney, University of New South Wales*

Conference dinner

Thursday 8 December

Buses leave from Princes Street bus stops, near the corner of Alfred Street at the University of Auckland at 5.00 pm. Please be prompt!

Admittance onto the bus will be given only for those folks who confirmed their attendance on registration, as it is now fully booked. Your name badge will have a ***green dot*** *on it to confirm you signed up for this function.*

The conference dinner will be held at Villa Maria Estate in the Waitomokia Volcanic Crater. The event will consist of canapes and a winery tour, a three course meal, and is inclusive of a drinks service (alcoholic and non-alcoholic). Villa Maria's Cellar Selection wines will be made available as part of the dinner service. Costs for attending the dinner are included in

your general registration. For those wanting to try single vineyard and reserve range wines you are welcome to at your own expense.

During the dinner, Phil Shane will give his keynote address.

To attend, all you will need to do is ensure you are at the bus departure point on time.

This is a very nice dinner venue, so we would appreciate if you would please come dressed in tidy apparel (smart casual), not field gear.

Quiz night

Friday 9 December, 7.30 pm

NIWA, 41 Market Place, Viaduct Harbour Precinct

Finish the AQUA Conference by testing your Quaternary knowledge at the AQUA quiz night. This event will be held at the NIWA office near the Viaduct Harbour. Drinks and food platters will be provided.

Admittance into the venue will be given only for those folks who confirmed their attendance on registration, as it is fully booked. Your name badge will have a ***yellow dot*** *on it to confirm you signed up for this function.*

AQUA 2016 Public Science Lecture
5 December, 630 PM
Old Government House, University of Auckland

MARSDEN FUND
TE PŪTEA RANGAHAU A MARSDEN

Lake Ohau Climate History (LOCH) project: A 17,000 year-long annually-resolved paleoclimate record and its potential to decipher the phasing of high frequency climate modes in Southern New Zealand

Geological records that span millennia yet still capture paleo-environmental information at seasonal-annual resolution can make an important contribution to understanding the spatial and temporal variability of climate processes that vary at high frequency, such as the El Niño Southern Oscillation (ENSO) and the Southern Annular Mode (SAM). However, such records are scarce and are particularly rare in the southern hemisphere. In February/March 2016 two sites were double-cored by hydraulic piston corer (HPC) in Lake Ohau, New Zealand (44°17'S, 169 °55'E) as part of the Lake Ohau Climate History (LOCH) project. Both sites yielded mm-scale laminated sediments representing annually-resolved accumulation in the lake basin from ~17,000 years before present to today. We outline LOCH project developments to date, including the first usage of a globally transportable HPC system. This system uses principles established by the Ocean Drilling Program and is capable of coring >100 m of unconsolidated sediment. We also report the initial results of physical properties core scanning, including computed tomography (CT) which yields whole-volume core density data at 600 micron resolution, as well as paleomagnetic and micropaleontological studies. We provide preliminary time-series analysis of annual to centennial-scale climate variability reconstructed for the past 1,300 years and highlight the potential of the complete 17,000 year long record to decipher the phasing of high frequency climate modes in southern New Zealand and the mid-latitudes of the Southern Hemisphere.

Dr Marcus Vandergoes

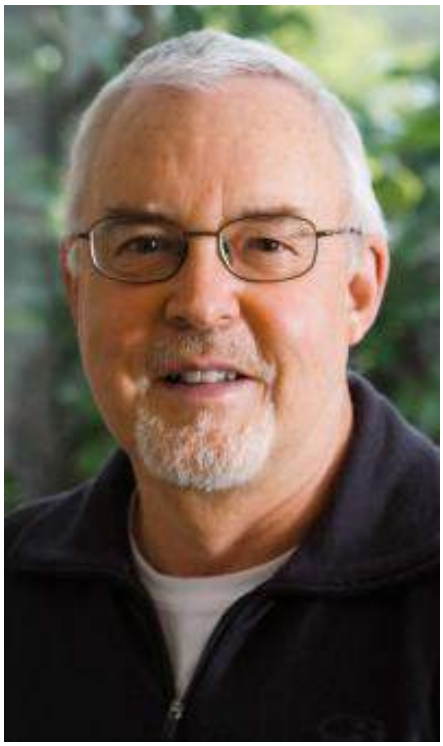
Marcus Vandergoes is a senior scientist at GNS Science specialising in environmental change, paleoecology and paleoclimatology. A particular focus of Marcus's research is to understand the role of the Antarctic and Southern Ocean in driving past climate change in New Zealand and the Southern Hemisphere, and the natural (pre-instrumental) variability of environmental change using natural archives covering the past 150,000 years. He has a key interest in multi-proxy environmental reconstruction that integrate disciplines including paleoecology, glacial geomorphology, geochronology and organic geochemistry. A focus of this work has been to develop methods to quantify past environmental and climate change by deriving temperature estimates using ecological indicators (chironomid (midge fly larvae) and bacterial biomarkers) from New Zealand lake sediments. His field work and research experience includes working in Antarctica, New Zealand subantarctic Islands, Patagonia, and the USA.

AQUA 2016 Keynote address
6 December, 430 PM
Old Government House, University of Auckland

AQUA 2016

The role of climate change in South Polynesian colonization and cultural development AD 1200-1800

Climatic determinism, has had a troubled history in accounting for cultural variation or change, yet at some scales of analysis, or by magnitude, various cases of climate change can be hypothesized as highly influential for cultural trajectories, notably in oceanic islands. How far might that seem plausible for the initial colonization of South Polynesia (New Zealand and its outlying islands) in the 13th century and for the cultural transformation that occurred during Maori history prior to the 19th century? Initial colonization has been understood primarily within a framework of 'traditionalism' in which long-distance voyaging is thought to have involved sophisticated maritime technology operating in modern oceanic climates. Recent work casts doubt on both aspects of that model and suggests that climatic change may have played an influential role. Transformation of initial Polynesian colonists into New Zealand Maori was undoubtedly an intricate process involving a diversity of variables, in which population growth is generally regarded as the primary underlying impulsion. However, cultural change was at least contextualized within the span of the LIA and that might have played a more prominent role than is generally assumed. The most conspicuous archaeological evidence of cultural transition is an expansion of agricultural sites and forts, beginning in the fifteenth century, which is skewed strongly toward the upper North Island. This new settlement pattern, less developed in central districts and virtually absent further south, marked a north-south gradient of economic opportunity that has its origins in a deteriorating climate. As evidence from tribal histories can be read as recording the concurrent emergence of a similar north-south trend in responses to warfare, including by migration, the influence of climatic change in creating the Maori social landscape might be more profound than has yet been envisaged.



Professor Atholl Anderson

Atholl Anderson FRSNZ is descended from Maori-Pakeha families on Rakiura. He has undertaken a lifetime of archaeological research spanning the entire Indo-Pacific from Madagascar, Seychelles and Diego Garcia, through the Batanes (Philippines), Yaeyama (Japan) and Palau islands, to New Caledonia, Fiji, Niue, Kiribati, French Polynesia, and the Juan Fernandez and Galapagos groups. His main interest has been in pre-European island colonisation, encompassing themes of seafaring, migration chronology, colonisation behaviour and environmental change. He is an Emeritus-Professor of the Australian National University where he held the chair of Prehistory in the Institute of Advanced Studies. He was Leverhulme Professor at York, Slater Fellow and Distinguished Fellow at Durham, Research Fellow at the University of Tokyo and a Visiting Fellow at Clare Hall and Corpus Christi College, Cambridge.
(Biographic details taken from the Royal Society website)

AQUA 2016 Public Science Lecture
7 December, 630 PM
Old Government House, University of Auckland

Australian Government
Australian Research Council

Back to the Future: Last Interglacial Warmth and the Stability of the Antarctic Ice Sheets

Recent studies modelling the Antarctic ice sheet contribution to future global sea level rise range from negligible to substantial (>7m). A useful analogue in this regard is the Last Interglacial (LIG; 135-116 ka) during which reconstructed past sea levels imply a significant ice mass loss from both Greenland and Antarctic ice sheets, contributing to a global sea level 6.6 to 9.4 metres above present day. Climate reconstructions and models of the Last Interglacial, however, suggest a wide range of global temperatures, from relatively small differences compared to present day to large warming (>2˚C) at high latitudes (so-called 'polar amplification'). This limits our understanding of the sensitivity of the ice sheets to warming. Previous work combining terrestrial and marine records spanning the LIG is challenge given chronological and seasonality biases. Marine records are arguably better constrained in these regards but recent work has highlighted the importance of ocean current drift in introducing temperature biases into palaeo-reconstructions where the offset may reach 1.5 °C for planktonic foraminifera living for a month and 3.0 °C for longer-living species. Here we exploit an updated marine record of quantified temperature estimates across the LIG d18O plateau and attempt to quantify for bias introduced by ocean current drift to generate an accurate and precise estimate of global LIG temperatures. Using the new reconstructed sea surface temperatures we drive a coupled ice-sheet/ice-shelf model to investigate the contribution of Antarctic ice sheets to global sea level rise during the LIG.

Professor Chris Turney

Chris Turney is a Professor of Climate Change and Earth Science at the University of New South Wales. Working across the globe, Chris is extending historic records back to 130,000 years ago to better understand the future. As part of this work, Chris co-ordinates the international Earth's Past Future Project (www.earthspastfuture.com). Chris has published more than 165 papers, 1 textbook and 3 popular science books with 2 Highly Cited Papers listed in Thomson Reuters' Essential Science Indicators. Described by the UK Saturday Times as the 'new David Livingstone', Chris' team communicate their findings in the field as Intrepid Science (intrepidscience.com), reporting discoveries when they happen, where they happen. Chris has received several awards, including the Australian Academy of Sciences Frederick Stone Award (2014), the inaugural Sir Nicholas Shackleton Medal (2007) and the Geological Society of London's Bigsby Medal (2009). Chris is a Fellow of the Royal Society of Arts, Geological Society of London, and the Royal Geographical Society.

AQUA 2016 Keynote address
8 December, 12 PM
Old Government House, University of Auckland

AQUA 2016

Ascarina lucida and the climatic interpretation of the NZ Quaternary

Ascarina lucida (hutu) stands out among NZ plants as an environmental indicator. A small, disturbance favoured, bird dispersed tree, it ranges virtually the whole length of the mainland and reaches the Kermadec Islands as an outlier. Nevertheless, *Ascarina* appears to be incredibly choosy about sites, and is not often common. A primitive, basal angiosperm, its inefficient vascular system makes it highly vulnerable to dry air but, as a disturbance specialist, it needs open canopy space. Having been derived in relatively recent times from the tropical islands to the north, it will only tolerate light frosts; nevertheless, it is most abundant in the cooler south. It therefore occupies a quite limited range of sites: in the South Island in the very wettest areas between sea level and 500 m; in the North Island on cloud-capped mountains between 250 m and 750 m.

Ascarina produces abundant, wind-dispersed pollen. However, nowhere in New Zealand does its present pollen values match those of the early to mid Holocene or, for that matter, previous interglacial peaks. It appears then, that its hyper-abundance in the past is trying to tell us something about full interglacial climates. Exactly what this message might be, and its implications for climatic patterns of the past, will be the subject of this address.

Dr Matt McGlone

Matt McGlone's Quaternary science research has spanned more than four decades and covered most of New Zealand and the sub-Antarctic Islands. His work has provided a valuable contribution to improving our understanding of climate change, botanical, ecological, and anthropological processes. Key components of Matt's palynology, macrofossil, and charcoal work helped to detect the timing of human arrival in New Zealand and the deforestation impacts caused by Maori and Europeans. He has also integrated a diverse set of research threads using different proxies to reveal climate changes over interglacial-glacial cycles. Matt's work in New Zealand has also highlighted the effects of ENSO variability and seasonality on New Zealand vegetation and landscape changes, and enabled a better research platform for investigating inter-hemispheric climate change linkages.

AQUA 2016 Keynote address
8 December, 830 PM
AQUA 2016 Conference Dinner, Villa Maria Estate

AQUA 2016

Long life of Rangitoto volcano revealed by drilling

Drilling through the edifice of Rangitoto, the youngest and largest volcano in the 'monogenetic' Auckland Volcanic Field (AVF), reveals the multi-stage eruptive and magmatic history of a small basalt shield volcano. Previously, the volcano was thought to have been constructed in one or two short episodes about 500 cal yr BP. New data indicates activity commenced up to 6000 cal years BP, involving minor effusive and pyroclastic volcanism until 650 cal yr BP. This period either represents an early, less productive phase of a single polygenetic volcano, or alternatively, Rangitoto is better described as a volcanic complex that includes one or more buried edifices concealed by the main structure. A voluminous shield building phase occurred 650-550 cal years BP, erupting isotopically-uniform sub-alkalic basalts. Four batches of magma distinguished by trace element chemistry were erupted sequentially. Some of the temporal-compositional trends are consistent with cycles of progressive partial melting at the source. The final phase of activity (~550-500 cal years BP) was explosive and less voluminous, producing scoria cones at the summit. This phase involved more diversity in magma compositions including more mafic sub-alkalic basalt, and alkali basalt, pointing to sourcing of magmas simultaneously from different depths in the mantle. Rangitoto volcano contributes to a growing body of evidence that major periods of volcanism in 'monogenetic' basalt fields occur at centers that have experienced multiple eruption episodes. Changes in magma composition accompany changes in eruption style, but a lack of an obvious shared pattern in magmatic evolution at various volcanoes points to the localized mantle heterogeneity and conduit systems. Hazard scenarios for regions traditionally classified as 'monogenetic' need to encompass the possibility of prolonged episodes of activity and reawakening of volcanoes, a significant implication where infrastructure is built on such regions.

Associate Professor Phil Shane

Phil Shane studies the eruption histories of volcanoes. A major focus is the rhyolite eruptive history of the Okataina Volcanic Centre in central North Island. This work involves using the mineralogy and geochemistry of pyroclastic deposits to gain insight to pre-eruptive mechanisms such as triggering and magma-mixing. U-Th geochronology of zircons is being used assess magma longevity. A similar study is being conducted on volcanoes in Dominica and St Lucia. At Mt Ngauruhoe, a study focusing on plagioclase crystallisation histories is being undertaken. The ascent and eruption of basaltic magmas in the Bay of Islands is a new investigation that has started. The eruptive history of the basaltic Auckland Volcanic Field using tephra layers in ancient lake sediments is another current area of study. The purpose of that study is to assess past frequency and magnitude of eruptions for hazard analysis. This also involves drilling a deep hole through Rangitoto volcano to assess its volcanic history. Other programs include the deep-sea tephra record from Kermadec arc volcanoes; and the dispersal of tephra in oceans surrounding New Zealand. (biographic and career details taken from the University of Auckland website)

Monday 5 December

Millennial Scale Climate Variability		
8.50 am	Jonathan Tyler	Millennial scale variability in the East Asian Monsoon during the last 55,000 years recorded in the bulk organic geochemistry of Lake Suigetsu, Japan
9.10 am	John Tibby	An environmental record through Marine Isotope Stage 3 from North Stradbroke Island, south-east Queensland, Australia
9.30 am	Helen Bostock	Millennial scale events from marine sediment cores in the SW Pacific during Marine Isotope Stage 3
9.50 am	Shaun Eaves	Millennial-scale climate variability during the last glacial termination recorded by New Zealand glaciers
10.10 am	Chris Fogwill (Chris Turney)	Antarctic ice sheet discharge driven by atmosphere-ocean feedbacks during the Last Termination
Australasian peat deposits and their palaeoecological potential		
11.00 am	Scott Mooney	Twentieth Century changes in the fire regimes of high altitude ecosystems in eastern Australia: Evidence from long, multi-proxy records
11.20 am	Len Martin	A long peat-based palaeoclimate record in eastern Australia: change in response to westerly winds and sea-surface temperatures
11.40 am	Will Reynolds	Monsoon-controlled environmental change in tropical north Australia inferred from an organic swamp deposit near Darwin
12.00 pm	Joss Ratcliffe	Carbon accumulation in restiad peatlands
12.20 pm	Paul Hesse	Exotic aerosols in the Falkland Islands: a record of South American dust and pollen transport to the South Atlantic since 13 ka
Poster session 1: Tephras, coastal dynamics & processes, speleothems		
1.40 pm - 3.00 pm	David J. Lowe	A new attraction-detachment model for explaining landsliding in clay-rich Quaternary tephras, eastern North Island, New Zealand
	Andrew P. Hammond	A late Quaternary tephrochronological framework and landscape evolution model for loessial cover beds in Hawkes Bay district, New Zealand
	Aleksandra Zawalna-Geer	Extracting a primary Holocene crytoptephra record from Pupuke maar sediments, Auckland, New Zealand
	Remedy C. Loame	Hazard hunting: X-ray micro-CT reconnaissance analysis of c. 20 ka lake sediment cores for tephra seismites and cryptotephras
	Helen Bostock	Using Micro-XRF to identify crypto-tephra in marine sediment cores
	Mirja Heinrich	The eruption triggers, mechanisms, deposition and hazards of the largest scale explosive eruptions of Tongariro volcano
	Caleb Gasston	Buried Faults in the Auckland Region
	Yuli Heled	Cooling history and crystallization of the Whakamaru Ignimbrite, Taupo Volcanic Zone, New Zealand
	Tsun-You Pan	The last interglacial sea level highstand — evidence from Yorke Peninsula, southern Australia
	Shanshan Liu	LiDAR and EM conductivity investigation of a Holocene coastal landslide complex: Pourewa Landslide Zone, Auckland, New Zealand
	Alastair J.H. Clement	Holocene evolution of the Manawatu coastal plain incised-valley system
	James C. Veitch	Unravelling possible climatic and/or tectonic signals preserved in Holocene coastal geomorphology around Lake Wairarapa
	David Bevan	Rapid mapping of a Holocene coastal landslide using Structure-from-Motion (SfM) photogrammetry: Ohuka Landslide, Port Waikato, New Zealand

	Trish Fanning	Holocene coastal landscape change: Albatross Bay, north Queensland, Australia
	Craig Sloss	Facies scale depositional model for Plio-Pleistocene bottom-current controlled carbonate drift deposits
	Craig Sloss	Large scale soft sediment deformation features preserved in Early Pleistocene inner carbonate shelf sequence: Debris flow or seismic induced soft sediments
	Nicholas Gampell	Speleothem Records of Volcanic Eruptions in New Zealand
	Kia Matley	The use of speleothem palynology to elucidate late Holocene vegetation change in the Nullarbor Plain
	John Tibby	Diatoms as indicators of past cave environments in the Naracoorte Cave system, south-eastern South Australia
	Russell Drysdale	A cross-hemispheric comparison of Last Interglacial climate variability using Italian and NZ speleothem records
SHAPE: Glacial cycles and the LGM		
3.30 pm	Peter Kershaw	Lake Wangoom - unfinished business
3.50 pm	Rewi Newnham	Last Glacial pollen-climate reconstructions from Northland, New Zealand
4.10 pm	Georgina Falster	Coherent millennial-scale hydroclimate variability in southern Australasia during the last glacial period
4.30 pm	Tim Barrows	The last glacial maximum in Australasia
4.50 pm	Jasper Knight	Re-evaluating the Last Glacial Maximum in southern Africa
5.10 pm	Lynda Petherick	The Last Glacial Maximum in the Southern Hemisphere
Public science talk		
6.30 pm	Marcus Vandergoes	Lake Ohau Climate History (LOCH) project: A 17,000 year-long annually-resolved paleoclimate record and its potential to decipher the phasing of high frequency climate modes in Southern New Zealand.

Tuesday 6 December

Human-environment interactions		
8.30 am	Kira Westaway	When did humans become modern?
8.50 am	Anthony Romano	North by Northwest: a palaeoenvironmental study of the archaeology in northwest Tasmania
9.10 am	Lydia Mackenzie	Late Holocene fire regimes and vegetation change in the South Wellesley Islands, tropical northern Australia
9.30 am	Alexander Harpur	Anthropogenic influences on the sedimentary evolution of the Coromandel Harbour
9.50 am	Andrew Rees	Testing lessons from the past: using paleoenvironmental data to define pre-human baselines at Lake Pounui, New Zealand
10.10 am	Marcus Vandergoes	The rate of landscape transformation following Polynesian and European arrivals in the Mackenzie Basin, South Island, New Zealand
The evolution of ENSO over Australasia		
11.00 am	Michela Mariani	Quantifying land-cover changes from pollen in Tasmania: a Southern Hemisphere first
11.20 am	Kristen K. Beck	Terrestrial-aquatic ecosystems responses to ENSO in Tasmania
11.40 am	Michael-Shawn Fletcher	Disentangling the role of people and ENSO on Australia's tropical savanna: a case study from near Darwin
12.00 pm	Cameron Barr	A 7500 year history of El Niño-Southern Oscillation variability derived from a quantitative Australian precipitation record
12.20 pm	Anthony Fowler	Prospects for a multi-millennial reconstruction of ENSO from kauri
Poster session 2: SHAPE, Millennial-scale variability, Australasian peats		
1.40 pm - 3.00 pm	Patrick Moss	Holocene Environmental Change for a High-Dune Site in Subtropical Eastern Australia
	Alison Kelsey	The Milankovitch connection: astronomical forcing of millennial-scale climate signals
	Amber Ditchfield	Lake Kai iwi muds, a Last Glacial Cycle record of ecological and climate variability from far northern New Zealand
	Christopher Kemp	Precipitation in Australia during MIS3: An analysis of published palaeoclimate datasets
	Michael-Shawn Fletcher	The Winds of Change: understanding millennial-scale variability of the Southern Westerly Winds
	Paul Augustinus	Sedimentary Organic Matter δD record from Pupuke Maar, Auckland, New Zealand: 46 ka of Paleoprecipitation from Northern New Zealand
	Paul Hesse	The Last Glacial Maximum in the Desert Dunefields
	James Shulmeister	The climate of SE Australia at the LGM
	Gianna Evans	Periodicity of wind and precipitation signals evaluated from high-resolution Itrax scans, Lake Kawaupaka, New Zealand
	Lynda Petherick	SHeMax: The Last Glacial Maximum in the Southern Hemisphere
	Andrew Lorrey	Quaternary environments and the scientific value of New Zealand swamp kauri
	Christopher Fogwill	Obliquity control on southern hemisphere climate during the last glacial

	John-Mark Woolley	Glacial chronology and Holocene environmental history of Lake Tennyson, North Canterbury, New Zealand
	Valerie van den Bos	Auckland lakes as climate dipsticks: unique insights into the nature and drivers of the past 117,000 years of climate change
	Greer Gilmer	Holocene changes in ocean circulation and climate at Moubray Bay, Northern Victoria Land, Antarctica
	Reka-H Fulop	Status of the new in-situ 14C extraction scheme at ANSTO
	James Shulmeister	Glaciation of the upper Rangitata Valley, South Island, New Zealand
	Briony Chamberlayne	Geochemical signals in bivalve shells as evidence of hydroclimate variability in the Coorong Lagoon, South Australia
	Christian Ercolani	Modern and paleo-weathering regimes in sedimentary records determined by boron isotopes
	Lynda Petherick	Climatic and environmental variability in southern America during the Last Glacial Maximum: A synthesis.
	I. A. Jara	Vegetation, fire and climate links in the Andean *Nothofagus* forest of Northern Patagonia
	Annika V. Herbert	Quantitative reconstruction of Australian climate change since the Last Glacial Maximum using pollen
	Charles Maxson	Glacial to interglacial changes in stable carbon isotopes from planktonic foraminifera from the SW Pacific Sector of the Southern Ocean
	David J. Lowe	Extracting DNA from allophanic paleosols on tephras for paleoenvironmental reconstruction: a new two-step DNA isolation method and application to a buried Holocene paleosol, New Zealand
	Emily Field	Using multiple dating methods to understand controls on geochronological complexity in organic spring deposits
	Allen Gontz	Applications of GPR in Peat Environments
	Peter Negus	Are artesian spring wetlands long-term stable refuges from climate change?
	Joss Ratcliffe	Contemporary carbon fluxes do not represent the long-term carbon balance for an Atlantic blanket bog
	Xianglin Zheng	Exploring historical moisture availability in south-eastern Australia
Human-environment interactions		
3.30 pm	Justine Kemp	Optical and U- series dating of the burial site and skeleton of Kiacatoo Man, New South Wales
3.50 pm	Ethan Cochrane	Distinguishing Human-Induced and Natural Coastal Geomorphological Change: Late Holocene Case Studies from Fiji and Sāmoa
4.10 pm	Craig Woodward	The effect of Maori deforestation on wetland hydrology, catchment erosion and eutrophication: a case study from the South Island
4.30 pm 4.50 pm	Keynote Address: Atholl Anderson	The role of climate change in South Polynesian colonization and cultural development AD 1200-1800

Wednesday 7 December

Mid-conference field trip

Public science talk		
6.30 pm	Chris Turney	Back to the Future: Last Interglacial Warmth and the Stability of the Antarctic Ice Sheets

Thursday 8 December

Coastal dynamics & processes		
8.30 am	Patrick Moss	Coastal Environments of Eastern Tasmania for the Last Millennia from High-Resolution Analysis of Salt Marsh Sediments
8.50 am	Deirdre D. Ryan	Interpretations of Holocene coastal evolution at the River Murray Mouth as inferred from the antecedent morphology of the last interglacial shoreline
9.10 am	Allen Gontz	Cooloola Island - The Great "Lost" Sand Island of Southeast Queensland
9.30 am	Alastair J.H. Clement	Reconstructing Holocene relative sea-level changes in the New Zealand region: current challenges and future directions
9.50 am	Daniel Ellerton	The formation and evolution of the Cooloola Sand mass over the later Quaternary
10.10 am	Amy J. Dougherty	Northland barriers provide records of sea level and storms during Late-Quaternary highstands
Open science		
11.00 am	Rebecca Hamilton	Forest, fire and monsoon feedbacks: insights from mainland south-east Asia
11.20 am	Rebecca Ballard	Mapping the Bridgewater Formation, Nepean Peninsula, Victoria. A new technique using drones.
11.40 am	Emily Field	Evidence of regionally synchronous environmental and climatic change across the Kimberley during the Holocene
12.00 pm 12.20 pm	Keynote Address: Matt McGlone	*Ascarina lucida* and the climatic interpretation of the NZ Quaternary
Speleothems		
1.40 pm	Ellen Corrick	Speleothem records of millennial-scale climate events during the last glacial period: implications for ice core chronologies
2.00 pm	Anthony Dosseto	Ancient times of a wetter Australia as recorded by speleothems of the Flinders Range
2.20 pm	Andrew Pearson	Speleothems as high-resolution archives of soil carbon export in New Zealand
2.40 pm	Quan Hua	Rainfall variability and temporal changes in the dead carbon fraction in an Indonesian speleothem
3.00 pm	Russell Drysdale	The timing of glacial terminations from Corchia Cave (Italy) speleothem records
At conference dinner	Keynote Address: Phil Shane	Long life of Rangitoto volcano revealed by drilling

Friday 9 December

	Tephras and volcanism	
8.50 am	Jenni L Hopkins	Multi-criteria correlation of tephra deposits to source centres applied in the Auckland Volcanic Field, New Zealand
9.10 am	Jan Lindsay	Preparing for the next local volcanic eruption in Auckland, New Zealand
9.30 am	Bianca Dickson	Solving the Monkey Puzzle: Long term environmental history of Araucaria Araucana
9.50 am	Remedy C. Loame	Using tephrochronology to reconstruct and date both fault rupture and hydrothermal activity at Whirinaki Fault, Taupo Rift, NZ
10.10 am	David J. Lowe	Tephra seismites: a new tool to evaluate, date, map, and model paleoseismicity using tephra liquefaction in c. 20,000-year-old lake sediments in the Waikato region, New Zealand
	Open science	
11.00 am	Heather A. Haines	The Effect of Regional Variations in Rainfall on Reconstructing Precipitation Patterns Using Tree Rings
11.20 am	Christopher Kemp	A new > 100,000 year Australian palaeoclimate record: Fern Gully Lagoon
11.40 am	Sanja Van Huet	Overview of Late Quaternary-aged fossil sites from the Nepean Peninsula, Victoria
12.00 pm	Duanne White	Tectonic drivers for river disequilibria in the south-eastern highlands of Australia
12.20 pm	Leo Rothacker	Human impact overprints natural controls on soil systems in the Iron Age
	Poster session 2: Open science, Human-environment interactions, ENSO	
1.40 pm - 3.00 pm	Peter N. Eze	Alluvial soil geochemistry and micromorphology based evidence of environmental change in the Sabie-Sand River Basin, South Africa
	Leo Rothacker	Past and modern weathering conditions in the Murrumbidgee Basin (Australia)
	Andrew Douie	Reconstructing past climate in the north Waikato area, North Island, New Zealand, using subfossil leaves preserved in diatomite
	Rosabella Borsellino	Glacial Geomorphology of the Brabazon and Butler Downs in the Rangitata Valley, New Zealand
	Loraine Watson-Fox	In Search of Wild Rices
	Martin Ankor	Quantifying lake hydrological and isotopic responses to climate change: A coupled hydrologic-isotopic mass balance model applied
	Martin Ankor	Digital field notes: How to make iThingies work for you.
	Martin Brook	Quaternary geology of the Auckland urban region, New Zealand: geotechnical properties and engineering implications
	Haidee Cadd	Validating the use of Infra-red spectroscopy to infer changes in fire history, carbon dynamics and dust flux from lake sediments
	Pana Panaretos	Stable isotopes in shearing shed deposits in far western NSW: long records of land cover change?
	Tori Brewster	Adaptation in the hind limbs of extinct Island Emus (Dromaius species)
	Heather A. Haines	Using the ITRAX Core Scanner to Develop a Ring-Width Chronology from Subtropical Australian Araucaria cunninghamii Trees with Faint, unidentifiable ring boundaries

	Cameron McKenzie	The search for the source: the lancefield megafauna deposit
	Patricia Gadd	Can the Molybdenum Incoherent/Molybdenum Coherent scattering ratio (Mo Ratio) be used as a substitute for LOI determinations of organic content?
	Andrew Pearson	Using FTIR spectroscopy to build high-resolution records of total organic carbon in New Zealand lake sediments
	Jie Chang	The development of an independent paleo-temperature proxy using stable oxygen isotopes (δ18O) of chironomid head capsules from s
	Monique McKeown	A Sedimentological Survey of an Inner Reef Island in the Maldives
	Robyn Inglis	Geomorphological and archaeological approaches to the Palaeolithic surface record of SW Saudi Arabia
	Krystyna Saunders	Tracing Tasmania's mining history using high-resolution scanning XRF and quantitative trace metal analyses
	Brett Rip	Poutō dune lake palaeolimnology – learning from the past to help manage the present
	Craig Woodward	Towards a comprehensive record of Quaternary environmental change from the Snowy Mountains, Australia
	Michela Mariani	Disentangling the interplay between the ITCZ, southern westerlies and ENSO during the Holocene.
	Jacinta Greer	Carbon isotope ratios of fossil leaves reveal south-east Queensland's La Niña dominated past
	Jonathan Tyler	The nature and causes of 'megadroughts' in south-eastern Australia: evidence from the Holocene sediments of West Basin, Victoria
	Zoë Thomas	Evidence for subdued ENSO variability during super-interglacial warmth from a tropical Queensland record
	Tess Chapman	Coral Reconstruction of mid-Holocene Ocean-Atmospheric dynamics of the Great Barrier Reef
	Jonathan Palmer	Changes in ENSO-like expression during Greenland Stadial 1 (GS-1) chronozone revealed by New Zealand tree-rings
SHAPE: Interglacials and circulation		
3.30 pm	Matt Ryan	Thresholds in vegetation cover during the super-humid MIS 11 interglacial from southwestern New Zealand
3.50 pm	Greer Gilmer	Southern Hemisphere Westerly Winds and climate change at the Subantarctic Auckland Islands since the Late Glacial
4.10 pm	Krystyna Saunders	Relationships between the Southern Hemisphere westerly winds, temperature and carbon dioxide during the Holocene
4.30 pm	Joseph Prebble	Early Holocene ocean circulation in the Southwest Pacific
4.50 pm	A/Prof Alan Hogg	Decadally-resolved Lateglacial radiocarbon evidence from New Zealand kauri
5.10 pm	Elyssa De Carli	Unrecognised dammed Holocene palaeolake at the terminus of the Murray-Darling River Basin, Australia: palaeoclimate implications

Digital field notes: How to make iThingies work for you

Martin Ankor

Customised field software was developed using Filemaker Pro for the purpose of recording sampling notes, coordinates, photographs and other relevant fieldwork data in the Filemaker Go app. Customised software of this nature is straightforward to implement and can ensure quality control of field data collection, regardless of the skill set and expertise of the field personnel. In addition, double handling and re-interpretation of field data is minimised and the data collected is optimised for the task at hand, e.g. Photographs may be recorded for species identification, or coordinates for sampling location. These benefits are applicable to both conventional fieldwork, and citizen science projects. In the past programmers would be required to develop custom software. Recently however, software has become available, such as Filemaker, that enables complete solutions to be developed rapidly by people without a programming background, with features such as field validation, auto-populating menus, and customised layouts. This solution has been applied to several sampling programs for both lake and terrestrial samples. Here we present examples of the database and principles used in the development of such tools.

Quantifying lake hydrological and isotopic responses to climate change: A coupled hydrologic-isotopic mass balance model applied

Martin Ankor

Jonathan Tyler, Byron Steinman

A hydrologic-isotopic mass balance model was developed and applied to Lakes Bullen Merri and Gnotuk in Victoria, Australia to investigate the influence of basin morphometry upon a lake's hydrological and isotopic response to climate change. Calibrations were successful for ~3 m water level change from 1965 to 2001. No calibration was able to simulate a water level change of ~19 m from 1889 to 2006. It follows that catchment flow to the lake is not proportional to catchment area, suggesting influence from groundwater, and demonstrating the need for long-term lake monitoring. The model broadly captures the trends observed in δ18O and δD, of a sparse monitoring dataset from 2006 to 2015. Observed and modelled values indicate opposing trends in δ18O and δD, which implies lake re-equilibration to past climate change. Sensitivity experiments to varying lake morphology indicated that following a hydroclimate shift, lake isotope ratios underwent transient excursions opposite in sign to the change in lake volume, before returning to equilibrium. The rate and size of isotopic excursion varied as a function of basin slope. Applying a 1400 year hypothetical climate, with both ENSO type cycles and stepped hydroclimate shifts to Lake Gnotuk suggested that on the shallow slopes at lower lake levels, the seasonal isotopic cycle would obscure both ENSO cycles and stepped shifts; whereas with higher lake levels and steeper basin slopes, the excursions may become identifiable. These results offer insights into the selection and interpretation of lake isotope records as palaeoclimate tracers.

Sedimentary Organic Matter δD record from Pupuke Maar, Auckland, New Zealand: 46 ka of Paleoprecipitation from Northern New Zealand

Paul AUGUSTINUS

Alayne STREET-PERROTT, Tom STEPHENS, Yongsong HUANG

Here we report a continuous palaeoprecipitation and water-balance reconstruction from New Zealand spanning the last ca. 46 cal. kyr BP. Marked palaeolimnological changes in Lake Pupuke, Auckland, New Zealand, have already been identified using sedimentology, magnetic susceptibility, grain size and geochemistry (carbon, nitrogen and sulphur concentrations, bulk organic matter δ13C and δ15N with variable erosional influx, biomass and benthic REDOX conditions linked to changing effective precipitation and seasonality. The terrestrial n-alkane δD record contained in Lake Pupuke sediments extends and refines these records based on reconstruction of past changes in the δD of precipitation in the Auckland region. Variation in hydrogen isotope composition is attributed to an amount effect and suggests drier glacial climatic conditions between 43.6 and 14.2 cal. ka BP, with driest intervals observed at 38.5 to 35.4, 26.8 to 24.2 and 17 to 14.2 cal. ka BP. From 14.2 to 5.2 cal. ka BP a transition to more depleted terrestrial n-alkane δD values marks a progressively wetter climate, culminating in a particularly wet period between 5.2 and 2 cal. ka BP. A marked aquatic macrophyte δD peak between 5.2 and 2 cal. ka BP contrasts with depletion in terrestrial n-alkane δD and is explained by the large increase in the abundance of aquatic macrophytes during this period. The aquatic macrophyte n-alkane δD enrichment is driven by evaporative enrichment of lake surface waters during the summer months associated with intensification of ENSO and increased seasonality with warm, dry summers and wetter winters.

Mapping the Bridgewater Formation, Nepean Peninsula, Victoria. A new technique using drones

Rebecca Ballard

BALLARD, Andrew, VAN HUET, Sanja

The use of drone technology for geological mapping is relatively new but rapidly becoming more common practice. Drone technology has a wide range of applications including; collection of remote data from sites with limited access; photogrammetry and 3D imaging; vertical mapping and incorporation of stratigraphic overlays; quantitative comparison between stratigraphic time periods; data sharing through online collaboration. New and innovative uses for drones are being developed regularly. A new mapping technique, 'Stretched Correlative Continuum' (SCC), is being developed and will ultimately provide a 'stretched', flat representation of vertical topographic sections. The distortive effect of inlets, bays, headlands and other topographic and erosional features makes visual stratigraphic correlation between sites challenging, as some features may be hidden and others overly prominent. The SCC will produce visually flattened data from multi-image drone footage that will enable features that are 'around corners' to be included, flatten the multiple images produced during the drone 'run' and enable correlative mapping of the stratigraphy between sites over large regions. This technique is currently being tested on the regionally extensive Bridgewater Formation, Nepean Peninsula, Victoria.

A 7500 year history of El Niño-Southern Oscillation variability derived from a quantitative Australian precipitation record

Cameron Barr

J. Tibby, M. Leng, A. Henderson, J. Overpeck, J. Cole, S.J. Phipps, F. McRobie, J. Tyler, J. Marshall, G. McGregor , Q. Hua

The opposing El Niño and La Niña phases of the El Niño-Southern Oscillation (ENSO) have major impacts on regional rainfall patterns that affect billions of people worldwide. It is, therefore, critical to understand how these phases will change under future climates. Palaeoclimate proxy data can help to refine our understanding, but this requires a broad spatial distribution of long records that span differing background conditions and forcings, such as was evident during the Holocene. However, the current suite of Holocene proxy ENSO records are generally discontinuous, low resolution, spatially biased to the eastern Pacific or document only one mode. As such, the scale and timing of Holocene ENSO variability remain unclear.

Here we present a quantitative rainfall reconstruction from sub-tropical Australia, derived from the δ13C of sub-fossil *Melaleuca quinquenervia* leaves preserved in lake sediments, that records El Niño and La Niña modes over the past 7500 years. Capturing both phases enables the characterisation of mid- and late-Holocene ENSO variability, while tight chronological control facilitates precise timing of regime shifts. The mid-Holocene is characterised by more La Niña-like background conditions, before a significant shift towards increased variability and more frequent El Niño conditions is evident ca. 3200 cal yr BP. These conditions prevailed until the Little Ice Age, in which persistently wet conditions are evident.

In addition to being the first quantitative rainfall record of its type from Australia, the record also provides insight into the evolution of ENSO over the mid- to late-Holocene and the influence of forcing mechanisms external to the Pacific region.

The last glacial maximum in Australasia

T.T Barrows

Mills, S.C., Almond, P., Hope, G., Pillans, B., and Fifield, L. K

The last glacial maximum in Australia was a time of maximum cooling and a reduction in absolute precipitation across most regions. Glaciers formed in the highest parts of the Kosciuszko Massif and ice caps formed in Tasmania and on the island of New Guinea. After more than a century of mapping, the extent of glaciation remains unrefined in many parts of Australasia. Additionally, the timing of glaciation is also only known from a handful of sites. To remedy this, we have initiated a project to remap glacial geomorphology in Australia and in Papua New Guinea (PNG) using modern techniques and employing photogrammetry to model and measure landforms. To constrain the timing we are exposure dating key glacial sequences in Tasmania, PNG and New Zealand. Together with this, we are re-investigating the limits of periglacial activity and re-evaluating various means to date the formation of these landforms. Among the landforms investigated are scree slopes in NSW, blockstreams in Victoria and a rock glacier in Tasmania. Initial results indicate that despite prolonged cooling during oxygen isotope chronozone 2 in the Southern Ocean, maximum cooling on land was brief in Australia and PNG. Deglaciation was rapid in Australia but much more delayed in the low latitudes. Maximum cooling ranged from 6-10 °C and there are indications of discontinuous permafrost at high elevations. Spatial heterogeneities in cooling and drying probably occurred and these were probably related to synoptic circulation.

Terrestrial-aquatic ecosystems responses to ENSO in Tasmania

Kristen K. Beck

Michael-Shawn Fletcher, Linda Barry, Patricia Gadd, Henk Heijnis, Geraldine Jacobsen, Giri Kattel, Krystyna Saunders

El Niño Southern Oscillation (ENSO) is one of the main drivers of fire activity, terrestrial ecosystem processes and landscape change in the Southern Hemisphere. Recent studies from across southeast Australia reveal a transition from a Southern Westerly Wind (SWW) dominated climate to an ENSO dominated system during the mid-Holocene (between ca. 6-5 ka). We present a new record from Paddy's Lake in northwest Tasmania that reveals an initial onset of ENSO influence at ca. 6.7 ka, demonstrating a hypersensitivity of terrestrial ecosystem dynamics in this region to tropical ENSO variability. But what of aquatic ecosystem dynamics? Here we compare our record of terrestrial ecosystem dynamics around Paddy's Lake with the first ever record of aquatic ecosystem dynamics derived from subfossil Cladocera remains in Tasmania. This multi-proxy dataset (charcoal, pollen, organic and inorganic geochemistry, cladocerans and rotifer) allows us to test for linkages between terrestrial and aquatic ecosystem dynamics and long-term climatic change. Our results reveal a tight coupling between aquatic and terrestrial ecosystem dynamics through the SWW-dominant phase of the record (ca. 14.5-6 ka). We also observe a tight coupling between terrestrial pollen accumulation and δ15N, which we speculate reflects the influence of terrestrial productivity over aquatic ecosystem N cycling. Finally, we observe a decoupling of terrestrial and aquatic ecosystem dynamics after ca. 6 ka, following the first of a series of local ENSO-driven fire events. Our results highlight the persistent influence of climate over terrestrial-aquatic ecosystem linkages and underscore the pervasive influence of ENSO over southeast Australian natural systems.

Rapid mapping of a Holocene coastal landslide using Structure-from-Motion (SfM) photogrammetry: Ohuka Landslide, Port Waikato, North Island

David Bevan

Martin Brook, Jon Tunnicliffe, Warwick Prebble

The availability of high-resolution Digital Surface Models (DSMs) of coastal landforms is of increasing interest for scientists involved in the study of Quaternary environmental change. Among the range of terrestrial and aerial methods available to produce such a dataset, this study applied the Structure-from-Motion (SfM) approach to low-altitude aerial images collected by Unmanned Aerial Vehicle (UAV). The SfM image-based approach was selected as a mapping tool in order to provide a rapid, cost-effective, and highly automated method, able to produce 3D information from unstructured aerial images. SfM generates high-resolution topography and coregistered texture (colour) from an unstructured set of overlapping photographs taken from varying viewpoints, overcoming many of the cost, time, and logistical limitations of LiDAR and other topographic surveying methods. This project is part of a broader investigation into the engineering geomorphology of the Ohuka Landslide at Port Waikato, New Zealand. Geomorphic features include a large arcuate scarp, flanked by gullies, which indicate the lateral boundaries of slope failure. Other topographic features include a ~500 m wide bench with uphill-facing scarps, pull-apart zones, and mounds, parallel to the coast. These features are interpreted as the result of sliding and extension triggered my Holocene sea level rise, and erosion of the coastal toe slope. Sliding was facilitated along saturated clay seams, in particular the 1 Ma Kidnapper's Tephra. SfM greatly facilitated the imaging of subtle slope failure features related to past as well as recent slope activity. Our results and experiences indicate SfM is an inexpensive, effective, and flexible approach to capturing complex topography formed by Quaternary environmental changes.

Glacial Geomorphology of the Brabazon and Butler Downs in the Rangitata Valley, New Zealand

Rosabella Borsellino

James Shulmeister & Stefan Winkler

The inland valleys of New Zealand's South Island were heavily glaciated during the last glacial cycle. Subsequent fluvial incision has eroded out glacial deposits from the valleys in many locations, making it difficult to reconstruct glacial dynamics and chronology. The Brabazon and Butler Downs lie in a fault controlled intra-montane basin that has been largely protected from fluvial erosion and the area contains extensive evidence for multiple glacial margins. This paper presents a detailed glacial geomorphology map of the Brabazon and Butler Downs. Glacial landforms have been mapped and subdivided into three main zones: an upper zone distinguished by a flight of kame terraces, a middle zone containing kettles and meltwater channels, and a lower zone of lateral moraines. The new map provides insight into former glacial behaviour and chronology in the region and provides a related framework for future paleoclimate reconstructions.

Millennial scale events from marine sediment cores in the SW Pacific during Marine Isotope Stage 3

Helen Bostock

Bryn Taiapa, Lionel Carter, Patricia Gadd, Geraldine Jacobsen, Vladimir Levchenko, Helen Neil, Lisa Northcote

Marine Isotope Stage 3 (MIS3) is an important period in the Earth's climate history as it contains a series of millennial scale events evident in ice core records. This study developed high-resolution marine sediment records from two cores in the New Zealand region to identify millennial scale variability during MIS3 in the SW Pacific. Core TAN1106-28, from south of New Zealand, is bathed by subantarctic waters, south of the subtropical front (STF), and MD97-2121, off the east coast of Hawkes Bay, is bathed by subtropical waters, north of the STF. Grainsize, carbonate content, stable isotopes, radiocarbon dates and micro-XRF studies were used to reconstruct ocean/climate variability at the core sites. The southern core TAN1106-28 displays millennial scale events in both productivity fluctuations and terrestrial accumulation. Productivity at core site TAN1106-28 increased during warm Antarctic Isotope Maxima (AIM) events possibly caused by increased light and warmth, while terrestrial proxies increased during stadial phases, likely due to increased onshore glacial activity. In contrast, there is little evidence for millennial scale fluctuations in MD97-2121. The expression of AIM events in marine sediment records to the south of the STF, and the dampening of this signal in MD97-2121 north of the front, strongly suggests the STF acts as a barrier to the AIM signal, restricting the expression of the Antarctic climate signal in the Southern Hemisphere mid latitudes.

Using Micro-XRF to identify crypto-tephra in marine sediment cores

Helen Bostock

Bryn Taiapa, Lionel Carter, Patricia Gadd, Ian Schipper, Geraldine Jacobsen, Vladimir Levchenko

Tephra layers provide important chronostratigraphic markers in marine cores. However many of these tephras are crypto-tephras and are not observable in the sediment during core logging or Xrays. This study used high-resolution micro-XRF elemental analyses (1 mm resolution) to help identify crypto-tephras in marine sediment core MD97-2121 from offshore central Hawkes Bay. Elements Si, K, Ca, Ti, Fe, Sr and Zr were used to identify potential crypto-tephra in the sediment. The use of the micro-XRF data to identify crypto-tephra was only moderately successful as several events identified in the elemental data did not have elevated concentrations of glass shards. However, two additional, previously unidentified, crypto-tephras the Rotoehu and the Tahuna were identified during Marine Isotope Stage 3 (MIS3). The tephras were confirmed by visual inspection using a binocular microscope and glass shards were picked and analysed for major elements using an electron microprobe. Further confirmation was provided by radiocarbon dates analysed on planktonic foraminifera below the crypto-tephra.

In contrast to basaltic tephras, identification of rhyolitic tephras using micro-XRF techniques is non-trivial as they commonly have similar elemental signatures to other rocks that contribute background terrigenous sediment to marine cores. However, the use of fast, non-destructive micro-XRF techniques can assist in identifying potential sections of sediment cores for more detailed sampling and traditional tephra identification methods.

Adaptation in the hind limbs of extinct Island Emus (Dromaius species)

Tori BREWSTER

Sanja VAN HUET, Elizabeth WELDON

The modern emu Dromaius novaehollandiae (Christidis & Boles 2008) has two extinct relatives; the King Island emu, D. ater (Vieillot 1817), and the Kangaroo Island emu, D. baudinianus (Parker 1984). These extinct emu taxa are externally distinguishable from the modern emu by their smaller stature. Previous studies have suggested that isolation, through sea level rise, from the Australian mainland contributed to the morphological differences between the mainland and Island populations (Heupink, Huynen & Lambert 2011). Previously published work has suggested that the smaller stature of the extinct island emus was due to insular dwarfism (according to Fosters Island Rule) (Heupink, Huynen & Lambert 2011). However, environmental differences such as the vegetation, topography, land area and climate (Boyer & Walter 2010) on King and Kangaroo Island may have also contributed to the dwarfing of the Island emus. The mainland emu D. novaehollandiae has adapted to an open vegetative patchwork of wet and dry sclerophyll forests and semi-arid plains and has been noted to practice a cursorial locomotion suited to this environment (Abourachid & Renous 2000). By contrast, King and Kangaroo Islands, prior to white settlement, were characterised by scrubby and dense vegetation (D'Costa, Grindrod' & Ogden 1993; Hope et al. 1977). This vegetatively closed environment would suit ground dwelling birds that have developed a more graviportal-style locomotion (Cracraft 1974). Preliminary findings show an increase in overall robustness and a decrease in overall length in the tarsometatarsus (lower leg bone) of the island emus. This is consistent with the hypothesis that isolation and differences in vegetative environment may have contributed to graviportal development in the Island birds.

Quaternary geology of the Auckland urban region, New Zealand: geotechnical properties and engineering implications

Martin Brook

Ross Roberts, Sian France, Ann Williams, Warwick Prebble, Nick Richards

The Auckland urban area is mainly underlain by Miocene East Coast Bays Formation sandstone and siltstone, overlain by Quaternary Tauranga Group sediments. Due to rapid growth, infrastructure development and residential subdivision is expanding into areas dominated by the Tauranga Group, which were previously relatively undeveloped as a result of the geotechnical challenges these materials pose. The engineering geology of these sediments is therefore of increasing importance. The thickness of the Tauranga Group is highly variable, increasing within paleo-valleys and decreasing up valley flanks. Fluctuating sea-levels and a range of material sources have resulted in sediment variability (sand, clay, silt and peat), as well as cycles of deposition and erosion. These deposits have very variable lithology and material properties, may be unconsolidated to compacted, but are typically soft and susceptible to creep and shallow flow on gentle slopes, when saturated. Impediments to planned development includes high construction costs related to geotechnical risks. Ground settlements from excavation and dewatering to facilitate construction are difficult to predict due to variability within the Tauranga Group. In addition, Auckland Volcanic Field ("AVF") material, typically as basalt flows or mantles of tuff and ash associated with specific volcanic centres, can lead to complex groundwater regimes and the risk of differential ground settlement. Other geotechnical risks include the amplification of seismic shaking, potentially liquefiable soils, high (and variable) compressibility, slope instability, erosion susceptibility and chemical changes as a result of dewatering organic deposits. Hence, site-specific investigations are particularly important because of the range of Quaternary-age materials encountered.

Validating the use of Infra-red spectroscopy to infer changes in fire history, carbon dynamics and dust flux from lake sediments

Haidee Cadd

John Tibby, Jonathon Tyler, Cameron Barr

Lake and wetland sediments are a powerful archive that can provide long-term information on terrestrial ecosystem change. A combination of pollen, charcoal and mineralogical analyses can be used to produce robust conclusions on the drivers of ecosystem change through time. However, the time, cost and sediment volume required to analyse multiple proxies from a single sediment core often inhibits high-resolution multi-proxy records being developed from long sediment cores. Analysis of sediment samples in the visible to mid-infrared (IR) spectrum enables rapid and cost-effective analysis of small quantities of sample material for multiple mineral and organic sediment components. IR spectroscopy is routinely used to determine variations in mineral and carbon content of surface soils and has been successfully used to determine total inorganic carbon (TIC), total organic carbon (TOC) and biogenic silica content from sediment cores. An important component of the organic carbon content of soils and sediments is the presence of charcoal, both for its ecological and cultural significance. Whilst IR spectroscopy has been successfully used to determine charcoal content in soils, this technique has not yet been applied to lacustrine sediments. Here, we examine the use of IR spectroscopy to infer lake sediment charcoal, TOC and clay mineral composition by comparing IR analyses with conventional measurements from a ~100,000-year sediment core from Welsby Lagoon, North Stradbroke Island. Our aim is to develop a quantitative calibration that can be used to generate several high-resolution records, both from this site and similar sites across Australia.

Geochemical signals in bivalve shells as evidence of hydroclimate variability in the Coorong Lagoon, South Australia

Briony Chamberlayne

Jonathan Tyler, Christopher Izzo, Bronwyn Gillanders, Deborah Haynes, Geraldine Jacobsen, John Tibby

Resolving intra- and inter- annual scale variability in the context of centennial-millennial scale climate change remains an ongoing challenge in palaeoclimatology. Bivalve sclerochronology offers a potential solution to this challenge. Bivalves frequently record sub-annual scale variability in the geochemistry of their growth increments. When shells are abundantly preserved in sedimentary sequences, they provide archives of both short and long term variability.Here we present a new record of hydroclimate variability based on the oxygen isotope and elemental composition of the micro-mollusc Arthritica helmsi from the southern Coorong Lagoon, South Australia. Bulk shell analyses trace lagoonal water evaporation/inflow at ~20 year resolution over the last 2500 years. Replicate analyses on whole shells, plus laser ablation ICP-MS analysis on several individual shells from select layers provide an index of intra- and inter- annual hydroclimate variability for select layers. Our analyses suggest that the range of variability varies alongside low frequency climate variability, whereby centuries of enhanced evaporation (higher 18O) are associated with a greater range of short term variability. During these periods of increased seasonality, it was the seasonal maxima that was most responsive to low frequency change, while the minima remained comparatively stable. These results, along with preliminary calibration data on modern shells from the Coorong, are discussed in the context of understanding the dynamics of climate extremes in response to long term climatic change.

The development of an independent paleo-temperature proxy using stable oxygen isotopes (δ18O) of chironomid head capsules from south-eastern Australia

Jie Chang

Shulmeister, J., Gröcke, D.R., Woodward, C.

The results from the first systematic investigation of stable oxygen isotopes (δ18O) of the subfossil chironomid head capsules (HCs) in the Southern Hemisphere are presented. We examine the potential for the δ18O of two groups; the genus Chironomus and the subfamily Tanypodinae, as a temperature proxy for use in south-eastern Australia. δ18O of Chironomus HCs was analysed from sixteen lakes and δ18O of Tanypodinae was analysed from nine lakes in south-eastern Australia. Overlapping measurements from five lakes were obtained which allowed direct comparison between the taxa. The δ18O of Chironomus HCs is strongly correlated with air temperature but only for lakes in areas with high precipitation to evapotranspiration ratios. Overall Tanypodinae HCs have stronger correlations with the δ18O of lake water, δ18O of precipitation. δ18O of Tanypodinae HCs and summer air temperatures are strongly correlated (r = 0.84) supporting their strong potential to be applied as a temperature proxy. Chironomus spp are both tube feeders and efficient users of haemoglobin and these factors appear to disassociate their δ18O values from immediate environmental effects in situations where oxygen supply is limited. While both taxa show promise we recommend that paleotemperature reconstructions focus on Tanypodinae.

Coral Reconstruction of mid-Holocene Ocean-Atmospheric dynamics of the Great Barrier Reef

Tess Chapman

Bradley Opdyke, Helen McGregor

A fossil Porites core from the northern Great Barrier Reef was examined to reconstruct sea surface temperature (SST) variations and upwelling events in the early to mid-Holocene. The coral core is uniquely located where the South Equatorial Current (SEC) Bifurcates. Upwelling reaches the interior reef presumably through jets of water that move through the channels between the ribbon reefs. A suite of ten trace elements were analysed via LA-ICP-MS in three coral samples, with particular emphasis on Sr/Ca, Ba/Ca, Li/Mg and U/Ca ratios. The 2010-2016 sea surface of the temperature of the area is between 23°C and 29°C, with a 6 degree variation. In comparison Sr/Ca ratios in the fossil material reveal a larger relative annual variation of 11°C. Ba/Ca ratios are used as a nutrient proxy and as such can be analysed to observe seasonal upwelling that occurs during the winter months. Today, upwelling is associated with the SEC and the South East Trade winds. Therefore, Ba/Ca in the fossil corals was able to be used as a proxy for the strength of south east trade winds. There were more upwelling events seen in the fossil core compared to modern day values suggesting higher variations in the strength of trade winds. Furthermore, Coral extension coincides with upwelling events, suggesting that the influx of nutrient rich water promotes calcification more so than higher seasonal temperature variations indicated by Sr/Ca values.

Reconstructing Holocene relative sea-level changes in the New Zealand region: current challenges and future directions

Alastair J.H. Clement

Pippa L. Whitehouse, Craig. R. Sloss

New Holocene relative sea-level (RSL) reconstructions show spatial and temporal variations in the timing, magnitude, and duration of RSL changes around the New Zealand coast. A number of potential drivers operating at a range of scales may be responsible for this variation, Post-glacial meltwater loading on the continental shelf around New Zealand is predicted to have a significant effect on the timing and magnitude of RSL changes through the phenomenon of continental levering. Observed RSL records may also be significantly affected by tectonics, wave climate, sediment regime, sediment compaction, and the marine reservoir effect. However, these variables are currently poorly constrained. Efforts to produce robust, precise, and accurate reconstructions of RSL changes around New Zealand, and thereby elucidate the impacts of these drivers on RSL records, are hampered by a dearth of robust palaeo sea-level indicators: only 206 in the current New Zealand dataset. There are broad gaps, both spatially and temporally, in the current coverage offered by these palaeo sea-level index points. Filling these gaps requires careful geomorphic appraisal of the New Zealand coast, as current sampling strategies may induce temporal bias by favouring the sampling of mid- and late-Holocene deposits while ignoring or omitting to sample early-Holocene deposits.

Holocene evolution of the Manawatu coastal plain incised-valley system

Alastair J.H. Clement

Craig R. Sloss, Ian C. Fuller

Vibracores and well logs were used to reconstruct the evolution of the lower Manawatu valley, North Island, New Zealand, in response to Holocene relative sea-level (RSL) change and rapid sediment influx from the bordering axial ranges. Features identified within the Holocene fill include: lowstand incision of the river during the Last Glacial Maximum (LGM), and buried LGM fluvial terraces; the estuary extent at the culmination of the Holocene marine transgression; the Holocene sedimentary succession that filled the valley associated with the Holocene RSL highstand; and late-Holocene coastal progradation of ~5 km. The Manawatu valley was infilled quickly in response to rapid sediment delivery by the Manawatu River. The palaeo estuary achieved a maximum extent at c. 7,500 cal yr BP, and was almost completely infilled by 4,900 cal yr BP. Rapid infilling produced an almost instantaneous transition from estuarine to alluvial conditions as the coastal plain prograded down the valley. Evidence of a transitional bay-head delta facies is limited, possibly as the rapid infilling eliminated the necessary accommodation space, thereafter leading to sediment bypass. The RSL record for the valley shows that the marine transgression culminated c. 7,500 cal yr BP. Thereafter, RSL indicators record a brief highstand, followed by a fall in RSL. This fall is interpreted as a record of subsidence of the valley due to a combination of sediment compaction, post-glacial water and sediment loading, the evolution of the Wanganui Basin, and neotectonics.

Distinguishing Human-Induced and Natural Coastal Geomorphological Change: Late Holocene Case Studies from Fiji and Sāmoa

Ethan Cochrane

Alex Morrison, Haunani Kane, Charles Fletcher III, Timothy Rieth, Mark Horrocks

The human colonization of Remote Oceanic islands approximately 3000 years BP was coincident with regional environmental processes such as late Holocene sea level drawdown. Island colonization also included human introduction of exotic plants and other alterations to native vegetation. Both regional processes and local human behaviour thereby contributed to geomorphological change in the coastal settings where many colonizing populations settled. Distinguishing human versus natural agents of geomorphological change, however, can be difficult, but is necessary to explain sequences of human adaptation and environmental change. In this paper I present two case studies, from Sāmoa and Fiji, using a range of techniques including sedimentology and grain-size analysis, plant microfossils and foraminifera, archaeofauna, radiometric data, and simulation modelling, to untangle human-induced and natural coastal change.

Speleothem records of millennial-scale climate events during the last glacial period: implications for ice core chronologies

Ellen Corrick

Russell Drysdale, John Hellstrom, Eric Wolff, Isabelle Couchoud, Dominik Fleitmann

In this paper we undertake a comprehensive comparison of speleothem records of millennial-scale climate events of the Last Glacial period. We aim to determine the extent to which the timing of these events was synchronous between different cave sites from around the world. In order to perform the most robust comparison possible, we will standardise the data sets by first recalculating the radiometric ages (using common isotope decay constants) and then by producing new depth-age models using a common Bayesian Monte Carlo approach. We follow reproducible methods of identifying and defining the events in each of the data sets, before statistically comparing their precise timing across all of the records. In doing so, we will assess the extent to which speleothem records are globally consistent, and provide comment on whether or not they can be used to provide age anchor points to constrain Greenland ice-core chronologies. Additionally, we will explore the varying levels of sensitivity that speleothems exhibit to millennial-scale climate events. We conclude by providing recommendations to further the application of speleothem records to radiometrically constrain Greenland ice-core records.

Unrecognised dammed Holocene palaeolake at the terminus of the Murray-Darling River Basin, Australia: palaeoclimate implications

Elyssa De Carli

Hubble, T., Penny, D., Petley, D., Job, T., Hamilton, R., Clarke, S., Gadd, P., Brand, H., Helfensdorfer, A

The Murray-Darling River Basin (MDB) is Australia's largest river system covering 14% of Australia's landmass, with precipitation and discharge strongly influenced by globally significant oceanic-atmospheric circulation systems. The Basin is central to Australia's agricultural productivity, and with water security threatened by projected climate change, understanding Basin response to climatic variability over geological timescales is fundamental for adaptive management. Current reconstructions of Basin palaeoclimate draw heavily upon remote proxies and an offshore archive of terrigenous sediment flux to the submerged continental shelf to reconstruct fluvial discharge and south-eastern Australia's hydroclimatic variability. Here we identify an in situ laminated sequence formed within a previously unrecognised Holocene palaeolake, confined within the lower Murray River Valley and dammed at the coastal-fluvial interface, and propose an alternative hypothesis for the geomorphic evolution of the lower Murray River. Our results demonstrate that suspended-sediment was sequestered at the terminus of the MDB for the majority of the Holocene, effectively starving the continental shelf of fluvial sediment and giving a false impression of reduced palaeodischarge driven by increasing aridity in the widely used offshore archive. The palaeolake archive we describe provides the first in-situ high-resolution record of Murray and Darling catchment floods and Basin response to hydroclimatic variability. This discovery will reinvigorate debate regarding Holocene climate in Australia, generate detailed long-term data on Basin response to climatic variability and be of significance in documenting Holocene variability of synoptic-scale oceanic-atmospheric climate systems in the Southern Hemisphere.

Solving the Monkey Puzzle: Long term environmental history of Araucaria Araucana

Bianca Dickson

Michael-Shawn Fletcher, Patricio Moreno

Natural disturbance is a key process driving ecosystem dynamics. Vegetation succession, a fundamental process underpinning ecology, explains the development of an ecosystem following disturbance. Despite the importance of disturbance in ecosystem dynamics, disturbance ecology is a relatively unexplored field. Focus is typically afforded to the role of ubiquitous disturbance events (e.g. fire), which often reveal deep ecological imprints. However, relatively little is known about the long term influence of less widespread disturbances such as volcanism on ecosystems.The current distribution of Araucaria araucana forests, at high altitude and primarily within one of the highest densities of active volcanoes on Earth, prompts questions over the role of volcanic disturbance in this ecosystem. This project set out to better understand long-term vegetation dynamics and response to volcanic events (areal deposition of volcanic ejectite - tephra) in A. araucana forests of the Araucanía region of Central Chile. A sediment core was extracted from Lago Cilantro (a site located within an A. araucana forest surrounded active volcanoes) and analysed for the effects of volcanic disturbance on vegetation using a set of palaeoecological proxies. While shifts in the local vegetation were correlated with volcanic events, A. araucana ecosystems are remarkably resilient to even large-scale (>2.5 m) deposition of volcanic ash. This project will increase knowledge of how potentially vulnerable species, such as A. araucana, respond to both climatic change and disturbance to predict their response to future environmental changes.

Lake Kai iwi muds, a Last Glacial Cycle record of ecological and climate variability from far northern New Zealand

Amber DITCHFIELD

Paul AUGUSTINUS, Gianna EVANS, Patricia GADD

Far northern New Zealand has few paleoenvironment records that span beyond the past 30,000 years and most of these are from bogs displaying variability in sedimentation rates and completeness. Consequently, we have produced a lake sediment-based multiproxy record of environmental change from northern New Zealand, in an attempt to expand the available paleoenvironmental records through the whole Last Glacial Cycle (LGC). Overlapping sediment cores were collected from the middle of the 17 m-deep lake using a UWITEC barge-mounted coring system, with a complete composite lake sediment sequence of ~10 m-length developed via visual matching of stratigraphy of core section logs. This process was aided by Itrax scanner-derived time series of sediment X-ray density and multi-element geochemistry. The composite core generation was further supported by matching of tephra in offset core lengths, sediment TOC, TN, TS, LOI% and grain size variability. The 46 ka Rotoehu tephra was identified at 2.92 m depth in the sequence with the ca. 36 ka Hauparu at 1.93 m and Mayor Island-sourced peralkaline tephra at 4.38 m which probably matches the ca. 79 ka M1 tephra. 14C ages from below the Rotoehu tephra are all >50 ka. Based on compaction and sedimentation rates down to the Rotoehu and M1 tephra, it appears that the sequence encompasses all of the LGC. This inference is supported by preliminary pollen analysis of the whole composite core that indicate subtle climate oscillations coeval with the Marine Isotope Stages. Work is ongoing to refine the vegetation record and sequence chronology.

Ancient times of a wetter Australia as recorded by speleothems of the Flinders Range

Anthony Dosseto

Jan-Hendrik May, Stephen M. Eggins

Finding archives that have continuously recorded palaeoclimatic conditions can be challenging in Australia. The Flinders Range has a large number of rock shelters with fossil speleothems that could help fill this gap using uranium-thorium dating. The age of speleothems may indicate periods wet enough for speleothem growth, while the calculated initial 234U/238U can also be used as a proxy for water availability in the environment feeding water to rock shelters. Our results show speleothem growth has taken place in the Flinders Range as recently as 500 yr ago. Despite semi-arid conditions, growth could be still taking place at present. Thus, dating alone could be insufficient to diagnose wet conditions. Initial 234U/238U ratios indicate increasingly wetter conditions between 13 and 9 ka, followed by drying conditions between 8 and 5 ka. The latter episode is at odds with other studies (Marx et al., 2009; McCarthy and Head, 2001; Quigley et al., 2010). This may reflect that speleothems record transient conditions while other proxies are on/off switches. In this case, the mid-Holocene would have been wet but getting drier. Some speleothems provide a 500 ka record of water availability and show increasingly wetter conditions between 450 and 70 ka, showing little influence of previous glacial cycles. Following the wettest conditions recorded at 70-80ka, there was a dramatic shift to drier conditions between 70 and 60 ka. While our approach deviates from classical speleothem studies, it provides a versatile way to derive palaeo-environmental information, as illustrated here for southern Australia.

Northland barriers provide records of sea level and storms during late Quaternary highstands

Amy J. Dougherty

Jeong-Heon Choi, Mark Dickson and Anthony Dosseto

Anticipating the likely physical response of coastal barriers to future climate change requires knowledge of their past evolution. Prograded coastal barriers preserve a record of previous beach behaviour within their accreting sands. Paleo-beachfaces can be imaged at decimeter resolution with Ground-Penetrating Radar (GPR) and precisely dated using Optically Stimulated Luminescence (OSL) providing a history of process drivers along an active coast. The height of paleo-beachfaces, which is fundamentally linked to past ocean elevations, can then be used to reconstruct sea-level curves; the geometry of paleo-beachfaces, intrinsically linked to wave-energy, can provide a record of storms. Data from three Holocene prograded barriers (Omaha, Marsden Point and East Beach) and one Pleistocene barrier (One Tree Point, which forms the Bream Bay composite barrier system with Marsden Point) provide insight into Quaternary sea level and storms for this Northland Region of New Zealand. A distinct decrease in the height of the beach-dune interface was captured in GPR data collected across all three sites, indicating that sea level fell in a nonlinear fashion form a +2 meter mid-Holocene highstand. Analyses of the Pleistocene barrier extend this record back to Marine Isotope Stage 5e when it appears that an overall drop in sea level occurred from around an +6-4 m highstand to +2 m during the Eemian. As sea level fell, storm-eroded beachfaces were preserved which formed prominent reflections throughout all of the GPR records. Analysis determined recurrence intervals of ~250, ~500 and ~1,000 years with differing impacts indicating storm intensity increased as frequency decreased.

Reconstructing past climate in the north Waikato area, North Island, New Zealand, using subfossil leaves preserved in diatomite

Andrew Douie

Bethany Fox, Elizabeth Kennedy and David J Lowe

The Kellyville maar, located near Mercer and dated at 1.48 ± 0.10 Ma, is part of the basaltic South Auckland Volcanic Field that was active from c. 1.6–0.5 Ma. The crater of the maar, ~2 km in diameter, is infilled with partly eroded lake sediments. The uppermost sediments comprise finely laminated diatomite rich in subfossil leaves. This project will characterise the subfossil leaf assemblage in terms of taxonomic diversity and then apply the Climate Leaf Analysis Multivariate Program, CLAMP. CLAMP is a leaf physiognomic model for woody dichotomous plant taxa (basal angiosperms, magnoliids and eudicots) used to help reconstruct past climate and other parameters. Five leaf traits are examined: size, shape, apex, base, and margin. A total of 31 trait states fall within the five categories. By calibrating the observed values to a calibration data set, CLAMP is able to produce up to 11 specific parameter estimations that fall within five broader parameters: temperature, growing season, precipitation, humidity, and altitude/elevation. The model has been shown to produce predictions that are relatively consistent with findings from other paleoclimate proxies. Because of the relatively young age of the deposit, the taxonomic analysis will be compared to extant species as well as extinct species known from the Neogene and Quaternary periods. Ultimately, we hope to use CLAMP and the Kellyville subfossil leaves to reconstruct regional climate at MIS 50 is at c. 1.5 Ma from LR04 benthic stack Lisieki and Raymo 2005.

The timing of glacial terminations from Corchia Cave (Italy) speleothem records

Russell Drysdale

Petra Bajo, Giovanni Zanchetta, John Hellstrom, Isabelle Couchoud, Eleonora Regattieri, Ellen Corrick, Jon Woodhead

The mechanisms that force glacial terminations constitute an ongoing debate in palaeoclimatology. A key to resolving the debate is the provision of precisely dated proxy records that can be tied to the expression of these events in marine sediments, which are difficult to date. We present speleothem data from an Italian cave system spanning several terminations of the Middle Pleistocene Transition and Late Pleistocene, and tie these to marine records from the North Atlantic. This allows us to anchor the marine record in radiometric time and thus constrain the timing of ice-sheet collapse and explore the potential astronomical parameters responsible.

A cross-hemispheric comparison of Last Interglacial climate variability using Italian and NZ speleothem records

Russell Drysdale

Giovanni Zanchetta, John Hellstrom, Isabelle Couchoud, Petra Bajo, Eleonora Regattieri, Ellen Corrick, Jon Woodhead

We compare precisely dated, high-resolution speleothem stable isotope records of the Last Interglacial (LIG) from Corchia Cave (Italy) and Nettlbed Cave (NZ). Both records show an early LIG optimum of several thousand years, indicating synchronous bipolar warming immediately following Termination II. From 127 ka, we see bipolar cooling, which first occurs in NZ. This heralds the beginning of a series of anti-phased, millennial-scale cooling/warming events. It appears that peak warming during the early LIG (which was warmer than present) may have triggered ice-sheet melting (possibly WAIS and definitely Greenland), which seems to have paved the way for a resumption of a weak 'interglacial version' of the bipolar seesaw, which was too weak to have been felt in East Antarctic ice cores. High-resolution Southern Ocean marine records are needed to confirm this hypothesis.

Millennial-scale climate variability during the last glacial termination recorded by New Zealand glaciers

Shaun Eaves

Andrew Mackintosh, Brian Anderson, Kevin Norton, Stephen Tims, Richard Jones, Feng He, Joel Pedro

The last glacial termination (c. 19-11 ka BP) represents the most recent natural reorganisation of the global climate system. This event offers insight to the transient response of the earth system to external and internal forcing. Global climate model simulations provide opportunities to test the hypothesised drivers and physical mechanisms of global deglaciation, however the veracity of these simulations requires assessment using climate proxy data. Here we present a new cosmogenic 10Be moraine chronology and glacier-model derived temperature reconstructions from the Spenser Mountains, situated on the northern edge of the Southern Alps. At the Last Glacial Maximum, numerous cirque glaciers around the western slopes of the Spenser Mountains fed a large outlet glacier that filled the Matakitaki River valley. We have mapped and dated multiple moraine crests present in these cirques, which record the former ice geometry at several times during the last glacial termination. We used a 2D numerical glacier model to provide quantitative palaeotemperature estimates for each of these dated former ice limits. Combining our new data with recent and published glacier reconstructions from the central North Island and Southern Alps, we find that our glacier-based temperature reconstruction for the last glacial termination in New Zealand shows close agreement with that predicted by transient global climate model simulations. Climate model sensitivity experiments suggest that the majority of the warming in New Zealand during the last glacial termination was the product of CO2 rise and changes in oceanic heat transport linked to the bipolar seesaw.

The formation and evolution of the Cooloola Sand mass over the later Quaternary

Daniel Ellerton

James Shulmeister, Kevin Welsh, Tammy Rittenour

The Great Sand Region of south east Queensland is home to Fraser Island, the world's largest sand Island and the adjacent Cooloola Sand Mass. Together these large, Pleistocene aged coastal sand barriers form the terminus of the longest downdrift sediment system on the planet. At Cooloola, several phases of dune building, stabilisation and erosion have resulted in the development of stacked dune and soil sequences that form a chronosequence moving east to west. Previous work in the region has focused on the surface morphology and soil development along the chronosequence as well as the hydrology and biology of the area. Comparatively little work has been conducted on the timing of dune emplacement and the evolution of the dunefield over the late Quaternary.This study aims to develop a robust chronostratigraphic framework for the Cooloola Sand Mass using optically stimulated luminescence (OSL) dating. Samples have been collected from each major dune system along the chronosequence as well as from cliff exposures along Rainbow Beach, a coastal bluff along the northern edge of the sand mass. In addition to dating the Cooloola dunefield, this study is also using ground penetrating radar (GPR) surveys and digital terrain models to develop a better understanding of the morphology and structure of Cooloola. The latest available OSL results will be presented. OSL dates suggest dune emplacement occurring at ~700 ka, ~500 ka, 150-140 ka, 72-58 ka and 2-3 ka. The ages appear to coincide with glacial periods

Modern and paleo-weathering regimes in sedimentary records determined by boron isotopes

Christian Ercolani

Damien Lemarchand, Anthony Dosseto

Silicate weathering (through soil formation) is an important process that regulates climate over millennial timescales. However, little is known about how pedogenesis responds to climate variations. Boron isotopes (δ11B) in sedimentary records may be used to understand how the role of vegetation on clay formation has varied over time, possibly in response to climatic variability. This is because boron (B) isotopic fractionation occurs during precipitation of secondary products and interaction with vegetation (Lemarchand et al., 2012). However to interpret sedimentary records, we need to understand how the signal is transferred from sediment source regions to the depositional environment. In the present study, we analyze modern sediments of the Murrumbidgee River Basin, NSW Australia and then use that information to help interpret the boron isotope signature of paleochannel deposits (deposition ages: 13 – 105 kyr). Analyses of the clay-sized minerals along the course of the modern river show an evolution towards heavier compositions, indicating that the δ11B signal acquired in the upper catchment is lost during transport. This implies that paleochannel deposits are recording conditions of clay formation on the plain. Results from paleochannels show a pattern of decreasing δ11B values over the last glacial cycle, reaching a minimum during LGM. This is interpreted as a decreasing role of vegetation on clay formation between MIS 5 and MIS 2, which resumes in the Holocene. These results show a tight coupling between the role of plant ecosystems on pedogenesis with climatic variations over the last glacial cycle.

Periodicity of wind and precipitation signals evaluated from high-resolution Itrax scans, Lake Kawaupaka, New Zealand

Gianna Evans

Paul Augustinus

Sediment cores from Lake Kawaupaka were analyzed to investigate changes in wind and precipitation signals associated with positional shifts in the South Westerly Winds (SWW) over the late Holocene. Lake Kawaupaka is located along the west coast of northern New Zealand and east of an iron-sand beach. The lake itself is bed rock controlled, with the outlet along the northwestern edge formed by partially or wholly vegetated iron-sand dunes containing 40-80% titanomagnetite. In order to confirm the viability of the iron sand deposition in the lake sediments as a reliable wind proxy; results from magnetic susceptibility (MS), grain size, and percentage of magnetite in the lake sediments (Mag%) were compared. The grain size shows an oscillation between a domination of silt/clay sized particles and sand sized particles. Peaks in the MS and Mag% coincide with periods of sand deposition confirming that the sand is sourced from the iron-sand beach to the west. TOC/TN ratios indicate periods of increased influx of terrestrial organic matter associated with increased runoff due to increased precipitation. The result from these proxies have been utilized to confirm wind and precipitation signals recorded within high-resolution Itrax elemental geochemical data. This geochemical time-series was analyzed with a Morlet Wavelet function to identify periodicity and frequency of wind and precipitation in order to investigate changes in the timing and intensity of Southern Hemisphere climate drivers such as El Niño Southern Oscillation (ENSO) and the Southern Annular Mode (SAM).

Alluvial soil geochemistry and micromorphology based evidence of environmental change in the Sabie-Sand River Basin, South Africa

Peter N. Eze

Jasper Knight

Three pedons on the alluvial terraces of the Sabie-Sand River Basin within Kruger National Park, South Africa, were studied to improve our understanding of recent environmental changes, assess degree of chemical weathering and pedogenesis in the area using geochemical and micromorphology proxies. Particle-size distribution was obtained using Malvern Mastersizer; soil geochemistry was determined by XRF and thin sections by routine laboratory procedures. Calcification is the dominant pedogenic process in these alluvial soils. The Chemical Index of Alteration (CIA) proved a more suitable index than Chemical Index of Alteration (CIW) for evaluating weathering in the terraces. The micromass and b-fabrics are mostly granostriated and partly brown mosaic speckled. MISECA values for the degree of soil development range from 4 to 9, which mean weakly to moderately-developed soils. Coarse secondary calcite nodules and coatings are responsible for cementation as observed in pedon 2, which suggests calcium carbonate precipitation from periodical flooding and evaporating groundwater events. The features and diagnostic properties of the soils on the alluvial terraces along the Sabie-Sand River provide evidence for land surface impacts of recent environmental changes in this internationally important conservation area. Precise dating of calcium carbonate precipitates is, however, needed to put the observed evidence into a wider geochronological perspective.

Coherent millennial-scale hydroclimate variability in southern Australasia during the last glacial period

Georgina Falster

Jonathan Tyler, John Tibby, Peter Kershaw, Cameron Barr, Katherine Grant, Geraldine Jacobsen, Chris Turney

The response of Southern Hemisphere (SH) terrestrial precipitation to internal and external forcings during the Last Glacial Period (LGP; 30,000-10,000 yr. BP) is unclear, particularly in the mid-latitudes. Climate models are used to reconstruct the global earth system response to external and internal forcing during the LGP, but require support from proxy data when used to reconstruct climates outside of their calibrated range. Here we present a well-dated and high-resolution record of LGP hydroclimate variability inferred from the sediments of Lake Surprise, Victoria, Australia. Hydrological changes are interpreted from δ13C analysis of organic matter and μXRF derived dust concentration, and both tracers indicate abrupt changes coeval with other sites across Australasia. We use a Monte Carlo Empirical Orthogonal Function approach to assess the shared response of these sites to internal and external forcings, and develop a composite record of regional hydroclimate change for southern Australasia. The combined evidence suggests that Antarctic temperature and Southern Ocean sea surface temperature (SST) were the primary influences on precipitation at the Australasian sites during the LGP, with secondary influence from Indian Ocean SST.

Holocene coastal landscape change: Albatross Bay, north Queensland, Australia

Trish Fanning

Oon S., Fanning P.C., Sloss C.R., Petherick L., Westaway K.

Albatross Bay, in the Gulf of Carpentaria, provides an ideal setting to examine coastal landscape evolution in response to mid- to late-Holocene sea-level fluctuations. Located in a far-field site unaffected by glacio-isostatic sea level change, and with limited terrestrial sediment supply, there is negligible sedimentary-isostatic loading. The region is also in an intra-plate setting and has been relatively tectonically stable over the Quaternary. Field work was undertaken at three locations around Albatross Bay. The Kwamter and Wathayn locations are dominated by estuarine floodplain and mangrove fringe, backed by a single gravelly to sandy beach ridge, while the Red Beach location comprises multiple beach ridges overlying estuarine muds. At Wathayn, a cliff cut into the bauxite bedrock landward of the beach ridge most likely formed when Holocene sea levels were at their maximum elevation above present mean sea level, around 6 – 7,000 years ago. OSL age determinations on the beach ridge sediments and radiocarbon dates from shellmounds formed above them indicate that the beach ridge most likely formed shortly after, as sea-level began to recede. At Red Beach, OSL dates indicate that beach ridges started forming around 2,500 years ago. The 9 distal ridges were formed over a period of about 1,000 years, while the four proximal ridges were formed between 850 and 270 years ago. The age spread indicates that this beach ridge sequence likely formed relatively rapidly on a prograding shoreline following a late-Holocene sea level still-stand and subsequent regression commencing ca. 2500 years ago.

Using multiple dating methods to understand controls on geochronological complexity in organic spring deposits

Emily Field

Jordahna Haig, Jan-Hendrik May, Sam Marx, Geraldine Jacobsen, Atun Zawadski, David Child, Henk Heijnis, Hamish McGowan, Patrick Moss

Organic spring deposits in water-limited and arid environments provide high-resolution archives of climatic and environmental change in regions typically lacking conventional sites for this research. Since these springs are perennial water sources in otherwise challenging environments they have also been a focus of human and faunal activity and often include cultural and palaeobiological material. Despite the obvious potential of these spring sediments the vast majority of records have been complicated by confusing radiocarbon chronologies. This compromises the integrity of any reconstructions from such sites, and has implications for obtaining reliable dates for spring sediments found to contain artefacts.

We used a variety of techniques on three springs in northwest Australia to establish a protocol for building chronologies for organic spring deposits. Dating techniques included 14C with AAA and HyPy pre-treatments on several fractions (pollen, roots, charcoal, bulk organics). Additional chronological information was obtained by 210Pb analysis with validation by 239+240Pu, and Ln/Tn for stratigraphic information. Results suggest that pollen concentrate and bulk organics are unsuitable for obtaining accurate 14C dates in these settings, however macro-charcoal with AAA pre-treatment is appropriate where there is no post-depositional alteration. Due to the fluctuating nature of groundwater in springs it is essential that charcoal separates are examined for alteration not only via SEM but also EDX to determine their suitability, and HyPy pre-treatment may be necessary where alteration is apparent. Age control for recent organic spring sediments may prove more difficult due to post-burial uranium enrichment which is common to organic sediments in open systems.

Evidence of regionally synchronous environmental and climatic change across the Kimberley during the Holocene

Emily Field

Patrick Moss, Hamish McGowan, Patricia Gadd

The Kimberley's water limited environment means that there are few suitable sites such as permanent lakes and wetlands from which to develop high-resolution records of environmental and climatic change. Newly identified organic spring deposits found across the Kimberley offer valuable alternatives as archives of environmental change.Here we present multi-proxy records from three springs (Fern Pool, Gap Springs and Black Springs) on a broadly north-south transect 100 km in length. These records span similar time frames and can therefore shed light on whether climatic and environmental changes through the Holocene to present were felt regionally across the Kimberley. Data will be presented on ITRAX geochemistry, LOI, micro-charcoal (<150 µm), pollen and non-pollen palynomorph analysis. ITRAX and LOI reveal significant morphological changes of the springs related to major climatic shifts, in particular increased monsoon activity during the early Holocene. Analysis of pollen and non-pollen palynomorphs reveal changes in spring morphology in addition to the surrounding tropical savanna indicative of climatic change. Micro-charcoal accumulation rates provide a record of biomass burning and fuel loads.These springs therefore provide three, independent, high-resolution Holocene records of regional hydroclimate variability in northwest Australia forced by a number of climatic drivers including ENSO and its interplay with other teleconnections. These springs also provide an environmental context for changes seen in the archaeological records of the region.

Disentangling the role of people and ENSO on Australia's tropical savanna: a case study from near Darwin

Michael-Shawn Fletcher

I will present a 6000 year pollen and charcoal record from Giraween Lagoon, near Darwin in the Northern Territory. The site is critically located to test for the role of people and climate in driving long-term fire-vegetation change in the northern Australia. The region lies within a zone of strong correlation between inter-annual rainfall anomalies and ENSO. Recent speleothem-based palaeoclimate data from the Kimberly, in northwest Australia, reveals a dynamic interplay between the ITCZ and ENSO over recent millennia and I test for coherence between palaeoclimatic reconstructions and vegetation/fire activity change. The results reveal a long-term climatic modulation of fire activity, while the recent invasion by Europeans and forced removal of Aboriginal people and fine-scale fire management from the landscape reveal a deep, yet cryptic influence of human management in this landscape.

The Winds of Change: understanding millennial-scale variability of the Southern Westerly Winds

Michael-Shawn Fletcher

Agathe Lise-Pronovost, Joel Pedro, Henk Heijnis, Kristen Beck, Michela Mariani

The behaviour of the Southern Westerly Winds (SWW) in the Australian sector during the Last Glacial Cycle has been the source of continuing and unresolved debate for decades. We have recently developed a high resolution multi-proxy analysis from Lake Selina, western Tasmania, that provides critical insights in to millennial-scale SWW variability in the Australian sector of the Southern Hemisphere. I will present data spanning >230,000 years that relates to changes in the strength of SWW flow over Tasmania. I will principally focus on two key time periods, the Last Glacial Maximum and the Last Glacial-Interglacial Transition, drawing on recently developed data from a range of sites across Tasmania to decipher how the SWW have responded to global (orbital) and local forcing through the Last Glacial Cycle.

Antarctic ice sheet discharge driven by atmosphere-ocean feedbacks during the Last Termination

Christopher Fogwill

C.S.M. Turney, N. R. Golledge, D. Etheridge, M. Rubino, D.P. Thornton, J. Woodward, M.E. Weber

Reconstructing the dynamic response of the Antarctic ice sheets to warming during the Last Glacial Termination (LGT; 18,000-11,650 yrs ago) allows us to identify ice-climate feedbacks that could improve future projections. Whilst the sequence of events during this period are reasonably well-known, relatively poor chronological control has precluded precise alignment of ice, atmospheric and marine records, making it difficult to assess relationships between Antarctic ice-sheet dynamics, climate change and sea-level rise. Here we present results from a highly-resolved 'horizontal ice core' from the Weddell Sea Embayment, which records millennial-scale ice-sheet dynamics across this extensive sector of Antarctica. Counterintuitively, we find ice-sheet surface drawdown of 600 m across the Antarctic Cold Reversal (14,600-12,700 yrs ago), with stabilization during the subsequent millennia of atmospheric warming. Earth system and ice-sheet modelling highlights that this response was likely driven by strong ocean-ice feedbacks impacting Antarctic Bottom Water (AABW) production; however, the controlling mechanisms remain uncertain. Given the coincidence of the ice-sheet changes we record with marked shifts in atmospheric circulation we suggest that millennial-scale Antarctic ice-sheet dynamics during the LGT were modulated by global atmospheric teleconnections, which initiated and sustained strong ice-ocean feedbacks. This finding has significant implications for Antarctic ice sheet dynamics under contemporary climate change, highlighting that the inclusion of such feedbacks in ice-sheet models is critical to improving sea level rise projections.

Obliquity control on southern hemisphere climate during the last glacial

Christopher Fogwill

C.S.M. Turney, D.K. Hutchinson, A.S. Taschetto, and M.H. England

Recent paleoclimate reconstructions have challenged the traditional view that Northern Hemisphere insolation and associated feedbacks drove synchronous global climate and ice-sheet volume during the last glacial cycle. Here we focus on the response of the Patagonian Ice Sheet to atmospheric and oceanic change, and demonstrate that its maximum expansion culminated at 28,400 ± 500 years before present (28.4 ± 0.5 ka), more than 5,000 years before the minima in 65˚N summer insolation and the formally-defined Last Glacial Maximum (LGM) at 21,000 ± 2,000 years before present. To investigate the mechanisms that drove this early LGM (eLGM), we simulate the effects of orbital changes using a suite of climate models incorporating prescribed and evolving sea-ice anomalies. Our analyses suggest that Antarctic sea-ice expansion at 28.5 ka altered the location and intensity of the Southern Hemisphere storm track, triggering strong regional cooling over Patagonia and the wider mid-southern latitudes. In contrast, at the LGM, continued sea-ice expansion reduced regional temperature and precipitation further, effectively starving the ice sheet and resulting in reduced glacial expansion. Our findings highlight the dominant role that orbital changes play in driving Southern Hemisphere glacial climate via the sensitivity of mid-latitude regions to changes in Antarctic sea-ice extent.

Prospects for a multi-millennial reconstruction of ENSO from kauri

Anthony Fowler

Gretel BOSWIJK, Andrew LORREY

Kauri (Agathis australis (D. Don) Lindl.) is recognized as a high quality ENSO proxy, due to its longevity and signal strength, which has resulted in its use in several multi-proxy, multi-centennial, ENSO reconstructions. Recent success in extending the kauri master chronology to 2,488 BCE, by crossdating archaeological and living trees with the youngest end of swamp kauri chronologies, has raised the prospect of a multi-millennial ENSO reconstruction from kauri alone. However, progress towards this end has not been simple. Apart from fairly obvious (and valid) concerns about reconstructing ENSO based on a single teleconnection region, there are several other issues related to the fidelity of the kauri proxy record itself. These include a highly temporally variable age/size sample mix, low sample depth prior to the last millennium, the restricted spatial range of the swamp material, and the fact that the growing conditions for swamp material differ from those for archaeological and modern material. We review progress in understanding and dealing with these issues, and assess prospects for multi-millennial-scale reconstruction. We frame the review around the question of whether ENSO activity over the last few decades is elevated in multi-centennial and multi-millennial contexts.

Status of the new in-situ 14C extraction scheme at ANSTO

Reka-H Fulop

D. Fink, A.T. Codilean, B.Yang, T.J. Dunai

We present initial results of in situ cosmogenic 14C system blank and calibration sample measurements obtained with the recently established ANSTO in situ 14C extraction system. The 14C extraction scheme follows the design of the University of Cologne, which exploits the phase transformation of quartz to crystobalite in order to quantitatively extract the carbon as CO2. Offline high-temperature furnace extraction allows a relative rapid sample throughput and can accommodate samples ranging between 0.5 to 4 grams of clean quartz. Following extraction and isolation, the CO2 gas is graphitised using a micro furnace and them measured using AMS similarly as routine small radiocarbon samples. The relatively short half-life of 14C, namely, 5730 years, means that, compared to the other cosmogenic nuclides, it is substantially more sensitive to short term variations in process rates. Both the erosion of steep mountains and the dynamics of sediment transport, storage and recycling occur over timescales that are too short to be detectable by the cosmogenic nuclides that are currently used routinely, namely 10Be and 26Al. In situ 14C on the other hand is ideally suited for these short timescales, and used in combination with 26Al and 10Be, it will allow for rapid fluctuations in process rates and/or the relatively short timescales that characterise sediment transfer and storage to be measured accurately. Further, a range of geological processes can cause apparent exposure ages quantified using 10Be and 26Al that are either too high or too low. Holocene and late Pleistocene glacial exposure ages from Polar Regions are especially prone to problems, and very often circuitous statistical analyses are employed to 'correct' the obtained age distributions and/or to justify 'outlier' rejection. Due to its comparatively short half-life in situ 14C can provide a unique way to validate that measured 10Be concentrations reflect the true exposure age.

Can the Molybdenum Incoherent/Molybdenum Coherent scattering ratio (Mo Ratio) be used as a substitute for LOI determinations of organic content?

Patricia Gadd

Catherine Chague-Goff, Jordan Chi Hang Chan, Gianna Evans, Henk Heijnis, Len Martin, Craig Woodward

Data on the content of organic matter in sediment cores are beneficial as they provide information about past environmental and depositional processes. For decades, Loss on Ignition at 550°C (LOI550) has been used as a method for the estimation of organic content. However, this method is often time consuming and laborious. Since the emergence of core scanners, the Molybdenum Ratio (Mo Ratio), the incoherent and coherent scattering from Molybdenum X-ray tubes, has been increasingly used to estimate the organic content. In this study, we compare high resolution LOI550 data with Mo Ratio data from three sediment types (lacustrine, marine and peat sediments) to demonstrate the usefulness of core scanners in reducing the time spent conducting conventional LOI550 measurements. Using the Mo Ratio will save time. Furthermore, the resolution at which organic content can be inferred from Mo Ratio (0.2 mm with our scanner) far exceeds that at which LOI analysis can be performed in the laboratory. We will also discuss whether the Mo Ratio can be used as a quantitative technique to infer the organic content as well as trends in the data.

Speleothem Records of Volcanic Eruptions in New Zealand

Nicholas Gampell

Joel Baker, Simon Barker

Studies of historic volcanic eruptions in New Zealand are significantly limited by the short period of recorded events since human settlement. It has long been recognised that past volcanic eruption signals may be preserved in speleothems, an unexploited archive of volcanism, with trace elements considered to be a promising proxy. Environmental factors influence the chemistry in speleothem growth layers, providing unique signatures with potential links to past climate and/or geologic events, suitability dated using uranium-series methods. This study utilised LA-ICP-MS to provide a geochemical analysis of the major and trace elements in a well-dated shawl speleothem (8,000 yr BP) from the Wairoa cave system in the eastern North Island, New Zealand. The area is generally downwind from historic and pre-historic New Zealand eruptions, and is in close proximity to the planet's most frequently active zone of Quaternary volcanism on Earth, the Taupo Volcanic Zone. Identified chemical spikes have been correlated with a complex age-model and other proximal tephra archives, in an attempt to ascertain if diagnostic chemical fingerprints can be linked to their volcanic source. Preliminary findings suggest that the studied speleothem has recorded both historic and pre-historic eruptions, notably Taupo 232 AD. Identified offsets between ages could be due to uncertainties within the age model, biogeochemical cycling, or secondary processes that are similar to results of past studies. Ultimately, such research may make it possible to provide more accurate dates for volcanic eruptions, identify non-preserved eruptions in the conventional geological record, and lead to improved reconstructions of pre-historic volcanic activity.

Buried Faults in the Auckland Region

Caleb Gasston

Jan Lindsay, Martin Brook

The Auckland Volcanic Field (AVF) differs significantly from its southern counterparts, the south Auckland and Ngatutura volcanic fields, in that, at present, there is no clear relationship between shallow crustal structures and the spatial occurrence of vents within the field. The apparent non-relationship has consequences for probabilistic hazard analysis within the region, as the lack of apparent spatial control leads to difficulty in predicting future eruption centres. Despite a number of proposed structures by various authors, the apparent lack of coincidence between tectonic structures and vents may be due to the lack of proven structures within the region, with very little detail shown on the regional Geology maps of Edbrooke (2001) and Kermode (1992). This project utilises the results of a high resolution geological mapping exercise, taking advantage of modern GIS techniques, state of the art 3D modelling, and geophysical surveying to formulate a method that may be used to better prove and constrain the location and nature of proposed tectonic structures. This presentation will describe a case study, a single proposed fault in the Beachlands area of Auckland, named the Waikopua North Fault by Kenny et al. (2012), which will be modeled using the VULCAN software package, and surveyed using gravity and ERT geophysical methods.

Southern Hemisphere Westerly Winds and climate change at the Subantarctic Auckland Islands since the Late Glacial

Greer Gilmer

Chris Moy, Marcus Vandergoes, Christina Riesselman, Geraldine Jacobsen

Fjord sediment cores collected from the Subantarctic Auckland Islands (50.5°S) record changes in climate and Southern Hemisphere westerly winds (SHWW) since end of the last glaciation. The SHWW are an important component of atmospheric circulation in the mid to high southern latitudes, yet past variability is poorly constrained. The Subantarctic Auckland Islands are in a unique location at the core of the modern wind belt and climate changes driven by the westerlies can be reconstructed using the geochemical properties of fjord sediments. Norman Inlet on the east coast of Auckland Island is ideal for SHWW reconstructions due to the presence of a silled basin that has accumulated sediment since ice retreat. Physical property data, ITRAX XRF, and visual core descriptions indicate the cores capture a deglacial, lacustrine, marine incursion, and ultimately, a marine phase of sedimentation. A basal radiocarbon date indicates that sedimentation associated with retreating ice was underway in the basin by approximately 19,500 cal yr BP. Deposition of highly organic material began around 15,000 cal yr BP followed by flooding of the basin during the marine transgression by approximately 9,300 cal yr BP. High carbon concentrations and increases in the abundance of iron, sulphur, and manganese relative to titanium are indicative of anoxic conditions in the water column that are likely due to a significant decrease in wind strength. This high resolution record will be compared to existing records from New Zealand, South America, and Antarctica to build a broader picture of SHWW change across the Southern Hemisphere.

Holocene changes in ocean circulation and climate at Moubray Bay, Northern Victoria Land, Antarctica

Greer Gilmer

Christina R. Riesselman, Kyu Cheul Yoo, Jae Il Lee, Min Kyung Lee, Geraldine Jacobsen

Here we present initial results from a marine sediment core (LC-62 is 4.82m long) collected from an isolated basin in Moubray Bay, Northern Victoria Land (72° 04.5'S, 170° 27.4'E) by the R/V Araon during the 2015 ANA05B expedition. The core is composed of three sedimentary units. Unit 1 is a dark grey volcanoclastic sand with shell fragments, foraminifera, high magnetic susceptibility, and less than 5% biogenic silica by weight (wt% BSi). Unit 2 comprises a laminated diatomaceous ooze with the horizontal layering differentiated by changes in colour (cream, olive, and orange), texture (massive, fluffy) and density. Unit 3 is composed of disturbed diatom ooze which is characterised by undulating and interweaving layers of the same colours and textures that were observed in Unit 2. Although the style of accumulation differs between units 2 and 3, biogenic silica is high in pilot samples from both diatom ooze units. Initial acid insoluble organic (AIO) radiocarbon ages indicate the core covers a short time span from approximately 8 to 10ka. The ages show there is continuous sedimentation up core and no unconformity between units 3 and 2. Bulk δ13C values are -33‰ at the base of the core and increase upwards to -29‰ at 3.1m. Above this δ13C values plateau to the top of the core. There is a large variation in δ15N values, 0.5 to 3.5‰, but there is no trend up core. High-resolution biogenic silica, diatom assemblages and ITRAX XRF scanning still need to be completed on the core.

Applications of GPR in Peat Environments

Allen Gontz

Andrew Lorrey, Patrick Moss, Adrian McCallum, James Shulmeister

Studies that examine peats to reconstruct palaeoenvironments, palaeoecology and palaeoclimate have traditionally relied on time-intensive stratigraphic techniques (eg. shallow cores, excavations) to develop an understanding of bog architecture. Ground penetrating radar (GPR) is a proven technique that allows rapid acquisition of subsurface images. Relatively low velocities produce reasonable penetration and good vertical resolution using 160 MHz antennas. Often, the dielectric contrast between organic and inorganic materials, including charcoal, woody debris, and tephra can be distinguished. it can assist in ground-truthing for coring compression, and correlating samples and stratigraphic horizons at the bog scale, as well as locating specific subsurface features (i.e. deepest part of a bog) or interpreting past depositional environments in discrete geomorphic settings. We present examples from peat environments at Australasian sites to showcase the capability of GPR applied toward imaging bog structures. In doing so, we highlight GPR applications to identify sub-peat surfaces, horizons and pre-peat depositional environments. While GPR studies are not stand alone, they can provide a large-scale, rapid way to assess environmental contexts for peat systems. There is additional potential to use GPR as a bridge between Australasian studies that can help improve our understanding of peat bog environment-climate-geomorphic connections.

Cooloola Island - The Great "Lost" Sand Island of Southeast Queensland

Allen Gontz

Adrian McCallum, James Shulmeister, Daniel Ellerton

Southeast Queensland is home to the terminus of the world's largest downdrift sand system. Sand from New South Wales is transported north and deposited in southeast Queensland where it is reworked by waves, wind, tides, and rivers to create large sand islands. Three of the world's largest sand islands are located within this system: Fraser, Moreton and North Stradbroke islands. The islands share a similar morphology – a narrow southern tip and broadening to the north. Most of the northern or eastern points are pinned to bedrock. In profile, the islands have high eroding dunes on the eastern shore, rise to elevations over 200 m along a central dune ridge and then gradually decrease in elevation towards the western shore. Variable size bays are located between the mainland and the islands, often with small islands and narrow passages. Examination of digital terrain models created from LiDAR coupled with several reconnaissance-level GPR surveys suggest that during higher-than present sea level, the Cooloola Sand Mass was detached from the mainland and was one of the great sand islands. This suggests that at times during the Quaternary, all of the great sand islands alternated between islands and sand masses, based on sea level.

Carbon isotope ratios of fossil leaves reveal south-east Queensland's La Niña dominated past

Jacinta Greer

Francesca A. McInerney, John Tibby, Cameron Barr, Quan Hua

The El Niño–Southern Oscillation (ENSO) affects 2/3 of the planet's population, and understanding its evolution is critical to anticipating future changes. However, the timing and intensity of El Niño- and La Niña- dominated phases varies across different Pacific records spanning the past millennium, presenting a challenge when testing hypotheses of ENSO response to changing background conditions. There is a need for further records from ENSO affected regions, especially from Australasia, which is under-represented in the literature. Here we present a ~1500 year quantitative precipitation record from sub-tropical Australia, based on the measured carbon isotope ratios (δ13C) and calculated carbon isotope discrimination (Δ) of sub-fossil Melaleuca quinquenervia leaf fragments extracted from a sediment core from Swallow Lagoon, North Stradbroke Island, south-east Queensland. AMS 14C-dating of a subset of these leaf fragments produces an age-depth model covering 514-2013 CE. We find no evidence to support a La Niña-dominated Medieval Climate Anomaly (MCA) and an El Niño-dominated Little Ice Age (LIA), as has previously been proposed (e.g. Mann et al. 2009 Science 326), with the median rainfall during these periods being statistically indistinguishable. Hence there were La Niña-dominated conditions in sub-tropical Australia during both the LIA and MCA, suggesting that the ENSO system was controlled by internal variability over these intervals. If internal variability has been the dominant driver of ENSO in the past, our ability to predict future ENSO patterns will rely heavily on our understanding of these internal processes.

Using the ITRAX Core Scanner to Develop a Ring-Width Chronology from Subtropical Australian Araucaria cunninghamii Trees with faint, unidentifiable ring boundaries

Heather A. Haines

Patricia Gadd, Henk Heijnis, Jon M. Olley

Subtropical Australian Araucaria cunninghamii (Hoop Pine) trees in Southeast Queensland (SEQ) have been found to produce annual ring patterns that can be used to develop ring-width chronologies. However, while at some locations the trees sampled have displayed rings that are capable of being identified visually, trees at other locations have displayed wood properties that are too faint for ring boundaries to be recognized. Previously, trees with such characteristics would be excluded from ring-width chronology development. The ITRAX X-Ray Fluorescence (XRF) core scanner has provided an alternate option to developing these ring-width chronologies. The core scanner produces high resolution optical images as well as an X-radiograph image and density information. The ring boundaries in A. cunninghamii trees from a site in D'Aguilar National Park, Southeast Queensland, Australia, which cannot be visually identified, were analysed using the ITRAX core scanner. On the 20µm X-radiograph image the ring boundaries become clearly identifiable with confirmation of these boundaries provided by the density information. By overlaying the optical image, X-radiograph, and density pattern a ring-width chronology has being developed for this location which would not have been possible using traditional dendrochronological methods. Additionally, information provided by the XRF elemental analysis, specifically for calcium (Ca) and strontium (Sr), is being evaluated by also overlaying these elemental patterns on the X-radiography image. The elemental analysis will be used to assist in the development of a rainfall reconstruction for the SEQ region.

The Effect of Regional Variations in Rainfall on Reconstructing Precipitation Patterns Using Tree Rings

Heather A. Haines

Jon M. Olley

Long-term instrumental precipitation records for Southeast Queensland are not available making a study of rainfall variability difficult without the use of proxy precipitation records. However, the regional area represented by proxy records is not well understood. Here the spatial variability in rainfall across Southeast Queensland is investigated using 140 instrumental rainfall stations. Pearson correlation analysis between stations is determined to categorize them into 80%, 85%, and 90% correlated groupings. For each group annual deviations from the mean are developed for the 1908-2007 period and above and below average rainfall phases determined and their patterns analysed. These patterns indicate that rainfall is not uniform across Southeast Queensland but in fact can be broken into several well correlated instrumental groups. The only currently available proxy rainfall reconstruction for the region, a 140-year Toona ciliata tree-ring width record from Lamington National Park developed by Heinrich et al. (2009), is then compared to instrumental station groupings to which it belongs spatially as well as to Brisbane City rainfall. The correlation between the reconstruction and the rainfall station groupings improves as rainfall group correlation increases and all three groups show slightly greater correlations than that observed to Brisbane City, although all four correlations are significant. Correlation with groups further away from the tree-ring site shows no correlation between tree growth and rainfall records. This indicates that a single site reconstruction of precipitation is not representative of the entire Southeast Queensland region but is significantly representative of a smaller spatial area around the site location.

Heinrich et al. (2009). Interdecadal modulation of the relationship between ENSO, IPO and precipitation: insights from tree rings in Australia. Climate Dynamics, 33, 63-73.

Forest, fire and monsoon feedbacks: insights from mainland south-east Asia

Rebecca Hamilton

Dan Penny

Global-scale biome modelling indicates that seasonally dry tropical forest should be susceptible to a state shift to tropical savanna under changing (reduced) precipitation regimes, increased seasonality, or the introduction of the fire into these systems. This reorganisation could have significant implications given the role of tropical forests in global climate regulation and the provision of ecosystem services that are central to human well-being. Modelled forest-savanna feedbacks have, however, not been well tested within the extensive and ecologically significant dry forest ecoregion of south-east Asia. Multi-proxy analysis of sediment cores extracted from crater lakes within the heart of this ecoregion permits analysis of long-term fire and vegetation dynamics, and provides one of the longest continuous palaeoclimatic records from the East-Asian and Indian monsoon intersection zone. Results of this environmental reconstruction show that representative forests are resilient both to persistent burning, and to periods of reduced precipitation. This highlights the limitations of generalist biome-scale models, and indicates that factors such as landscape heterogeneity maintained by traditional land use practices may be critical to maintaining the persistence of forest in the face of future climate change.

A late Quaternary tephrochronological framework and landscape evolution model for loessial cover beds in Hawkes Bay district, New Zealand

Andrew P. Hammond

Alan S. Palmer

A late Quaternary terrestrial stratigraphic framework is provided for the andesitic ash and quartzo-feldspathic soils mantling the uplands, downlands and other geomorphic surfaces of central Hawkes Bay district utilising both macroscopic and crypotephras as datums. These distal volcanic ash accessions are derived from the rhyolitic and andesitic volcanoes of the central North Island's Taupo Volcanic Zone (TVZ) and Egmont Volcano. Macroscopic rhyolitic tephras such as the Kawakawa/Oruanui (25.4ka cal. yr BP), Waimihia (3.4 ka cal. yr BP) and Taupo Tephra and Ignimbrite (1.7ka cal year BP) were readily identified by their distinctive field characteristics and known stratigraphic positions within cover bed sequences. Cryptotephra identification required the use of a combination of techniques, namely existing or known knowledge of ash distributions from volcanic ash trajectory and isopach maps, the likely occurrence of volcanic ash layers within known stratigraphic positions within multilayered soil-loessial units and undertaking volcanic glass counts to verify the presence of volcanic glass accumulates. Electron microprobe analyses were undertaken on glass concentrates and the glass chemistries derived thereof were subject to a variety of statistical techniques to elucidate volcanic provenance, likely eruptive event and date/s from more proximal TVZ master or reference volcanic sections. This tephrochronological framework is then used to derive a late Quaternary terrestrial soil-landscape history for the central portion of the district and is linked to the New Zealand INTIMATE record.

Anthropogenic influences on the sedimentary evolution of the Coromandel Harbour

Alexander Harpur

B. R. S. Fox, W. P. de Lange, A. G. Hogg

Anthropogenic sediments with elevated heavy metal concentrations are infilling the Coromandel Harbour at rates greater than those observed during pre-human times. Environmental management planning for proposed harbour development projects is restricted by a lack of harbour-wide sediment dynamics and chemistry knowledge. This project aims to bridge this knowledge gap firstly estimating anthropogenic sedimentation accumulation rates (SARs) throughout all regions of the harbour and secondly assessing harbour-wide anthropogenic heavy metal contamination in surface sediments. Sedimentological data has been collected from 17 intertidal and subtidal sediment cores. Anthropogenic SARs have been estimated using radiocarbon and pollen dates. Heavy metals have been analysed using X-ray fluorescence (XRF). Anthropogenic heavy metal contaminant enrichments have been calculated in comparison estimated pre-human "baseline" averages. Here, we present an overview of the anthropogenic influence on harbour development and discuss the ongoing implications of anthropogenic sedimentation for harbour dependent systems. The majority of anthropogenic sediment in the harbour appears to be sourced from pine plantations in the southern part of the catchment. Present day SARs of up to ~1 cm/yr occur near the outwash zones of streams associated with pine forestry. Anthropogenic sediments throughout the harbour are enriched in heavy metals relative to pre-human sediments by a factor of ~1.3, likely in response to historic mining outwash and intensified erosion of heavy metal-rich soils.

The eruption triggers, mechanisms, deposition and hazards of the largest scale explosive eruptions of Tongariro volcano

Mirja Heinrich

S. Cronin, P. Shane

Mt. Tongariro is an unusual composite volcanic complex in being made up of many vents, normally associated along fault-zone lineaments within the Tongariro graben. New Zealand's most popular hiking trail, the Tongariro Crossing, passes across the active central parts of this volcanic system. The high ballistic, gas, surge and ashfall hazards from several historically active vent sites were exhibited most recently during the 2012 explosive eruptions from Upper Te Maari Crater. The volcano has also produced a number of very large eruptions, as evidenced in the tephra record, with several well documented episodes including the Mangamate set of eruptions from ~10.9-11.2 cal. ka B.P., and the ~16.6 cal. ka B.P. Rotoaira Tephra. Despite knowledge of a few of these vents, the established stratigraphic record around Tongariro Volcano implies a very sporadic eruption history, with short, rare pulses of large-magnitude and volume pyroclastic eruptions. This new study will examine the eruption record of Tongariro in three ways: 1) A new composite eruption record will be built for the volcano, in particular by investigating a number of "mystery" tephra layers seen that have distributions and compositions consistent with Tongariro; 2) the physical, textural, sedimentological and chemical properties of several of the largest scale pyroclastic eruptions will be examined to interpret eruption durations, steadiness, and size, along with the use of chemical and petrological indicators to understand the magma source, rise and eruption triggering mechanisms, and 3) sequences of closely-spaced eruptions showing evidence of widespread landscape destabilisation will be examined to develop scenarios for post-eruptive impacts and recovery times from large scale eruptions of this volcano. Key features that we expect to shed light on are the durations of eruptions and the reasons for the unusually widely dispersed distribution of tephra from many of the large-scale Tongariro eruptive episodes, including identification of multiple vents. From this multicomponent study we anticipate developing a series of new eruptive scenarios for hazard management planning at this volcano, as well as to compare and contrast its magmatic processes to the near neighbouring Ruapehu volcano, which has a very different style of eruption and a more typical stratovolcano form.

Cooling history and crystallization of the Whakamaru Ignimbrite, Taupo Volcanic Zone, New Zealand

Yuli Heled

Mike Rowe, Isabelle Chamberfort

Ignimbrite deposits are often made up of multiple successive flows which cool as either single unit or multiple cooling units depending on the interval between flows. Groundmass crystallinity through the Whakamaru Ignimbrite shows a pattern corresponding to a single cooling profile. However silica polymorph variation through the section hints at possible multiple cooling units within the deposit. Abundant cristobalite, indicative of fast cooling, in the middle of the section is inconsistent with a single cooling unit. A change in chemical concentration in the middle of the section supports the interpretation of multiple cooling units. Multiple cooling units, and thus variation in cooling history, may be correlated with the physical structure of the deposit and its ability to control fluid flow.

Quantitative reconstruction of Australian climate change since the Last Glacial Maximum using pollen

Annika V. Herbert

Sandy P. Harrison

Large scale quantitative palaeoclimate reconstructions are vital for our understanding of the climate system and for evaluating climate model performance. We present the first continent-scale quantitative palaeoclimate reconstruction for Australia going back to the Last Glacial Maximum. A possible regional bias has been identified in the temperature reconstructions, which is probably caused by a lack of modern samples from the extreme ends of the temperature range. Despite this possible bias, multiple significant, large-scale climatic events have been identified, including the cold event associated with glacial re-advance in Tasmania and the Snowy Mountains at around 16 ka BP, as well as a cold event apparently coinciding with the Antarctic cold reversal at around 13 ka BP. This last cold period appears to have been terminated by a significant warm period at around 9 ka BP. The mid-Holocene appears to have been significantly drier than today in most areas and the end of the last glacial period appears to coincide with a sudden increase in bio-available moisture. Whilst future studies need to improve the temperature coverage of the training set, this study proves the viability of performing large scale quantitative palaeoclimate reconstructions using pollen data from across Australia.

The Last Glacial Maximum in the Desert Dunefields

Paul Hesse

Matt Telfer

A meta-analysis of luminescence ages of Australian desert dunes (Hesse, in press, Quat. Intl) shows no evidence for enhanced dune activity in the Strzelecki and Simpson Deserts but some evidence of enhanced LGM activity in the Mallee dunefield. One problem in this kind of meta-analysis is the very small amount of suitable data with (1) multiple ages in dune profiles, (2) regularly sampled, (3) to the dune bases, (4) in a confined area of (5) similar dunes. Two new data sets are now available which meet most or all of these criteria: from Roxby Dunefield (Hughes et al., 2014, Quat. Austr.) and the Strzelecki Desert (Telfer et al., subm.). Both data sets confirm the previous findings that (1) there is no evidence of enhanced LGM dune activity, (2) dunes were active episodically through the dated period, but (3) even neighbouring dunes did not accrete simultaneously. This result is also evident in Southern Africa and North America as well as China and South America. Because of the problems with data distribution and sampling bias it is not yet possible to rule out a climate influence however it is also true that the hypothesis of climate control (e.g. at the LGM) on dune activity cannot currently be sustained. The question raised by these analyses is how well we understand dune processes (erosion, re-working, accumulation etc.). The complex picture of dune, dust, playa and vegetation responses to changes in desert climates challenges us to first improve our basic understanding of processes.

Exotic aerosols in the Falkland Islands: a record of South American dust and pollen transport to the South Atlantic since 13 ka

Paul Hesse

Finn Viehberg, Karsten Schittek, Lisa Ungrad, Quan Hua, Duanne White

South America is thought to be a major contributor of dust to the Southern Ocean and Antarctica and therefore to affect the hemispheric energy balance and carbon cycle. However, Patagonia is an arid and deflated landscape without any continental records of dust flux. The Falkland Islands, downwind of Patagonia, offer an opportunity to recover such a record from the blanketing peat accumulation.A short peat core taken in 2013 from East Falkland was dated by 14C, analysed by iTrax XRF scanner, LOI and DBD, and pollen analysis. The peat extends back to approximately 13 ka and ceases at around 2 ka (probably due to turf cutting). LOI and iTrax confirm a component of inorganic, siliceous minerals which we infer to be dust transported from South America. The transport of aerosols from South America is confirmed by the presence of exotic pollen (e.g. Araucariaceae), also found by Turney et al. (2016) for the last 2.6 ka. mDust fluxes were high from 13 ka until around 10 ka and remained low except for a brief excursion around 8 ka. A similar pattern was found at a site in the Beagle Channel (Vanneste et al., 2016. Sci Reports), except that at the Falklands the post-ACR/YD decrease in dust flux was delayed by up to 1 kyr. The results support the Patagonian origin of dust to the South Atlantic and suggest a dominantly glacial origin.

Decadally-resolved Lateglacial radiocarbon evidence from New Zealand kauri

Alan Hogg

John Southon, Chris Turney, Jonathan Palmer, Christopher Bronk Ramsey, Pavla Fenwick, Gretel Boswijk, Ulf Büntgen, Michael Friedrich, Gerhard Helle, Konrad Hughen, Richard Jones, Bernd Kromer, Alexandra Noronha, Frederick Reinig, Linda Reynard, Richard Staff, and Lukas Wacker

The Last Glacial-Interglacial Transition (LGIT; 15,000 - 11,000 cal BP) was characterised by complex spatiotemporal patterns of climate change, with numerous studies requiring accurate chronological control to decipher leads from lags in global palaeoclimatic, -environmental and archaeological records. However, close scrutiny of the few available tree-ring chronologies and radiocarbon-dated sequences composing the IntCal13 radiocarbon (14C) calibration curve, indicates significant weakness in 14C calibration across key periods of the LGIT. Here, we present a decadally-resolved atmospheric 14C record derived from New Zealand kauri spanning Greenland Stadial 1 (GS-1; ~12,900 – 11,650 cal BP). Two floating kauri 14C time series, curve-matched to IntCal13, serve as a radiocarbon backbone through GS-1. Floating Northern Hemisphere (NH) 14C datasets are matched against the new kauri data, forming a robust NH 14C time series to ~14,200 cal BP. Our results show that IntCal13 is questionable from ~12,200 - 11,900 cal BP and the ~10,400 BP 14C plateau is approximately five decades too short. By precisely aligning Southern and Northern Hemisphere tree-ring 14C records with marine 14C sequences, we document two relatively short periods of North Atlantic Meridional Overturning Circulation (AMOC) collapse during GS-1. Hence, sustained North Atlantic cooling across GS-1 was not driven by a prolonged AMOC reduction but was probably due to an equatorward migration of the Polar Front. The radiocarbon interhemispheric offset appears to be lower prior to GS-1, before reaching 'near-modern' values at ~12,660 cal BP, consistent with synchronous recovery of overturning in both hemispheres and increased Southern Ocean ventilation.

Multi-criteria correlation of tephra deposits to source centres applied in the Auckland Volcanic Field, New Zealand

Jenni L Hopkins

C.J.N. Wilson, M-A. Millet, G.S. Leonard, C. Timm, L.E. McGee, I.E.M. Smith, E. Smith

Tephrochronology is central to the reconstruction of eruptive histories of volcanically active regions. It is particularly helpful in resolving volcanic events occurring on timescales that are at shorter than the precision of traditional radiometric methods. However, in areas where proximal tephra deposits are poorly preserved or ambiguously sourced, there is currently no way of attributing distal deposits to their source, limiting their use in unravelling the volcanic history of such areas. We present a novel approach to overcome this problem using the late Quaternary basaltic Auckland Volcanic Field (AVF, New Zealand). We use geochemical compositions of the glass from tephra deposits and correlate this to geochemical signatures of proximal whole rock deposits. This approach was tested using artificial tephra created by crushing glassy whole-rock material and comparing the bulk and glass compositions with glass from the independently correlated tephra from the same eruption. We identify that incompatible trace elements and ratios (e.g. (Gd/Yb)N) are least affected by fractional crystallisation processes, but display large variations related to the magmas' mantle sources. As a consequence, trace elements have comparable signatures between whole rock and tephra, and in addition provide a forensic tool to distinguish different volcanoes formed by distinct magma batches. To strengthen our correlations, we detail a number of other criteria, including ages and locations of source centres and tephra horizons, thickness of tephra deposits and scale and style of eruptions from the field. With these combined criteria, we present a revised age-order model for the evolution of the AVF.

Rainfall variability and temporal changes in the dead carbon fraction in an Indonesian speleothem

Quan Hua

Michael Griffiths, Russell Drysdale, Petra Bajo, Daniella Jenkins, John Hellstrom, Kathleen Johnson, Michael Gagan, Jian-xinZhao

The number of speleothem-based paleoclimate records has increased significantly in recent years. To assess the potential hydrological control on speleothem radiocarbon variability, we constructed a high-resolution dead carbon fraction (DCF) record from a speleothem from Flores, Indonesia for two different periods, the Younger Dryas (YD) chronozone and the Last Millennium. A total of thirty-four 14C analyses were conducted on calcite extracted from U-Th dated stalagmite LR06-B1. To better characterise the paleoclimate and environmental changes, high-resolution stable-isotope (δ18O, δ13C) and trace-element (Mg/Ca, Sr/Ca) measurements were also conducted along the same stalagmite sections.

Broad comparison of the DCF record with the hydrologically-controlled proxy data suggests that rainfall increases were matched by DCF increases. In line with a previous interpretation of DCF variability for the same specimen, but during the interval 2.4-2.8 ka and the post-bomb period, we interpret the DCF during the YD and the Last Millennium to have been primarily controlled by limestone dissolution associated with changes in open- versus closed-system conditions, rather than other potential factors such as kinetic fractionation and/or variations in the age-spectrum of soil organic matter above the cave. It then follows that more abundant monsoon rainfall in Flores resulted in the soil-karst system being in a more closed state, which inhibited carbon isotope exchange between the karst-water dissolved inorganic carbon and soil-gas CO2, and ultimately led to a greater contribution of dead-carbon from the bedrock.

Our results indicate that DCF in tropical speleothems can be used as a proxy of past rainfall and consequently monsoon variability.

Geomorphological and archaeological approaches to the Palaeolithic surface record of SW Saudi Arabia

Robyn Inglis

Patricia Fanning, Anthony Sinclair, Geoff Bailey

The vast majority of Palaeolithic archaeological material in arid and semi-arid regions exists in the form of scatters of stone tools across the surface of present-day landscapes. This is particularly the case in the Sahararo-Arabian desert belt, a region vital to understanding the global dispersal of hominins from Africa. These surface artefacts possess little stratigraphic context, but comprise the only record we possess to examine spatial behavioural patterning and landscape use by hominin populations. Interpretation of the observed spatial distribution of artefacts is far from straightforward. Surface artefact distributions result from a complex interplay of varying human behaviours over time. Also, geomorphological processes affect the preservation, exposure and visibility of the artefacts, as well as alter the presence and location of attractive resources. The SURFACE project employs an interdisciplinary approach to understanding the distribution of Palaeolithic artefacts in SW Saudi Arabia. By combining remote sensing, geomorphological fieldwork, archaeological survey and GIS analyses, the project will develop a geomorphological context for the artefacts that will guide survey to areas of high archaeological potential, as well as allowing the robust interpretation of the observed artefact distribution in a dynamic landscape in terms of past landscape use. This paper will present the ongoing multi-scalar remote sensing and GIS analyses of existing archaeological data from the region ahead of new geomorphological and archaeological survey in the region in early 2017.

Vegetation, fire and climate links in the Andean Nothofagus forest of Northern Patagonia

I. A. Jara

P.I Moreno, R. M. Newnham, Brent V Alloway

A postglacial pollen and charcoal record from a small lake in the Andes Northern Patagonia (43°S) is presented with the aim of reconstructing long-term vegetation, fire and climate linkages. Deposition of inorganic glacial silts, dominance of a high-Andean grassland and absence of local fires prior to 16,000 cal yr BP indicates a glacial lake environment under hyper cold and moist conditions resulting from intense Southern Westerly Winds (SWW) flow. An abrupt transition to organic sedimentation and forest expansion occurred at around 16,000 cal yr BP, and since that time a closed Nothofagus forest has prevailed around the lake, suggesting a period with warmer temperature under weaker/southward-shifted SWW relative to the previous interval. A drought-intolerant, cold-resistant tree expanded between 13,600-12,000 cal yr BP, indicating that, despite forest expansion, overall cold/moist conditions prevailed before 12,000 cal yr BP. Decline of this cold-resistant species and high charcoal accumulation suggest a trend towards warmer and drier conditions as a result of weaker/southward-shifted SWW between 12,000-10,000 cal yr BP. Increasing seasonality superimposed on a long-term trend towards cold and wet conditions over the last 10,000 years were likely the drivers of the pollen and charcoal trends observed in the record during Holocene times. Local Nothofagus dominance is only interrupted by the expansion of non-arboreal elements associated with European settlement over the last 130 yr BP, showing that this recent anthropogenic disturbance was the most significant driver of vegetation changes over the last 16,000 years. The long-term increase seasonality during the Holocene seems to have played an important role in maintaining the dominance of Nothofagus forest over lowland broad-leaved forest communities in these mountainous environments.

The Milankovitch connection: astronomical forcing of millennial-scale climate signals

Alison Kelsey

Patrick Moss, Fred Menk

Various factors have been attributed to the cause of millennial-scale climate variability, including internal climate system dynamics that are not completely understood, changes in solar insolation, and gravitational forcing. Any periodicity tends to suggest some form of external forcing. The Milankovitch cycles are known to affect Earth's climate due to variances in solar insolation levels caused by periodic changes in the Sun-Earth distance, precession, and the tilt of Earth's rotational axis. Obliquity cycles change Earth's orientation to the Sun, whilst the closest point to the Sun in Earth's orbit, the perihelion, plays an important role in climate through its relationship to both precession and eccentricity. Precession changes the relationship between Earth's seasonal year and the perihelion, while changes in eccentricity alter Earth's proximity to the Sun. Both the Sun and Moon affect precession, with the precessional rate dependent upon distance between the Earth and the Sun. The interaction of these gravitational influences produces periodic cycles of solar and lunar declinations in astronomical data, influenced by the perihelion, lunation, and the rotating lunar orbital plane. Here we show that a chronologically-anchored model based on these interacting declination cycles reproduces millennial and centennial scale patterns of Holocene solar insolation reconstructed from Antarctic Be10 data, with insolation levels influenced by solar declination at the time of the perihelion. Consequently, millennial-scale climate variability can be seen as a high frequency extension of the Milankovitch cycles explained in terms of astronomical forces that cause periodic variations in gravitation and solar insolation.

A new > 100,000 year Australian palaeoclimate record: Fern Gully Lagoon

Christopher Kemp

John Tibby, Lee Arnold, Cameron Barr, Patricia Gadd, Geraldine Jacobsen, Henk Heijnis

Marine Isotope Stage 3 is a critical period in Australia's climate history due to ongoing debate about the interaction between climate and the extinction of megafauna in Australia. Well dated palaeoenvironmental and fossil records are needed to document both climate variation and megafaunal extinction during MIS3.Here we present preliminary findings from Fern Gully Lagoon, a new wetland site which has yielded a 9 metre continuous record spanning more than 100,000 years, located on North Stradbroke Island bordering Moreton Bay in south-eastern Queensland. Fern Gully Lagoon is separated from almost all groundwater influxes and receives very little input from runoff, so is isolated from most geochemical inputs apart from direct rainfall and aeolian flux. Due to the length of the record and its regional signal, it is almost unprecedented in south-eastern Queensland. The site presents a very high resolution paleoclimate record at ~110 years per cm, which combined with its basal age presents a rare opportunity found only five or six times in Australia to date.

Preliminary findings will be presented from micro-XRF scanning and LOI analysis. These proxies indicate that MIS3 climate variability had very little impact on deposited sediment makeup, with very little variation in sediment type or elemental breakdown seen through the period. From this we tentatively conclude that there was very little variation in climate during MIS3 at Fern Gully. The last glacial maximum presents a marked increase in aeolian input in the record, as does the increase in human habitation and ENSO activity at around 1000 BP seen by Turney and Hobbs (2006).

References:

Turney, C.S.M., Hobbs, D., 2006. ENSO influence on Holocene Aboriginal populations in Queensland, Australia. Journal of Archaeological Science 33, 1744-1748.

Precipitation in Australia during MIS3: An analysis of published palaeoclimate datasets

Christopher Kemp

John Tibby, Cameron Barr, Lee Arnold

The climate and the major drivers of that climate during Marine Isotope Stage 3 (29 to 59 ka BP) in Australia are not well understood. Substantial debate surrounds the role of climate in the extinction of megafauna and the extent to which millennial scale climate variability - which are canonical features of MIS3 ice core records - was experienced in Australia. Addressing these issues is hampered by the paucity of well-dated palaeoenvironmental records and the lack of multi-site studies that synthesise continental scale climate change back to 59 ka BP.In this study, we present a synthesis of 35 Australian palaeoclimate records. Qualitative assessments of precipitation at each of the sites through MIS3 is plotted using a method similar to Harrison and Digerfeldt (1993); detailing dry and wet phases, as well as periods of increasing or decreasing precipitation for each of the sites. We find evidence for a distinct pattern of changing climate through the stage, with a period of greater than mean precipitation centred around 45 ka BP, before extensive drying of the continent beginning at around 35 ka BP. There is some spatial variation in the distribution of precipitation, with a number of the south-eastern sites experiencing dry conditions during peak continental precipitation. The major precipitation trend follows the January insolation for the period, with higher insolation correlating with greater rainfall between 50 and 35 ka BP.

Lake Wangoom - unfinished business

Peter Kershaw

Chris Turney, Bert Roberts, Henk Heijnis, Geraldine Jacobsen, Simon Connor, Nick Walsh

The long, continuous palaeoecological record of Lake Wangoom is considered important to determination of patterns and causes of environmental change within the late Quaternary of southeastern Australia. However, it has been plagued by chronological uncertainties. The original study on the topmost 20m of sediment, seemed to cover a whole glacial cycle from forest, through steppe-grassland, to forest but, in deference to radiocarbon dates, was deemed to extend back only to MIS3 (Edney et al, 1989). In a subsequent extended record, forested periods were assigned interglacial status largely on the basis of U/Th disequilibrium dating, and the 40m record was considered to cover the last two glacial cycles (Harle et al. 2002). Due to increasing concern over the applicability of U/Th dating to Australian sequences and acquisition of an OSL age supportive of the radiocarbon ages, an attempt, with AINSE support was made, in 2008, to produce a more robust chronology through employment of an 'improved' U/Th dating method together with additional radiocarbon and OSL ages. Unfortunately, only samples for radiocarbon were taken before a temperature reversal in the refrigerator containing the cores resulted in sediment disintegration. Here we present the limited available results within a modeled chronology and provide a clean slate for more detailed future research. Of interest, for example, is the determination of signals constituting a 'glacial cycle' for chronological application to older and longer records from the region and a continuous c80-30ka sequence with correlative Sporormiella potential for resolution of debate surrounding megafaunal extinction at Lancefield Swamp.

Re-evaluating the Last Glacial Maximum in southern Africa

Jasper Knight

Jennifer Fitchett, SHeMAX Project Team

The Last Glacial Maximum (LGM) record in southern Africa is different to that of many other areas of the Southern Hemisphere, because only restricted cirque glaciers existed and thus there is neither a geomorphic signature nor a chronostratigraphic and regional-scale marker that represents the LGM. As such, the LGM in southern Africa is marked by proxy, non-glacial records that merely show climate changes throughout the last glacial period (marine isotope stage 2). There is the assumption that the LGM is defined by the period of greatest cold, but this is evaluation is dependent on proxy type, its temporal resolution and dating framework, and any transfer function or statistical relationship between the measured record and palaeotemperature. Different proxies clearly record different aspects of climate and thus give different palaeotemperature estimates, of both magnitude and timing. Here, we critically examine the basis on which the LGM is evaluated from different proxy records in southern Africa; the different climatic deduced and assumptions made thereon; the different viewpoints of LGM temperature/precipitation values; the extent to which these records are comparable; and whether there is such a thing as a southern African LGM. We also consider different viewpoints of the onset (maximal age) and termination (minimal age) of the LGM. This sets the scene for comparison of the southern African LGM with other regions of the Southern Hemisphere, which frames the context of the INQUA SHeMAX project.

Preparing for the next local volcanic eruption in Auckland, New Zealand

Jan Lindsay

G. Leonard, N. Deligne, T. Wilson

The Determining Volcanic Risk in Auckland (DEVORA) research program is a multi-agency, multi-disciplinary effort with a mandate to investigate the Auckland Volcanic Field (AVF), a (mostly) monogenetic volcanic field which spatially coincides with Auckland, New Zealand's most populous city. DEVORA research covers the geological context of the AVF, its volcanic hazards, and the risk these pose to Auckland. Here we discuss how volcanic hazard and risk research, specific to Auckland and also more generically, is used to evaluate volcanic risk for Auckland, and how DEVORA findings are used by emergency managers and policy and decision makers to prepare the city for a future volcanic eruption. Following a detailed hazard evaluation, the DEVORA team is developing and populating a suite of volcanic fragility functions quantifying damage, loss of functionality, and clean up from basaltic eruptions expected in Auckland. These, along with hazard intensity maps for the volcanic edifice (tuff rings and scoria cones), pyroclastic surges, lava flows, tephra fall, and ballistics, will be input into RiskScape, New Zealand's multi-hazard risk assessment tool. In the first instance, only impacts from specific eruption scenarios will be evaluated; probabilistic risk assessment will be developed in the future. DEVORA research findings are being used to inform the AVF Contingency Plan, a local government document which guides decision making in the case of volcanic unrest and potential eruptions. Moving forward, DEVORA will continue to ensure fundamental science forms the basis for key decision-making in the preparation for and response to a future AVF eruption.

LiDAR and EM conductivity investigation of a Holocene coastal landslide complex: Pourewa Landslide Zone, Auckland, New Zealand

Shanshan Liu

Martin Brook, Nick Richards, David Bevan, Warwick Prebble

The Kepa Road landslide complex is part of the Pourewa Landslide Zone (PLZ) in Orakei Basin, Auckland. The landslide is located on the northern banks of the tidal Pourewa Creek. Previous work reported the original failure was probably a translational block-slide, displacing c. 2 million m3 of lithified tuff rock between 7-10 ka. The initial translational failure was due to a favourably-oriented extremely weak layer of clay, high pore-water pressure at the top of the clay layer, and removal of the toe-slope by fluvial activity and Holocene marine transgression. Since the original block-slide, a range of secondary slope failures have occurred within the complex. These are periodically reactivated in response to rainfall-induced pore-water pressure fluctuations, and are typically confined to the upper soil layers. Such failures led to the realignment of Kepa Road in the 20th century. Kepa Road landslide complex was investigated using a frequency-domain electromagnetic conductivity meter (FDEM) tool to measure apparent conductivity, and a dynamic cone penetrometer (DCP) to measure subsurface soil strength. FDEM proved efficient in detecting high conductivity zones, indicating areas of potential weakness during high pore-water pressures. Moreover, the soil variations that were detected using both techniques, shed light on the engineering geomorphology of the landscape. Through expanding this combined geophysical / direct testing approach over the wider PLZ, we aim to provide a more complete understanding of the geomorphic development of the area. The study highlights the utility of combining LiDAR, geophysical, and direct testing when investigating the engineering properties of Pleistocene sediments.

Using tephrochronology to reconstruct and date both fault rupture and hydrothermal activity at Whirinaki Fault, Taupo Rift, NZ

Remedy C. Loame

D.J. Lowe, P. Villamor, A. Pittari, S.L.L. Barker, A. Rae, S. Milicich, M.G. Gomez Vasconcelos, M. Martinez

Fossil hydrothermal systems are found throughout the area parallel to the active Whirinaki Fault, located in the Taupo Rift, North Island, New Zealand. We established a history of fault rupture (paleoseismicity) and sinter development in the Meade paleoseismic trench and adjacent hill on the east strand of the Whirinaki Fault by restoring tectonic deformation and using tephrochronology to constrain the timing of fault movement and development of sinter formations. Ages for Okareka (21.8 calibrated [cal.] ka), Rotorua (15.6 cal. ka), Rotoma (9.4 cal. ka), and Taupo (1.7 cal. ka) tephras were used to constrain the timing of five identified fault rupture events (denoted Meade-Hossack [MH] 1–5) in the trench. Slip rates of 0.47 ± 0.07 mm/yr (long-term, between c. 240 ka and c. 21.8 cal. ka) and 1.47 ± 0.44 mm/yr (post-Taupo), and the recurrence interval of 1.8 to 5.4 cal. kyrs during the last 21.8 cal. kyrs, all correlate with trends for events of similar ages from other trenches on the Whirinaki Fault. The hydrothermal sinter probably began developing at the Meade site at c. 39 cal. ka, as dated by radiocarbon and supported by a similar age on interbedded Tahuna tephra (c. 39 cal. ka), and ceased by c. 21.8 cal. ka, matching early hydrothermal activity on the west strand of the Whirinaki Fault. This study highlights the usefulness of tephrochronology as a chronostratigraphic tool suitable for application to coeval geological processes.

Hazard hunting: X-ray micro-CT reconnaissance analysis of c. 20 ka lake sediment cores for tephra seismites and cryptotephras

Remedy C. Loame

D.J. Lowe, S.M. Davies, V.G. Moon, C.R. Magill, R. Johnston, N.J.G. Pearce, A. Pittari, B.R.S. Fox

X-ray computed micro-tomography (micro-CT) reconstructs a 3D image, or tomogram, from numerous X-ray-projection images with the aid of computer algorithms. Micro-CT is useful for sediment cores because both surface and internal features of solid, opaque materials can be visualized and analysed non-destructively and with less disturbance than traditional thin-sectioning methods. Micro-CT offers high-spatial resolution (with a 3-50-µm isotropic voxel size), allowing for better imaging of heterogeneities in deposits. Cores from ~20,000-yr-old lakes in the Waikato region contain cryptotephras ('hidden' glass-shard concentrations insufficiently numerous to be visible as a layer) and visible tephras, some of which have been disrupted by seismicity. Liquefied tephra layers are preserved in the sediments as 'tephra seismites', which are deformation structures characterized partly by downward injection of liquefied dense ash into underlying organic sediments. Using appropriate parameters for acquisition and analysis of the 3D image, micro-CT can be a powerful tool for the detection of cryptotephras and reconstruction of detailed 3D images of tephra seismites while preserving internal microstructures, which should provide insight into particle deposition and subsequent seismic disruption. Subtle differences between glass-shard concentrations and enclosing sediments allow additional core-scanning methodologies to be applied to identify cryptotephras. Such methods include X-radiography, X-ray density, magnetic susceptibility, reflectance, high-resolution imaging and spectrometry (grey-scale and colour), and elemental analyses via XRF using ITRAX. Construction of a comprehensive record of ash-fallout for the Waikato region by recognising cryptotephras as well as visible tephras provides the basis for new probability-based ash-hazard modelling, thereby enabling more-effective hazard-assessment strategies to be developed.

Quaternary environments and the scientific value of New Zealand swamp kauri

Andrew Lorrey

Gretel Boswijk, Jonathan Palmer, Alan Hogg, Chris Turney

Swamp kauri (Agathis australis) are trees of massive proportion that have been buried and preserved in bogs across Northland, Auckland and the Waikato regions of northern New Zealand. The buried trees are "sub-fossil", meaning their anatomical structure has not been completely replaced with a mineral precipitate. Swamp kauri wood is mined and milled as workable timber, but there are current concerns about the sustainability of the remaining swamp kauri volumes. While swamp kauri is a highly valued as a natural resource, it is also globally-unique for Quaternary science. Some recovered swamp kauri trees have dimensions in excess of 2.5m in diameter, while some attained great ages prior to death (>2000 years of growth) before they fell and were preserved for tens if not hundreds of millennia in anoxic bog environments. There are often associations of the buried wood with peats, tephra and macrofossils in several types of geomorphic settings. In this presentation, we overview findings from two recent nationally-funded projects focused on swamp kauri. One has evaluated the spatial extent and remaining volumes of swamp kauri, while the other was focused on an assessment of the scientific value of swamp kauri resources and its potential for current and future scientific research.

A new attraction-detachment model for explaining landsliding in clay-rich Quaternary tephras, eastern North Island, New Zealand

David J. Lowe

Kluger, M.O., Moon, V.G., Kreiter, S., Churchman, G.J., Hepp, D.A., Seibel, D., Jorat, M.E., Mörz, T.

Altered tephra deposits are highly susceptible to landsliding. Halloysite, a low-activity, 1:1 aluminosilicate clay mineral, is often associated with landslide-prone layers within weathered-tephra successions, especially in deposits with high sensitivity, which describes post-failure strength loss. However, the precise role that halloysite plays in the development of sensitivity and thus in sudden and unpredictable landsliding, is unknown. We show that an abundance of halloysite, dominated by a distinctive mushroom-cap-shaped (MCS) spheroidal morphology, governs the development of sensitivity, and hence proneness to landsliding, in weathered rhyolitic tephras <0.93 Ma in the Tauranga region, eastern North Island, New Zealand. We found that a highly sensitive tephra layer, which was involved in a landslide, has a high content of aggregated MCS spheroids with imperfectly-closed exterior surfaces, i.e., the spheroids have substantial openings on one side. We suggest that short-range electrostatic and van der Waals' interactions enabled the MCS spheroids to form interconnected aggregates by attraction between the edges of numerous paired silanol and aluminol sheets that are exposed in the openings and the convex silanol faces on the exterior surfaces of adjacent MCS spheroids. If these weak attractions are overcome during slope failure, multiple, weakly-attracted MCS spheroids can be separated from one another and the prevailing repulsion between exterior MCS surfaces results in low remolded shear strength, high sensitivity, and high propensity for flow-like landsliding. Our evidence indicates that the proposed electrostatic attraction-detachment model explains the high sensitivity and helps understanding of the mechanisms of landsliding in sensitive, altered tephras rich in spheroidal halloysite.

Tephra seismites: a new tool to evaluate, date, map, and model paleoseismicity using tephra liquefaction in c. 20,000-year-old lake sediments in the Waikato region, New Zealand

David J. Lowe

Loame, R.C., Moon, V.G., Kluger, M.O., Villamor, P., de Lange, W.P., Vandergoes, M.J., Rees, A.B.H., Davies, S.M., Johnston, R., Mörz, T.

Numerous hidden faults (>20) have been identified recently in the Hamilton Basin, many within or near Hamilton. Injection structures (dykes) associated with seismic liquefaction within Late-Pleistocene volcanogenic alluvium (Hinuera Formation) have now been identified at multiple sites, and C14-dates indicate they were caused by seismicity after ~21 (cal) ka , associated either with the 'new' faults in Hamilton Basin or (less likely) with the active Kerepehi Fault in adjacent Hauraki Basin (or both). Analysis of >80 cores extracted from ~12 shakllow lakes aged ~20 ka in Hamilton Basin has revealed that three tephra layers ~2-5 cm thick and comprising mainly fine-medium ash preserved in organic-rich lake sediment (gyttja) have been liquefied in some, but not all, lakes by seismicity, forming 'tephra seismites', which are liquefied volcanic-ash layers. Such layers include Rotorua (~15.6 ka), Waiohau (~14.0 ka), and Mamaku (~8.0 ka) tephras. Denser than the organic gyttja, the ash layers do not become buoyant as occurs in terrestrial settings upon liquefaction but instead are injected downwards forming distinct cracks as pore-water pressure is dissipated. However, the required earthquake magnitude and mechanisms that lead to liquefaction are not understood. As well as mapping the tephra seismites, and thus potentially palaeoseismic events datable via tephrochronology, by coring multiple lakes in the Hamilton Basin, we plan to characterise the seismites and lake sediments using micro-CT scanning, to determine mechanisms of liquefaction using experimental cyclical testing, and to deploy an aqueous piezocone penetration test (CPTu) to measure 'liquefaction' potential in tephras in lakes in situ.

Extracting DNA from allophanic paleosols on tephras for paleoenvironmental reconstruction: a new two-step DNA isolation method and application to a buried Holocene paleosol, New Zealand

David J. Lowe

Huang, Y.-T., Zhang, H., Cursons, R., Young, J.M., Churchman, G.J., Schipper, L.A., Rawlence, N.J., Wood, J.R., Cooper, A.

Soils developed from late-Quaternary tephras are commonly dominated by the nanocrystalline aluminosilicate, allophane, and are called Andisols. They contain large stores of organic matter and are potential reservoirs for DNA. However, DNA recovery from Andisols has been difficult because of strong chemical bonding between DNA and allophane and organic matter, and also because up to 80% of DNA can be physically protected in nanolabyrinthic networks of nanopores in allophane nano/microaggregates. We have developed a new two-step DNA isolation method for Andisols and allophanic paleosols, including those low in clay, which circumvents these problems. The method centres on (1) using a buffer that releases mainly microbial/fungal DNA and unbound DNA and prevents re-adsorption of DNA on allophanic materials, and (2) novel application of acidified ammonium oxalate (Tamm's reagent) to dissolve the allophane and thus release DNA which had been both chemically-bound and encased within nanopores. Sequencing of PCR products obtained from a buried allophanic paleosol at 2.2-m depth on a Holocene tephra near Mt Tarawera yielded endemic and exotic plants that differed from the European grasses growing currently on the soil's surface. This difference suggests that the DNA extraction method is able to access (paleo)environmental DNA derived from previous vegetation cover. Our method hence may be applied to Andisols and allophane-bearing paleosols, offering (1) a means to isolate paleoenvironmental DNA and thus facilitate reconstruction of past environments in volcanic landscapes (datable using tephrochronology), (2) a new way to evaluate biodiversity in such soils/paleosols, and (3) possible application to soil forensic analysis.

Late Holocene fire regimes and vegetation change in the South Wellesley Islands, tropical northern Australia

Lydia Mackenzie

Patrick Moss, Sean Ulm, Craig Sloss, Henk Heijnis

This study presents three records of environmental change during the late Holocene from wetlands across Bentinck Island in the South Wellesley Islands, northern Australia. This research explores the relationship between humans and the environment, and provides an environmental context for ongoing archaeological research in the region. Palynological results show initial changes in the vegetation are driven by late Holocene sea-level regression and coastal progradation, with mangroves transitioning to woodland and wetland communities over the last 850 years. Ongoing archaeological research in the South Wellesley archipelago finds permanent human occupation occurred in the last 1,500 years, with sites significantly increasing in the last 700 years. Macroscopic and microscopic charcoal results highlight the spatial and temporal variation in fire regimes across the island, reflecting the traditional fire management practices of the Kaiadilt people during the late Holocene. Results suggest low intensity fires characterizes the traditional occupation phase, with local and regional fires increasing significantly around AD 1950 when Indigenous fire practices were disrupted and the South Wellesley Islands abandoned. Subtle changes in the pollen record highlight the importance of multi-proxy approaches to reconstructing past environments in tropical northern Australia where vegetation is adapted to fire.

Quantifying land-cover changes from pollen in Tasmania: a Southern Hemisphere first

Michela Mariani

Connor S., Theuerkauf, M., Fletcher, M.-S., Kunes P., Saunders, K., Zawadzki, A., Jacobsen, G.

Quantifying vegetation changes from pollen records is an important and necessary step for palaeoecology that will augment the position of the discipline in a range of important endeavours, such as the development of meaningful conservation and management plans and for attempts to develop and test coupled global vegetation-climate models. Reconstructing past vegetation abundance and land-cover changes using pollen-based models is a relatively new approach developed and honed in Europe, which has not yet been tested in Australia. Here, we present the first ever attempt at applying this approach to part of the Australian landscape that is highly sensitive to climate-driven fire activity and which currently faces a real threat of widespread fire-driven ecosystem extinction – western Tasmania. During the last 12 ka this region has been punctuated with severe fire events which have drastically impacted these fire-threatened ecosystems. Regional fire activity in western Tasmania has been recently reconstructed and it is revealing a phase of increased fire activity between 3.5 – 2.5 ka. Importantly, this period corresponds to a phase of intensified El Niño activity and is linked with a vegetation shift according to pollen data available throughout the region. To date, biases inherent in the pollen records prevent a quantification of disturbance-driven landscape dynamics. By applying pollen-based models, we reveal a substantial change in regional land-cover in response to a climate-driven shift in fire regimes that has direct implications for contextualising recent fires and informing management in this World Heritage Area.

Disentangling the interplay between the ITCZ, southern westerlies and ENSO during the Holocene

Michela Mariani

Fletcher M.-S., Drysdale, R.N., Saunders, K.M

Conceptual models invoke a tight coupling between shifts in the position of the Southern Westerly Winds (SWW) and the Inter-tropical Convergence Zone (ITCZ), both hemispheric-scale climate features, through periods of dramatic global climate change, such as glacial terminations. Critically, little is known about how these systems interact through comparatively stable climate phases, such as the Holocene. Furthermore, there is little appreciation of the long-term interplay between important regional climate features, such as the Pacific Ocean El Niño Southern Oscillation (ENSO), and the SWW and ITCZ. Given that ENSO variability and the strength and position of the SWW are currently changing due to anthropogenic influences, it is essential that we attempt to disentangle both the role of key climate features in driving climatic change in the Southern Hemisphere and how these features interact through time. In this poster we present a compilation of palaeoclimatic proxies from across temperate and tropical regions within the Southern Hemisphere that reveals a strong teleconnection between ITCZ and SWW through the early to mid-Holocene, followed by a switch to an ENSO-dominated climate regime after ca. 6 ka.

A long peat-based palaeoclimate record in eastern Australia: change in response to westerly winds and sea-surface temperatures

Len Martin

Scott Mooney

Here we report the results of various palaeoenvironmental techniques applied to a small hydrologically sensitive, minerotrophic peat deposit in eastern Australia. Comprehensive dating of multiple organic fractions has revealed relatively constant accumulation rates over the last ~18,000 cal. BP. The site has responded to increasing temperature and increasing autochthonous sediment supply during the deglacial period. The application of high-resolution geochemistry has also revealed several abrupt changes, interpreted as responses to changes in westerly wind strength and rainfall. These changes include indicators of dust deposition (Ti and Fe peaks) which coincide with changes from marine cores after the cool period of the ACR and during the YD chronozone (De Deckker et al., 2012). Terrestrialisation of our site occurs roughly coeval with the Okarito bog record in western New Zealand (Newnham et al., 2007), suggesting larger scale drivers of change. During the late Holocene the site also preserves cyclical changes in the concentrations of marine aerosols as well as increased organic deposition, characteristics that are replicated across multiple sites in the region. We compare our record with relatively recent hypotheses about the strength of westerly circulation across the entire Southern Hemisphere (e.g. Fletcher and Moreno, 2012).

The use of speleothem palynology to elucidate late Holocene vegetation change in the Nullarbor Plain

Kia Matley

Kale Sniderman, John Hellstrom, Andrew Drinnan

The past vegetation and climate of the Australian arid and semiarid zones is poorly understood, in large part because of unfavourable conditions for the preservation of organic sediments. Fossil pollen preserved within speleothems provides a way to explore this history. We use two co-located, pollen-rich speleothems to reconstruct a history of vegetation change in arid Australia over the past 2000 years. U-Th dating has allowed for multi-decadal scale resolution, a first for arid Australian palynological studies.

In this study, we analyse the relative abundance of functional groups represented in the fossil record, and reconstruct a climate history based on the climatic tolerances of extant species. Initial results show that a high diversity of pollen types is captured within the speleothems, and a change in the relative abundance of trees, grasses and chenopods is observed.

Glacial to interglacial changes in stable carbon isotopes from planktonic foraminifera from the SW Pacific Sector of the Southern Ocean

Charles Maxson

Helen Bostock, Andrew Mackintosh

The Southwest (SW) Pacific Ocean is one of the least studied oceanic regions in the world, yet its role in the global carbon cycle is significant. Oceanic uptake of CO2 in this region is one of the largest in the world and acts as a buffer to climate change. To look at changes in the carbon cycle in this system back through time we utilize stable carbon isotopes (δ13C) of planktonic foraminifera to determine changes in the oceanic circulation and the carbon reservoir. Carbon isotopes can be measured directly in the modern ocean, but there are few measurements in the SW Pacific. In the first part of this study we created a model of modern water δ13C using a multiple linear regression of six different oceanographic parameters (temperature, salinity, phosphate, silicate, density, and oxygen) to map the δ13C levels of the surface oceans around New Zealand. Using the model as a modern baseline, we compare the δ13C from planktonic foraminifera in a series of cores back to the last glacial (25 ka). Cores were grouped into regions around New Zealand that were defined by different oceanic regimes (subtropical, subtropical front, sub Antarctic, and polar zones). Each zone was analyzed to distinguish local, regional, and global climate influences on the δ13C signal. We find that there are small regional differences, but that the δ13C signal is dominated by the global trend evident in the CO2 and δ13C of Antarctic ice cores.

A Sedimentological Survey of an Inner Reef Island in the Maldives

Monique McKeown

Composed entirely of sediment produced on surrounding coral reefs, reef islands are extremely dynamic structures. Despite the fundamental importance of sedimentary composition and deposition for island development and in turn future maintenance, few sedimentological surveys have been carried out on reef islands. Environmental changes which may influence reef-associated sedimentary landforms, such as islands and beaches, can be predicted with the help of linking surficial sediment patterns to the processes which underlie their depositional dynamics in reef environments.

Islands such as those in found in the Maldives, which have a maximum elevation of 2.4 m above sea level are especially vulnerable to sea level changes. Exploring the dynamics of what composes these islands and how these sediments are transported will be extremely helpful for investigating whether these islands will remain the same in the future. Samples were collected from Mahutigalla Island (Maldives), in which traditional sedimentological techniques such as sieving and settling have been used to determine the textures and hydrological behaviour of sediments. Coral tends to make up ~50% of the island, Halimeda ~20% and foraminifera making up ~12%, while the remainder was made up of various other components such as echinoderms and molluscs. Sediments tend to be poorly sorted and ranging in grain size from -2 phi to 2 phi, with grain size increasing outwards from the island. The generation of sediment suitable for maintaining this reef island is thus critically dependant on conditions remaining ideal for coral species, Halimeda and foraminifera to thrive.

The search for the source: the lancefield megafauna deposit

Cameron McKenzie

Sanja van Huet

The Lancefield Swamp megafauna deposit was one of Australia's first recorded megafaunal localities. Identified in 1843, the deposit comprises three sites: the Classic, Mayne and South. The fossil deposit at the Classic site has been dated between 59.4 to 44.1Ka, and the Mayne Site approximately 31.2 Ka. The Swamp site has been formed within, and is surrounded by, Miocene-aged 'Newer Volcanics' basalts which averages >3 meters in thickness. The remains of over 10,000 individual animals, representing various extinct megafauna and modern groups, have been recovered from fossil rich layer in the Swamp. The dominant species include the giant kangaroo Macropus titan and Diprotodon sp. There is no consensus regarding the depositional mechanism of the large number of bones at Lancefield. Previous studies have proposed insitu mass death, fluvial transport or overland mass sheet flow. Work at the Mayne and Classic Sites in 2015 found a dominance (~75%) of sand-sized quartz sediment in relation to the fossil material at the Mayne and Classic Sites. As the area is surrounded by Newer Volcanic lavas, this suggests that the quartz-dominated sediments at both the Mayne and Classic sites have been fluvially transported, and that this occurred concurrently with the deposition of the bone material.

Twentieth Century changes in the fire regimes of high altitude ecosystems in eastern Australia: Evidence from long, multi-proxy records

Scott Mooney

Patrick Baker, Kathy Allen, Fenja Theden-Ring, Geoffrey Hope

We describe the results of a multi-proxy study, combining sedimentary charcoal and tree-ring analyses from multiple sites across the Snowy Mountains region of south-eastern Australia region. Our aim was to assess how fire regimes have changed over long time scales. We found almost no evidence of high-intensity fires during the Holocene; however, in the mid-20th Century there is a sudden and dramatic shift from low-intensity fires with minimal charcoal signatures to high-intensity fires with substantial charcoal inputs. The dendro-analyses showed a complex pattern of moderate intensity fires with substantial spatial variability across the study landscapes. We also use a long composite record of (high resolution) charcoal accumulation across this region, and the insights from the dendro- component, to discuss the potential drivers of fire in these high altitude ecosystems. The clear shift in the fire regime of the mid-20th Century alludes to an important interaction between fire management practices and changing climatic conditions. The relative importance of climate variability and fire management practices on contemporary fire regimes are vigorously debated in Australia and are directly relevant to land management policies and their implementation.

Holocene Environmental Change for a High-Dune Site in Subtropical Eastern Australia

Patrick Moss

Cameron Barr, Rebecca Farrell, John Tibby

Minjerribah (North Stradbroke Island), south-east Queensland is the second largest sand island in the world and contains numerous wetlands that have provided important information on late Quaternary environments of subtropical eastern Australia. Key findings include a number of records that extend to the Last Glacial Maximum and beyond, providing information on the influence of climate change and human environmental impacts. The island also contains the oldest (~20,000 years ago) dated archaeological site in south-east Queensland. A 350 cm sediment core has been collected from Swallow Lagoon, a perched lake located within the highest dunes of the island (above 150 m), that provides a unique record of environmental change for the last 8,000 years. This study provides an overview of the vegetation and fire history of the site from analysis of fossil pollen and charcoal, particularly in terms of landscape response to key climatic drivers (i.e. El Niño Southern Oscillation and Pacific Decadal Oscillation) and evidence of human impacts on the high-dunes of Minjerribah. The pollen and charcoal records will be contrasted to a quantitative reconstruction of rainfall from the same site based on the carbon isotope composition of leaves of Melaleuca quinquenervia (Barr et al., this conference).

Coastal Environments of Eastern Tasmania for the Last Millennia from High-Resolution Analysis of Salt Marsh Sediments

Patrick Moss

Roland Gehrels, Harriet Trevers, Jodie Daniel, Louise Callard

Salt marshes are vegetated tidal flats that are directly influenced by alterations in sea-level, with former sea-levels documented in changes in microfossils such as foraminifera and diatoms. In particular, alterations in foraminiferal assemblages can be used to develop a sea-level transfer function that can provide a high-resolution record of sea-level change over hundreds of years. Furthermore, salt marsh sediments also provide a detailed picture of the local and surrounding vegetation, as well as fire history through well preserved fossil pollen and charcoal. This presentation will discuss sea-level alterations, local salt marsh vegetation changes and regional vegetation/fire history alterations from two sites along the eastern Tasmanian coast. The Little Swanport Marsh (located close to Swansea) provides a continuous/high-resolution sea-level and vegetation/fire history record from 1830 AD, a hiatus from 1514 to ~1830 AD and a lower resolution record from ~761 to 1514 AD. In particular, the dramatic impacts of European settlement are revealed, as well as significant sea-level rise from 1900 to 1950 AD (associated with the end of Little Ice Age) and in the later part of the 20th century (linked to anthropogenic global warming). Initial research from the second site, Lutregala Marsh (located on Bruny Island), suggests a similar sequence of events, although additional dating is required to confirm the chronology and the high-resolution pollen analysis suggests site specific differences between this location and Little Swanport.

Are artesian spring wetlands long-term stable refuges from climate change?

Peter Negus

Artesian spring wetlands are often unique habitats in arid and semi-arid regions of the world where they can be considered permanent islands of wetted habitat in a landscape that is otherwise harsh and dry. In these harsh dry conditions spring ecosystems can flourish with a diverse biota of vertebrates, invertebrates, vascular plants and algae. The surrounding severe conditions create extreme isolation with little opportunity for the biota to disperse. This and the long-term constancy in spring wetland conditions are often evoked to explain why the biota are endemic and rare. Few investigations have been made of this proposed environmental stability in artesian spring wetlands in Australia. This study aims to use proxy records to compare the variability (or constancy) in environmental conditions within spring wetlands with the variability in surrounding landscape and local climate conditions from two spring complexes in Queensland: Talaroo Springs and Edgabston Springs. Talaroo Springs is a hot spring complex located on a travertine mound with a ring of surrounding palustrine wetlands. The springs originate from a deep semi-confined local aquifer that intersects heated granitic rock. Edgbaston Springs is a Great Artesian Basin thermal spring complex with at least 100 individual spring wetlands. The spring wetlands can overlay large areas of trona.

Last Glacial pollen-climate reconstructions from Northland, New Zealand

Rewi Newnham

Kat Holt, Kevin Butler, Brent Alloway, Andrew Rees, Janet Wilmshurst, Irka Hajdas

Just as Northland today is a distinctive biogeographic region, so its Quaternary record appears to be rather different to the rest of New Zealand. Nevertheless, beyond the LGM/LGCP, Northland records are sparse, not well dated and reliant to a large extant upon extrapolating from the patterns of the last glacial-interglacial cycle. The sketchy picture includes widespread forest survival during glacials, albeit with a different complexion to the modern forests, assertions that dry periods associated with dune activity punctuated the last glacial and that, in pollen records, the taxa Agathis (Kauri) and Fuscospora (beech) may be used to discriminate between warm and cool phases, respectively. Two new pollen records from Pouto Peninsula and Kai Iwi lakes, western mid-Northland, spanning the last ~70 ka, present an opportunity to revisit and evaluate these and other notions in the wider context of the Australasian sector of SHAPE. Temperature reconstructions from these pollen records allow a more robust comparison with proxy climate records from elsewhere in New Zealand than has been possible previously. A third short pollen record from Rototuna, situated midway between the other two sites, provides further evidence for the vegetation and climate around the time of the, Rotoehu Tephra, a critical isochron for the last glacial in northern New Zealand, which is also present in the other two records.

Changes in ENSO-like expression during Greenland Stadial 1 (GS-1) chronozone revealed by New Zealand tree-rings

Jonathan Palmer

C.S.M. Turney, E.R. Cook, P. Fenwick, Z. Thomas, G. Helle, R. Jones, A. Clement, A. Hogg

The warming trend at the end of the last glacial was disrupted by rapid cooling clearly identified in Greenland (Greenland Stadial 1 or GS-1) and Europe (Younger Dryas Stadial or YD). This reversal to glacial-like conditions is one of the best known examples of abrupt change but the exact timing and global spatial extent remains uncertain. Whilst a major focus for reconstructing changing modes of variability has been in the Atlantic Basin, the Pacific Ocean suffers from a relative scarcity of sub-decadally resolved proxy-records. Here we provide the results from an investigation into a tree-ring chronology from northern New Zealand aimed at helping to address the paucity of data. The conifer tree species kauri (Agathis australis) is known from contemporary studies to be sensitive to dominant tropical-Pacific climate forcing: the El Niño – Southern Oscillation (ENSO). The 1070-year subfossil kauri chronology has been precisely dated by comprehensive radiocarbon dating and contains a striking downturn between ~12,500 to 12,380 cal. BP. Wavelet analysis shows a marked increase in ENSO-like periodicities occurring after the downturn event. Comparison to low- and mid-latitude Pacific records suggest a coherency in the changes to ENSO and Southern Hemisphere westerly airflow during this period. The drivers for this climate event remain unclear but may be related to solar changes which subsequently led to establishment and/or increased expression of ENSO across the mid-latitudes of the Pacific. Regardless of the precise mechanism, the change appears to have been independent of the Atlantic and polar regions.

The last interglacial sea level highstand — evidence from Yorke Peninsula, southern Australia

Tsun-You Pan

Colin V. Murray-Wallace, Anthony Dosetto, Robert Bourman

Yorke Peninsula in southern Australia is an important region for reconstructing relative sea-level histories of the last interglacial due its location on the tectonically stable Gawler Craton and in the far-field of Pleistocene icesheets. Here, we examine evidence for the relative sea-level highstand attained during the last interglacial maximum (128 to 118 ka) based on taphofacies analysis of marine molluscs and foraminifers, and amino acid racemization (AAR) dating of the Late Pleistocene Glanville Formation on Yorke Peninsula, southern Australia. At Point Turton, shelly, bioclastic limestones, overlain by fine sands are interpreted as an upward shoaling, subtidal to intertidal sandflat succession based on the presence of the molluscs Katelysia scalarina, K. peronii, Amesodesma angusta, and A. cuneata. Amino acid racemization dating of the fossil marine molluscs A. angusta and Katelysia sp. reveals that the Glanville Formation occurs extensively along the coastline of Yorke Peninsula. Glanville Formation crops out in coastal cliffs as a variety of sedimentary facies such as upward shoaling subtidal-intertidal facies, and as relict storm beach deposits in higher energy situations. A uranium-series age of 117 ±4 ka was obtained on a solitary coral Plesiastrea versipora from the subtidal facies of the Glanville Formation. These data, combined with elevations of the Glanville Formation along the Yorke Peninsula, suggest that the last interglacial sea-level highstand in southern Australia was approximately 4 m above present sea level.

Stable isotopes in shearing shed deposits in far western NSW: long records of land cover change?

Pana Panaretos

Scott Mooney, Katherine Crowder, Nicola Stern

The project has used stable carbon isotopes to generate a record of land cover change, using faecal deposits recovered from shearing sheds from Western New South Wales.Sheep faeces, which accumulate annually beneath shearing sheds, provide an untapped and potentially continuous record of vegetation change in semi-arid landscapes. Since the early 19th century, thousands of sheep have been mustered and taken through woolsheds to be shorn. During these annual shearing events, whilst sheep were gathered and taken through the woolshed, fresh faeces would have fallen beneath the shed floor and accumulated to form deposits.These faecal deposits are of great significance because the woolsheds provide a sheltered environment suitable for the accumulation and preservation of environmental proxies. Such proxies would otherwise be difficult to obtain in any other setting, in a semi-arid landscape. Stable carbon isotope analysis of the faecal deposits, has been used as a proxy for sheep diet and thus available vegetation on the surrounding property.

By using the accumulating sheep faeces beneath several historic shearing sheds, at Mungo and Yanga national parks, the project has attempted to generate an environmental record that extends beyond those of instruments and written sources. Laboratory measurements of stable isotopes 13C/12C, as proxies for C4 or C3 dominated vegetation were used to investigate if vegetation patterns through time, mirrored the historic record of rainfall.

Speleothems as high-resolution archives of soil carbon export in New Zealand

Andrew Pearson

Adam Hartland, Beth Fox, Shaun Barker, Marcus Vandergoes, John Hellstrom

DOC (dissolved organic carbon) loss from soil is known to have increased in the 20th century in the Northern Hemisphere, yet the environmental causes and mechanisms behind this phenomenon are highly contentious. This study aims to compare a terrestrial DOC record with other environmental proxy records from more conventional archives (e.g. lake sediments) in New Zealand. Analysis across a latitudinal (thermal gradient) will allow the determination of the effects of temperature on DOC release from soil, in a geographical area that has been minimally impacted by anthropogenic stressors such as acid deposition.

Speleothems are secondary carbonate deposits found in caves, and are known to provide high resolution (seasonal to annual) archives of climate. Speleothems can be dated via U-Th methods, which can be constrained by layer counting. DOC is known to be incorporated into speleothems during their growth, and has the potential to be an important environmental proxy.

3D fluorescence spectroscopic and TOC (total organic carbon) data will be presented, providing a combined measure of the soil-DOC flux and its compositional dynamics in the context of contemporaneous changes in climate during the Holocene.

Using FTIR spectroscopy to build high-resolution records of total organic carbon in New Zealand lake sediments

Andrew Pearson

Adam Hartland, Carsten Meyer-Jacob, Marcus Vandergoes, Jamie Howarth, Beth Fox, Shaun Barker

Lake sediments provide archives of temporal and geographic environmental change related to variations within lakes (autochthonous) and their wider catchments (allochthonous). This project seeks to utilise lake sediments as archives of terrestrial organic carbon export to address the extent that climate drives changes in surface water total organic carbon (TOC) concentrations. Fourier transform infrared spectroscopy (FTIR) can contribute to chronological records of TOC in lake sediments and requires only small amounts of sample material (>0.002g), thus enhancing the potential to build high-resolution TOC records. Sediment and KBr are compressed into a disc, through which the IR absorbance of the sample is measured in the mid-IR-range (3750-400 cm-1). Absorbance of IR radiation provides information on the chemical constituents of the sediment, whilst a partial least squares regression (PLSR) model can quantitate TOC based on the FTIR absorbance. Our initial PLSR model is based on 200 sediment samples from 12 lakes across New Zealand and exhibits a strong correlation between FTIR-inferred and conventionally measured TOC concentrations (cross-validated R2= 0.86). The technique has been applied in different environmental settings (Arctic to Mediterranean), but thus-far no regional FTIR-TOC model existed for New Zealand. This study presents the first FTIR-inferred record of TOC in lake sediments from New Zealand. Our sub-decadal record of the recent Holocene (from ~1000 years B.P.) is derived from catchments that have been relatively undisturbed by anthropogenic impacts. With this data we aim to test the effects of air temperature (linked to microbial metabolism in soils) on TOC export.

SHeMax: The Last Glacial Maximum in the Southern Hemisphere

Lynda Petherick

Jamie Shulmeister, Jasper Knight, Maisa Rojas

The SHeMax project seeks to develop a greater understanding of the timing and nature of the LGM in the Southern Hemisphere. In order to achieve this, proxy data archived in marine and terrestrial records from different settings in the Southern Hemisphere will be analysed for the period 35-15 kyr BP, encompassing the termination of the last glacial cycle, and the traditionally-accepted timing of the global LGM (~24-18 kyr BP). Emerging evidence suggests that instead of being a relatively short event centered on 21 kyr BP, the LGM in the Southern Hemisphere may have been an extended period of time, with an early onset at 35-30 kyr BP. It has also been suggested that the LGM was not uniformly cool and dry, but may have been characterized by millennial-scale variability. In this project, records from high-resolution marine and coastal sediments, lake sediments, speleothems, ice cores, glacial moraines, dunes and fluvial systems will be compared to produce a synthesis of climatic variability and explore the premise of an extended LGM in the Southern Hemisphere. The spatial focus will be ~20-80oS, which will allow investigation into teleconnections between the mid- and high-latitudes. In addition to the synthesis of environmental conditions, we will suggest drivers and/or triggers of climatic variability. A significant component of the SHeMax project is the comparison of proxy data with model simulations for the LGM e.g. PMIP, SynTRACE-21. The project will also investigate the response of humans during the LGM to climatic variability, in terms of settlement, migration and cultural development. We welcome anyone who would like to be involved in this project.

The Last Glacial Maximum in the Southern Hemisphere

Lynda Petherick

Jamie Shulmeister, Jasper Knight, Maisa Rojas

Traditionally the LGM is thought to have extended ~24-18 kyr, being driven by Northern Hemisphere summer insolation minima. However, many records from across the Southern Hemisphere indicate a gradual recession from minimum conditions starting at or after ~30 kyr BP, substantially earlier than the widely accepted global LGM (~24-18 kyr BP) defined by sea ice extent and the Last Isotope Maximum (~21.5-18 kyr BP) recorded in Antarctic ice cores. The current state of knowledge of climatic variability in the Southern Hemisphere for the period 35-15 kyr BP is essentially based on robust records from New Zealand, relatively few records from Australia, South America and southern Africa. A key issue is that palaeoclimatic records from the LGM do not tend to be preserved in all environments, and there has been very little work integrating records of different types, which has inhibited our understanding of Earth System responses to climate forcing, because different components of the Earth System have different sensitivities to forcing. Furthermore, high resolution ice cores from Antarctica show quite different conditions than records from the mid-latitudes, which requires further investigation. Greater knowledge of decadal and millennial scale climatic and environmental variability across the Southern Hemisphere, and whether or not these changes are in phase with Antarctica, is crucial for providing input for the validation of palaeoclimate models. Here we present a summary of the current state of knowledge, including possible differences in the timing of the onset and termination of the LGM, as well as the severity of the LGM, as recorded in different locations in the Southern Hemisphere.

Climatic and environmental variability in southern America during the Last Glacial Maximum: A synthesis

Lynda Petherick

Ignacio Jara Parra, and the SHeMAX Project Team

Palaeo-vegetation records indicate that the Last Glacial Maximum (LGM) in southern South America was characterized by cool temperatures (mean annual 6-8oC lower than modern). In the southern Andes, precipitation was double that of today at ca. 5000 mm. Further north, the LGM climate was drier. For example, palaeontological records from Argentina indicate a major shift in taxa at from 28-13 kyr towards mammalian communities tolerant of cold, dry climate conditions. Glacial records from the tropical Andes also indicate a drier climate. The termination of the LGM was characterised by three phases of major glacial advance in the central and southern Andes at ca. 34-28 kyr, 24.5-21.5 kyr and 20.5-19 kyr, which are postulated to have been driven by moisture supplied by the latitudinal westerlies. Well-dated peaks in grass taxa in the Taiquemó pollen record correlate well with phases of Llanhquihue glacial advance. Pollen assemblages from marine core ODP 1234 indicate significant, abrupt changes in vegetation communities in southern Chile, interpreted as representing changes in the latitudinal position of the westerlies and the storm tracks associated with them. The activity of the glaciers, and the corroborating pollen evidence, indicate millennial-scale climatic variability during the termination of the LGM super-imposed on a long-term trend of cooling from ca. 30 kyr . An early (ca. 30 kyr) onset of the LGM in South America is widely accepted. Vegetation assemblages indicate an extended LGM, with an expansion of grasses from ca. 30 kyr. From 26 kyr subantarctic parkland (characterised by increased Nothofagus dombeyi (sub-Antarctic beech) and Poaceae expanded across the mid-latitude Andes, replacing sub-Antarctic forest. Here we present key records from southern America, summarising the current state of knowledge of the timing, intensity and characteristics of the Last Glacial Maximum.

Optical and U- series dating of the burial site and skeleton of Kiacatoo Man, New South Wales

Timothy Pietsch

Justine Kemp, Jon Olley, Rainer Grün, Colin Pardoe, Rachel Wood

We present single grain optically stimulated luminescence ages for grave infill, surrounding sediments, and nearby channel deposits related to Kiacatoo Man, an extremely robust individual exposed in eroding palaeo-levee sediments near the Lachlan River, New South Wales. Bone from the mandible was also directly dated using U-series analysis. Attempts to undertake radiocarbon dating of the bone failed owing to an absence of collagen. Six luminescence samples from sediment surrounding the skeletal remains yielded mixed single grain dose distributions indicating high rates of bioturbation, while sediments 0.5-0.7 m below the skeleton provide a luminesence age based on single component D_e distributions of ~26 ± 2 ka. These results agree with a U-series age of 27.4 ± 0.4 ka of the skeleton based on the weighted mean age of four laser ablation cross sections. They also agree with a single age of 28 ± 2 ka determined for the bedload sediments of the adjacent palaeochannel. Together these results provide bracketing ages for the skeleton and burial that overlap within uncertainties of between 27 ka and 28 ka.

Early Holocene ocean circulation in the Southwest Pacific

Joseph Prebble

H. Bostock, G. Cortese, A. Lorrey, B. Hayward, E. Calvo, L. Armand, M. Kienast, K. Kim, G. Scott, H. Neil

According to recent global compilations, the mid-latitudes (30-60°S) of the Southern Hemisphere experienced an Early Holocene peak in surface temperatures, which were on average 0.5°C warmer than present between 11-7 ka (Marcott et al., 2013). In the SW Pacific the sparse published data for the early Holocene show sea surface temperature (SST) up to 3°C above present, but the timing and magnitude of the warming appears to have varied across the region. This new study samples a latitudinal transect of cores from 36-60°S across the early to middle Holocene, sampling subtropical waters north of New Zealand to polar waters in the Southern Ocean. Using a range of paleo-proxy data we reconstruct the circulation and position of the main frontal systems in the SW Pacific and Southern Ocean during the early-mid Holocene. Our consensus mean annual SST estimates suggest the early Holocene is characterised by a small increase in SST at core sites south of the Subtropical Front (STF). This suggests that there might be a subtle southward shift of the STF and increased subtropical water (STW) contributions to these core sites. This was most likely driven by lower westerly wind strength in this part of the Southern Ocean during the early Holocene. The expansion of the STF zone (STFZ) possibly resulted in a slightly higher productivity in the early Holocene in most of the STW and Subantarctic Water (SAW) cores. An analysis using the PICT tool suggests our conceptual model is reasonable.

Contemporary carbon fluxes do not represent the long-term carbon balance for an Atlantic blanket bog

Joss Ratcliffe

Roxane Andersen, Russell Anderson, Anthony Newton, David Campbell, Dmitri Mauquoy, Richard Payne

Peatlands are one of the largest terrestrial stores of carbon. Carbon exchange in peatlands is often assessed by measurement of contemporary fluxes, however it is uncertain how representative these fluxes are of the longer term carbon balance. Consequently the long-term stability of carbon sequestered in the present is called into question. Here we compare profile based measurements of carbon accumulation with the published net ecosystem carbon balance for the largest peatland in Britain, the Flow Country of Scotland. We estimate the long-term rate of carbon accumulation to be 15.43 g C m-2 yr-1 at the eddy covariance site, Cross Lochs, a result that is more than six times smaller than the contemporary carbon uptake of 99.37 g C m-2 yr-1. Long—term carbon accumulation at two other sites was found to be comparable to that of Cross Lochs, however no consistent response to climate was found between sites. We demonstrate that a strong contemporary carbon sink strength may not translate into higher long-term carbon accumulation. Contemporary carbon accumulation should be viewed in the context of the long-term ecological drivers, such as fires, eco-hydrological feedbacks, and the quality of litter inputs. This may be particularly important in a context where stable carbon capture and storage is hoped to be achieved through land-use change.

Carbon accumulation in restiad peatlands

Joss Ratcliffe

David Campbell, Louis Schipper, David Lowe

On a global scale, intact peatlands have been a consistent sink for carbon throughout the Holocene, sequestering 612 GtC, an amount comparable to that found in the atmosphere. Peatland carbon exchange is sensitive to changes in climate and to disturbance events such as fire and drainage. Carbon emissions from degrading peatlands are high and are estimated to be greater than those of global shipping and aviation combined. The pace of peatland loss in New Zealand has been among the most rapid of anywhere in the developed world, yet comparatively little is known about the ecohydrology and carbon dynamics of this peatland type or what impact partial drainage may have on the remnant areas which still contain peat forming vegetation. This project will combine measurements of contemporary carbon exchange with measurements of carbon accumulated in peat profiles, dated through a combination of AMS radiocarbon and tephrochronology. This will be done in order to investigate, over different timescales, the stability and strength of the carbon sink and also the resilience of restiad peatlands to fire and drainage.

Testing lessons from the past: using paleoenvironmental data to define pre-human baselines at Lake Pounui, New Zealand

Andrew Rees

Leise Cochrane, Marcus Vandergoes, Rewi Newnham

Lake Pounui, located at the southern tip of the North Island of New Zealand (NZ), is a fascinating site. With a rich ecological heritage, Lake Pounui features endangered aquatic macrophytes and a catchment predominantly covered by native forest. Recently, however, algal blooms have become a nuisance during summer months, surpassing national guidelines for swimmable waters – the lake appears to be approaching a tipping point. Here, we present monitoring data covering the last three years along with proxies archived by Lake Pounui's sedimentary record, which extends our short historical data-set to pre-human baseline conditions. Elevated charcoal influx and the appearance of palynological disturbance indicators pinpoint human arrival in the catchment to three hundred years ago. The transition from a pre- to post post-human environment coincides with a pronounced shift in diatom assemblages. By the same token, conditions pre-dating human arrival in NZ, between 3 and 2 thousand years ago, were even more eutrophic than present. These conditions abruptly ended concurrent with a major disturbance in the catchment, identified with µ-XRF. Consequently, Lake Pounui offers the unique opportunity to both compare tipping points driven by natural and anthropogenic forcings and interrogate the paleo record for evidence-based restoration targets.

Monsoon-controlled environmental change in tropical north Australia inferred from an organic swamp deposit near Darwin

Will Reynolds

Sam Marx, Jan Hendrick May, Jessica Reeves, Debashish Mazumder

The climate of northern Australia is dominated by the Australian monsoon; however, our understanding of palaeo-monsoon dynamics remains incomplete. Despite its importance for Australia, there are no high- resolution, continuous terrestrial monsoon records from within Australia's core monsoon region. This is, in part, attributable to the hot, wet and highly seasonal character of Australia's 'Top End' climate which inhibits preservation of the type of records (e.g. peats) commonly used in palaeoclimate studies. As a result, current records of monsoon activity are typically short, less than 5,000 years, poorly resolved or come from locations marginal to the monsoon tropics. Notwithstanding their relative scarcity, there are locations in the "Top End" that have the potential to preserve long continuous records of palaeoclimate. This study presents the first long-term record of variation in the Australian monsoon derived from the core monsoon region using a peat and sediment archive. A multi-proxy approach employing analysis of diatoms, pollen, geochemistry, and C & N isotopes was used to infer variations in the Australian monsoon over the last 30,000 years. Results indicate the monsoon was either weak or absent for most of the last 30 ka with C4 plants predominating. Additionally the Last Glacial Maximum does not stand out as distinctive in the studied swamp. A rapid return of moisture occurred since approximately 10 ka resulting in increased silt deposition and preservation of organics. Conditions favourable to the preservation of peat were established about 5.5 ka, while low δ13C values (~-25) indicated dominance of moisture-reliant C3 plants from this time. Increasing sand deposition after 5.5 ka, alongside an increased presence of salt-tolerant diatom species, and declining aquatic pollen taxa indicate greater climate variability possible due to increasing ENSO dominance. Overall the presented record demonstrates the rapid change in moisture availability which occurred in Australia's Top End during the late early Holocene

Poutō dune lake palaeolimnology – learning from the past to help manage the present

Brett RIP

Paul AUGUSTINUS, Tom STEPHENS, Mark Horrocks

A paleolimnological investigation of aspects of past ecosystem structure and function in several Poutō dune lakes (north Kaipara barrier, Northland, NZ) was undertaken to complement other research on dune lake catchment dynamics and drivers of changing water quality. Despite widespread use in Europe and North America of paleolimnological approaches to inform lake policy and management, this study represents one of the first applications of this approach to inform dune lake management in New Zealand. Here we examine select cores from the target lakes that span the past ca. 4000 cal yr BP, with a focus on limnological changes induced by European land use modification of the lakes and their catchments. The paleolimnologically-inferred changes in the lakes and their catchments prior to the last century have a high degree of similarity with pollen/spore and charcoal-inferred changes in the vegetation assemblage and burning reflecting Polynesian impacts. However, the last 100 years of European driven land use modification appears to have driven the major changes to the lakes and their catchments, with the lake histories sharing a pattern of enhanced erosional inputs that preceding changes to nutrient availability by several decades. Timing of the initiation of enhanced lake catchment erosion varies between lakes associated with differences in catchment land use. It is clear that a one-size fits all mode of lake water management is inappropriate given the variability in lake size, depth, lake water column stability, catchment land use and apparent differences in responses of the lakes to the catchment-derived inputs.

North by Northwest: a palaeoenvironmental study of the archaeology in northwest Tasmania

Anthony Romano

Michael-Shawn Fletcher, Michela Mariani

To achieve the global imperative of sustainability, we must understand the various factors that have shaped our environment. This is particularly important for landscapes recently colonised by Europeans, such as Australia, in which imported landscape management paradigms have resulted in widespread environmental degradation. It is in this context that integrative studies of archaeology and palaeoecology, which can provide important insights into how inhabited landscapes have evolved in concert with humans, are a critical and necessary endeavour. Tasmania has a long history of human occupation (ca. 40ka) and has been subject to significant environmental degradation since the European invasion. This study aims to provide an environmental context for the rich archaeological record of the Western Tasmanian Aboriginal Cultural Landscape (WTACL) National Heritage area and determine the impact, if any, of Aboriginal land management on the environment surrounding occupation sites. Multiple sites were cored across northwest Tasmania in close proximity to archaeological sites and analysed for environmental changes using palaeoecological proxies. We reveal that palaeoenvironmental changes were correlated with changes in human activity and climatic change. The various records reveal the combined effects of fire, climate, hydrology and people and suggest greater environmental variability between c. 2.5 – 1ka. This study is the first comprehensive research into the archaeology and palaeoecology of the northwest coast of Tasmania and will provide critical insights into long-term human-environment interactions in Australia.

Past and modern weathering conditions in the Murrumbidgee basin (Australia)

LEO ROTHACKER

ANTHONY DOSSETO, ALLAN R. CHIVAS, NATHALIE VIGIER

Soil development is a major control on the global carbon cycle because chemical weathering acts as a major carbon dioxide sink. However, little is known on how soil development responds to glacial-integlacial climatic oscillations. In recent years, lithium isotopes have become a useful tool for tracing chemical weathering conditions. This study aims to use this isotopic proxy in modern sediments and palaeochannel deposits to assess how weathering has responded to climate fluctuations over the last 100,000 years in the Murrumbidgee River catchment (south-eastern Australia).

Sediments from monolithological catchments (meta-sedimentary, volcanic and intrusive) display an almost identical range of δ7Li (-4‰ to +1‰), suggesting that changes in sediment provenance have little effect on the Li isotope composition of sediments delivered to the alluvial plain.
In palaeochannel sediments, we observe a slight increase in ❤7Li values from Marine Isotope Stage (MIS) 5 to 3, followed by a decrease through MIS 2 and 1. This could suggest that during periods of higher runoff (MIS 5 and 3), soil erosion was more active, leaving little time for clay formation and Li isotope fractionation. Conversely, as runoff decreased over the past 40 kyr, erosion also decreased allowing new soils to develop. These results show that over the last glacial cycle, soil development in the Murrumbidgee River basin has been strongly coupled to changes in runoff and erosion, responding rapidly (<10 kyr) to hydro-climatic variations.

Human impact overprints natural controls on soil systems in the Iron Age

L. Rothacker

A. Dosseto, A. Francke, A.R. Chivas, N. Vigier, A.M. Kotarba-Morley and D. Menozzi

Since the end of the last glacial period, humans have had an increasing impact on their environment. However, assessing the environmental impact of anthropogenic activities is difficult to reconstruct, due to the scarcity of evidences in geological records. Here we use uranium and lithium isotope compositions of sediments from Lake Dojran (Macedonia/Greece) to assess how soil erosion and formation have responded to climatic shifts and human intervention. Between 12,000 and 3,000 yr BP, soil denudation and soil development were decoupled, showing that they responded differently to climate change in the region. Physical erosion co-vary with rapid (<1,000 yr), regional climatic shifts. In contrast, soil development is insensitive to these shifts, instead increases continuously between 12,000 and 3,000 yr BP in response to the end of the Younger Dryas. At 3,000 yr BP, both uranium and lithium data suggest that erosion of deep horizons took place, unprecedented since the beginning of Holocene. This is interpreted as the response to widespread deforestation, in agreement with regional pollen records, which would have effectively 'reset' the landscape. The timing of this event coincides with the development of regional trade and the emergence of iron smelting technology in the region, which would have exerted significant stress on natural resources. Whilst plant cultivation and animal husbandry during the first half of the Holocene was a first step that humans took into the Anthropocene, the expansion of urban civilisations during the Iron Age significantly deepened their impact on the environment leaving unambiguous evidences in this lacustrine record.

Interpretations of Holocene coastal evolution at the River Murray Mouth as inferred from the antecedent morphology of the last interglacial shoreline

Deirdre D. Ryan

Robert P. Bourman, Colin V. Murray-Wallace

Modern coastal geomorphology is a product of first-order general physical processes and zero-order inherited geological frameworks. Tectonic controls in confluence with antecedent morphology dictate site-specific, long-standing imprints on coastal evolution. The depth of older strata, their integrity, and resistance to erosion, influence modern shoreface development and morphology. The River Murray Mouth is located in a region of ongoing subsidence at the northern extent of the Coorong Coastal Plain in South Australia. The coastal plain retains a long record of sea-level highstands in the form of calcrete-capped beach-barrier dunes and associated lagoon deposits reflecting the recurring development of a barrier coastline for at least the last ten interglacial periods. Previous investigations of the Murray Mouth region have identified the MIS 5e barrier, lagoon, and river mouth location, a MIS 5c aeolianite, and siliceous sands associated with glacial period climatic conditions. Relict sediments located offshore on the Lacepede Shelf indicate the development of barrier shorelines during interstadial periods and possible shorewards migration of barriers during the postglacial marine transgression. The remnants of the last interglacial shoreline and its contact with siliceous sands and Holocene sediments allow for inferences to be made regarding, not only the establishment and development of the modern coastline, but also the erosional history of the MIS 5 deposits during the intervening period of lowered sea-level. These conclusions are based upon our understanding of the behavior of transgressive barrier shorelines on low-gradient coastal plains, localised coastal processes, and the inherited geological framework.

Thresholds in vegetation cover during the super-humid MIS 11 interglacial from southwestern New Zealand

Matt Ryan

R.Newnham, G.Dunbar, M.Vandergoes, B.Alloway, S.Steph, A.Sabaa, B.Hayward, G.Scott, H.Neil, A.Rees, H.Bostock, R.Tiedemann

Quaternary paleoclimate records can offer valuable insights into the environmental effects of future warming, which is predicted to reach 0.3-4.8°C above pre-industrial values by the end of this century. Although many pollen records show step-changes in regional vegetation due to warming since the Last Glacial Maximum, there are few records that capture the response to warmer-than-present conditions. Here, we examine the response of forest elements on the West Coast of the South Island to 'super-warm' conditions experienced during Marine Isotope Stage (MIS) 11 (~410 ka) from terrestrial pollen extracted from marine cores ~100 km west of Hokitika. During peak warmth, MIS 11 sea surface temperatures were ~1.5-3°C warmer than present. This corresponds with a notable expansion and dominance of the thermophilous shrub Ascarina lucida at the expense of the currently dominant tall tree conifer Dacrydium cupressinum. The MIS 11 forest composition in this highly humid region also contrasts markedly with reconstructions of forest conditions during periods inferred to be up to 1.5°C warmer than present in the early Holocene and Last Interglacial, when D. cupressinum remained dominant in the region. The MIS 11 record suggests a forest ecology 'threshold' was crossed in response to warming, with a prolonged period of higher air temperature and reduced terrestrial seasonality following the extreme cold of MIS 12, while biogeographic barriers inhibited the migration of species from more northerly latitudes. These results suggest that New Zealand's most widespread tree – and by implication our lowland podocarp forests – may be under threat in the near future.

Relationships between the Southern Hemisphere westerly winds, temperature and carbon dioxide during the Holocene

Krystyna Saunders

B Perren, SJ Roberts, C Butz, M Grosjean, DA Hodgson

The Southern Hemisphere westerly winds drive Southern Ocean circulation. Changes in their strength or position, in particular relative to the Antarctic Circumpolar Current, are linked to changes in the upwelling of carbon rich deep water to the surface. These winds therefore exert significant control on the ocean-atmosphere CO2 balance. Modifications to their strength or position, in particular relative to the Antarctic Circumpolar Current, such as the observed intensification and poleward shift in recent decades, could influence whether the Southern Ocean acts as a net source or sink for atmospheric CO2. This presentation outlines a novel approach combining independent biological (diatoms) and geochemical (high-resolution scanning x-ray fluorescence and hyperspectral imaging) proxies to provide a centennial scale resolution record of the westerly winds over the last 12,000 years from sub-Antarctic Macquarie Island (54°S, 158°E). There is close agreement between the three proxies, which demonstrate large scale variations in westerly wind strength over the Holocene, which are related to Antarctic temperature and CO2 fluctuations.

Tracing Tasmania's mining history using high-resolution scanning XRF and quantitative trace metal analyses

Krystyna Saunders

L Schneider, P Gadd, H Heijnis, A Zawadzki, D Fierro, S Haberle, Maher B, M-S Fletcher

Many areas of Tasmania have been impacted by more than a century of mining since the start of European settlement. In this study, a multi-proxy approach using 210Pb, 137Cs and metal concentration profiles is employed to reconstruct the environmental history of mining activities from Mount Lyell near Queenstown, Tasmania, over the past 120 years. To track atmospheric inputs from mining activities, Se, Zn, Cu, As, Cd and Pb were analysed in sediments from five isolated lakes with varying distance from Queenstown. The ITRAX-XRF core scanner and ICP-MS geochemical techniques were utilised to build high-resolution metal pollution sedimentary records. The ICP-MS results were closely correlated with the ITRAX profiles, demonstrating the potential for combining these two techniques to improve the resolution of metal measurements in sediments. This multi-proxy method provided a series of high precision and reliable quantitative records of the history of contamination in remote areas of Tasmania which can be used for sediment quality assessment. The application of this approach enables a better understanding of the long-term pollution dynamics in remote areas, aiding in the management and protection of susceptible lacustrine systems.

Facies scale depositional model for Plio-Pleistocene bottom-current controlled carbonate drift deposits

Craig Sloss

Betzler, C. G., Gregor, P., Lüdmann, T., Alvarez-Zarikian, Reijmer, J.G., Reolid Perez, J., Ling Hui Mee, A., Noth

Located in the Indian Ocean, the Maldives carbonate edifice bears a record of oceanic circulation, sea-level changes and the onset and fluctuations of the Indian monsoon over the Neogene. The Maldives archipelago is comprised of a north-south–oriented double row of atolls that formed on a volcanic basement ridge, and encloses the Inner Sea (inner basin depositional center) with water depths up to 550 m. Following the partial drowning of parts of the carbonate platform during the middle Miocene, the inner basin has served as a continuous carbonate depositional center for current-controlled deposits carbonate drift deposits. The carbonate drift deposits are large-scale lobate clinoform bodies associated with the onset of current amplification in the Inner Sea. Basin sedimentary infill during the Plio-Pleistocence was dominated by inter-atoll currents, producing a current derived carbonate drift-fan deposition. Carbonate drift-fan (CDF) have not previously been fully described in the literature in terms of sedimentological characteristics and facies scale models. In this research, sedimentological and stratigraphic analysis, facies associations and the evolution of carbonate drift deposits have been determined. The new depositional models for carbonate drift depositional systems are compared to established models for Contourite Depositional Systems (CDS), which have primarily been established based on bottom-current driven siliciclastic depositional sequence. Results indicate that while there are many similarities between siliciclastic and carbonate bottom-current driven depositional environments, there are sufficient differences warranting a specific classification for carbonate drift deposits.

Large scale soft sediment deformation features preserved in Early Pleistocene inner carbonate shelf sequence: Debris flow or seismic induced soft sediments

Craig Sloss

Kathrine Giosefi, Luke Nothdurft, Jessica Trofimovs, Anna Habbeck, Brian G. Jones, and Christoph Shrank

The Castlepoint headland, comprised of the “Castle” (162 m high) and the “Reef” (50 m high), is located on the southeast coast of New Zealand (North Island). The subaerial exposure of the early Quaternary mixed carbonate and siliciclastic Castlepoint Formation is exposed due to rapid uplift associated with the subduction of the Pacific Plate beneath the Australian plate. Preserved within the Castlepoint Formation are large (meter scale) rounded features that are discordant with the adjacent bedding. These features were originally described as part of rapidly deposited cohesive gravity induce debris flows. The large discordant features the result of liquefaction associated with increased pore-pressure following rapid burial of overlying debris flows. The source of the debris flow was hypothesised to be an extensive neritic barnacle and molluscan rich carbonate depositional environment during the Pliocene and early Pleistocene, and redistributed downslope as part of a canyon-head debris flow in response to cyclic sea-level changes on the adjacent shelf. However, a detailed structural, sedimentological and stratigraphic investigation to reconstruct the depositional environment, and influence of neo-tectonics on post deposition deformation is poorly constrained. In this research the hypothesis that the Castlepoint Formation was deposited as a canyon-head debris flow is tested. An alternate hypothesis that that these discordant features are generated in situ in a shallow shelf, carbonate-rich depositional environment proximal to the carbonate factory. The discordant features representing soft-sediment deformation associated with seismic activity, as opposed to canyon gravity flow.

The climate of SE Australia at the LGM

James Shulmeister

T Cohen, C Woodward, T Barrows, J Kemp, K Fitzsimmons, D Clark, A Gontz, R Haworth, J Chang, D Mueller, A. Slee, D. Ellerton

Climatic conditions at the LGM in SE Australia have long been assumed to be both cold (mean annual temperature 8-10°C colder than modern) and arid. This model emerged from early work on periglacial phenomena and has been gradually reinforced over the last 40-50 years using proxies as diverse as pollen, dune activation and amino acid racemisation. Despite this apparent convergence of evidence, there have been some discordant elements in the story, notably the apparently greater flow in some rivers at around LGM time. This poster summarises the results of a recently completed project aimed at reinvestigating the LGM in south-eastern Australia. Overall cooling is confirmed at 8-11°C in winter but summer cooling was less at c. 6.5°C. Periglacial landscapes, or more precisely, freeze-thaw dominated landscapes are widespread on the high country along the Dividing Range as far north as 29°S. Wind patterns, at least in northern NSW and SE Queensland, were similar to the present day. A zone of higher rainfalls was maintained along parts of the eastern coast and highlands. Rivers appear to have flowed more strongly during the latter half of the last glaciation than in the Holocene, though the LGM itself was not a particularly high flow period. Nevertheless we query the inference of greater aridity as reduced evapotranspiration due to reduced forest cover and reduced temperatures makes significant aridity hard to achieve. We suggest that other factors, including increased sensitivity of vegetation to fire may play a role in de-stabilising vegetation cover and enhancing aeolian sediment production. Overall, we reconstruct the synoptic climatology of SE Australia at the LGM as remarkably similar to modern.

Glaciation of the upper Rangitata Valley, South Island, New Zealand

James Shulmeister

Glenn D Thackray, Tammy Rittenour, Stefan Winkler, Rosabella Borsellino

Over the last 6 years an extensive campaign of glacial sedimentological logging, geomorphological mapping and OSL and TCRN dating has been undertaken on the glacial deposits in the Butler and Brabazon Downs, Rangitata Valley, New Zealand. The Downs occupy a tectonic basin and are a particularly good location to investigate advances that were significant but are mainly recorded in stratigraphy and may not have been extensive enough to be recorded in terminal moraine systems. During the largest advances drainage was trapped against the western edge of the downs. While the highest topographic levels relate to large advances, lower on the downs most features relate to the gradual reduction of ice from about 28 ka onwards. During ice retreat, ice stagnated on the downs. During final retreat, low but elongated lateral moraines developed close to the modern Rangitata Valley floor. From sedimentological outcrops, six periods of extensive ice cover in the latter half of the last glaciation cycle can be identified. The earlier advances are roughly constrained to the mid-60 ka and the high 40kas, with four younger advances centred around c. 37, 28, 21 and 18 ka. A large lake occupied much of the basin between older and c.27 ka advances. Boulders are common on the Downs and, away from the flanks of the Sinclair Range, they can be safely ascribed as glacially transported. Many occur on moraine ridges while others occupy inter-kettle surfaces in areas of ice stagnation. Over 30 TCRN samples have now been submitted for dating.

Evidence for subdued ENSO variability during super-interglacial warmth from a tropical Queensland record

Zoë Thomas

R.Jones, I.Croudace, P.Moss, T. Herbert, M.Grosvenor, R.Wüst, J.Brown, J.Muller, M.Kylander, S.Rule, S.Lewis, S.Coulter

The El Niño-Southern Oscillation (ENSO) is a driver of global atmosphere-ocean dynamics, and can have severe and wide-reaching impacts on ecosystems and societies. ENSO behaviour under warmer climate conditions than today is highly uncertain, with models exhibiting widely differing projections in amplitude, frequency and global teleconnections. Palaeoclimate records offer the potential to improve our understanding of ENSO behaviour but most are fragmentary, suffer low resolution, and/or typically do not cover periods warmer than present day. Here we report a continuous, inter-annually resolved, multi-proxy record of hydroclimate spanning 220-80 ka from Lynch's Crater in tropical northeast Australia, a region highly sensitive to ENSO. This record offers new insights into changing ENSO behaviour across glacial-interglacial cycles. We find subdued ENSO variability during super-interglacial Stage 5e, a period globally warmer than present day with sea levels >6.6 m. In marked contrast, ENSO variability appears to have been enhanced during MIS 6. The precise alignment of northeast Australian terrestrial-marine sequences allows us to directly compare ENSO variability to trade wind strength (which controls the delivery of warm South Equatorial Current waters). Sea surface temperatures are observed to have rapidly increased into MIS 5 and then plateau, parallel with the expansion of wet rainforest taxa in Lynch's Crater, suggesting stronger trade winds during the last interglacial. We speculate that enhanced Indonesian Throughflow and Walker Cell circulation steepened the equatorial Pacific thermocline, dampening ENSO variability during this period.

An environmental record through Marine Isotope Stage 3 from North Stradbroke Island, south-east Queensland, Australia

John Tibby

Barr, C, Lewis, R, Arnold, L, Gadd, P, Henderson, A, Leng, MJ, McInerney, C, Nielsen, K, Yokoyama, Y, Moss, P

Marine Isotope Stage 3 (MIS3) is a critical period in Australia's history. During MIS3, humans arrived on the continent and the last megafaunal extinctions occurred. Evidence from many parts of the world indicates that there was marked millennial-scale climate variability during MIS3. However, the extent and magnitude of such MIS3 variability is poorly known in Australia. Furthermore, the extent to which (any) climate variability played a part in Australian megafaunal extinctions is a matter of ongoing debate. Further consideration of this issue is hampered by an absence of well dated records of sufficient resolution from the Australian mainland. We present a new high resolution record of environmental change derived from elemental analysis by X-ray fluorescence (μXRF) scanning of a sediment core covering the past ca.100,000 years from Welsby Lagoon, North Stradbroke Island, a large sand island off the coast of Brisbane. This record is complemented by compound specific H isotope analyses from leaf waxes and aquatic cellulose oxygen isotope analyses. The chronology has been developed from 21 OSL ages and 20 14C dates. As there is little or no overland flow into the lagoon, geochemistry of the sediments reflects changes in windblown dust from the Australian continent. Contrary to another recent study, we find no evidence to indicate that there was a substantial hydrological shift that occurred at the time of megafaunal extinction on the Australian continent (ca. 45-50 ka), but do find evidence of marked hydrological variability in MIS3.

Diatoms as indicators of past cave environments in the Naracoorte Cave system, south-eastern South Australia

John Tibby

Reed, L.

Diatoms are very commonly used indicator of water quality and habitat in a variety of aquatic environments. However, diatoms are also known to grow on a range of moist surfaces, including soils, moss and tree bark. We have recently analysed the diatom flora from two megafauna bearing deposits in the Nararcoorte Cave system, south-eastern South Australia. Although the flora from both the Bat and Blanche Cave deposits is dominated by a small number of species, it is also quite speciose. To complement the ongoing analysis of the fossil material, we sampled diatoms on a range of surfaces inside and outside the caves, focussing particularly on soils and cave sediments. We will assess the relationship between diatom species composition and environmental variables such as light, distance from the cave entry and soil moisture content. In future work we hope to develop transfer functions for inferring palaeonvironmental conditions important for understanding the context of megafaunal extinctions and use the diatoms to better understand the taphonomy of the cave sediments.

Back to the Future: Last Interglacial Warmth and the Stability of the Antarctic Ice Sheets

Chris Turney

Chris Fogwill, Nick Golledge, Nick McKay, Erik van Sebille, Richard Jones, Zoë Thomas and Helen Millman

Recent studies modelling the Antarctic ice sheet contribution to future global sea level rise range from negligible to substantial (>7m). A useful analogue in this regard is the Last Interglacial (LIG; 135-116 ka) during which reconstructed past sea levels imply a significant ice mass loss from both Greenland and Antarctic ice sheets, contributing to a global sea level 6.6 to 9.4 metres above present day. Climate reconstructions and models of the Last Interglacial, however, suggest a wide range of global temperatures, from relatively small differences compared to present day to large warming (>2˚C) at high latitudes (so-called 'polar amplification'). This limits our understanding of the sensitivity of the ice sheets to warming. Previous work combining terrestrial and marine records spanning the LIG is challenge given chronological and seasonality biases. Marine records are arguably better constrained in these regards but recent work has highlighted the importance of ocean current drift in introducing temperature biases into palaeo-reconstructions where the offset may reach 1.5 °C for planktonic foraminifera living for a month and 3.0 °C for longer-living species. Here we exploit an updated marine record of quantified temperature estimates across the LIG d18O plateau and attempt to quantify for bias introduced by ocean current drift to generate an accurate and precise estimate of global LIG temperatures. Using the new reconstructed sea surface temperatures we drive a coupled ice-sheet/ice-shelf model to investigate the contribution of Antarctic ice sheets to global sea level rise during the LIG.

The nature and causes of ‘megadroughts’ in south-eastern Australia: evidence from the Holocene sediments of West Basin, Victoria

Jonathan Tyler

Eliza Lockier, Andrew Chapman, Cameron Barr, John Tibby, Mark Rollog, Stephen Obrochta, Robert Klaebe, Megan Williams, Haimish Prodan, Priya, Olly Tsimosh, Yuexiao Shao, Megan Sharman, Patricia Gadd, Geraldine Jacobsen

Documenting and understanding centennial scale hydroclimatic variability in Australia is significant both to global climate science and to regional efforts to predict and manage water resources. In particular, multidecadal to centennial periods of low rainfall – ‘megadroughts’ – have been observed in semi-arid climates worldwide, however they are poorly constrained in Australia. Here, we present a sub-decadally resolved record of hydrological change at West Basin, Victoria, which spans the last 10,000 years. Using a variety of evidence, including µXRF inferred mineralogy, high resolution image analysis, diatom species analysis and the isotope geochemistry of carbonates, organic matter and aquatic cellulose, we document both sub-centennial and millennial scale variability in lake water depth and salinity, reflecting regional scale changes in precipitation/evaporation. We focus on two periods: (a) the transition toward more arid conditions during the mid-late Holocene, linked to the intensification of the El Nino Southern Oscillation (ENSO); and (b) decadal scale hydroclimate variability and the occurrence of megadroughts during the last 1000 years. These data will be discussed in the context of the causes of hydroclimate variability in south-eastern Australia, the implications for future management of water resources and considerations for future research in the region.

Millennial scale variability in the East Asian Monsoon during the last 55,000 years recorded in the bulk organic geochemistry of Lake Suigetsu, Japan

Jonathan Tyler

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The East Asian Monsoon (EAM) dictates the water resources for almost half the world's population, yet the response of the monsoon to centennial-millennial scale climate forcing remains subject to debate, particularly during the last glacial period. Here we investigate the bulk organic geochemical composition of the sediments of Lake Suigetsu, Japan, which lies near the north-easternmost extent of the modern day EAM. The total organic carbon content of the Lake Suigetsu sediments exhibits a remarkable similarity to two other lake records within a 100 km radius – Lake Biwa and Lake Nojiri – and by chronostratigraphically linking the records using co-occurring tephra horizons we derive a regional, composite record. The geochemical nature and sedimentary context of organic carbon at Lake Suigetsu, plus the regionally coherent nature of the environmental signature, support the interpretation that our composite record reflects changes in the intensity of summer rainfall in central Japan. The Lake Suigetsu radiocarbon dataset, placed on the globally unique floating varve chronology (circa 10 – 60 vyr BP), provides an important component of the IntCal13 radiocarbon calibration curve. This precise chronology allows a detailed comparison with both regional and global palaeoclimate records and we observe a consistent pattern of change between Asian Monsoon records across the continent. We use these data to re-evaluate the climatic teleconnections linked to the EAM and consider the mechanisms which drive millennial scale variability through the last glacial period.

When did humans become modern?

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Human influence on the environment has been generally associated with modern human traits. Although the timing of human arrival in Australia has been well established at 60-50 ka, the timing of the first signs of modernity is still debated. Recent dating of rock art in Sulawesi by Aubert et al. (2014) suggests that humans with modern traits were in Sulawesi by 40 ka. Were the humans occupying Australia at the same time also being modern and painting art? Recent work suggests that humans were occupying the Kimberley between 40-36 ka placing potential artists in the region in the same time frame as the Sulawesi art, but establishing the true age of the art has been problematic. A joint UNE, MQ and UoW team in collaboration with the Wunambal Gaambera people went about trialling three dating methods applied to the art in the Lawley and Mitchell river areas. OSL dating of fossilised mud wasp nests provided nine minimum age estimates, AMS 14C of beeswax and charcoal provided an additional four, while U-series dating of rock skins was unsuccessful. Results confirm that at least one phase of the northwest Kimberley rock art assemblage is Pleistocene in origin. Furthermore, the rock art assemblages are far more complex than generally accepted with different styles produced contemporaneously well into the last few millennia. However, this research provides a step closer to establishing the true significance of arguably the longest, most impressive and complex rock art sequence anywhere in the world.

Towards a comprehensive record of Quaternary environmental change from the Snowy Mountains, Australia

Craig Woodward

Jie Chang, Doug Clark, Brodie Cutmore, Patricia Gadd, Ken Green, Henk Heijnis, Adrian McCallum , Sam Marx, Krystyna Saunders, James Shulmeister, Atun Zawadzki

Kosciuszko National Park in the Snowy Mountains, Australia is an international Biosphere Reserve containing a Ramsar wetland, and is a key catchment for the Snowy Mountains hydro-electric scheme. There have been several paleoenvironmental studies that have examined late Quaternary climate variability in this area and investigated the effects of human impacts on the landscape. However, much is still to be learnt about how this area has changed in the past, and how it might be managed in the future. We present initial results from a project that explored the viability of a re-examination of human induced and natural environmental change in the Snowy Mountains. We aim to develop a comprehensive regional record of environmental change that utilizes the different responses of the four main alpine lakes to external drivers. We cored Blue Lake in the winter of 2016 and retrieved 8.5 m of core. This has now been scanned using high resolution x-ray fluorescence and shows strong potential for a high resolution record going back to the Last Glacial- Interglacial Transition. We have also taken short cores from Cootapatamba, Albina and Blue Lake for a preliminary examination of human impacts since the 19th century. We obtained excellent preliminary 210Pb chronologies from all sites and initial results suggest quite different responses from each lake to catchment impacts and climate change.

The effect of Maori deforestation on wetland hydrology, catchment erosion and eutrophication: a case study from the South Island

Craig Woodward

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Woodward et al. (2014) demonstrated that forest clearance can increase moisture availability/water depth in existing wetlands and even create new wetlands where none previously existed. They argued that this effect is widespread, but often overlooked because studies are usually not designed to look for post-deforestation hydrological changes in wetlands. Increased catchment erosion and increased nutrient input (eutrophication) are expected outcomes of forest clearance and we usually use proxies tailored to detect these effects. Additionally, it is often difficult to rule out the effect of climate variability on wetland hydrology following forest clearance. We present results from a multiproxy record of environmental change from a wetland in the South Island, New Zealand. The site was selected to investigate the impacts of Maori deforestation on wetland hydrology, and the export of nutrients and sediment from the catchment. We use a comprehensive set of proxies (chironomids, diatoms, macrofossils, macroscopic charcoal, δ13C, δ15N, high resolution XRF, pollen, bulk density) on an isotopically dated (210Pb, 14C) core to create a detailed record of wetland and catchment response to deforestation. This record is part of a larger project that will also use high resolution records from wetlands in uncleared catchments to reconstruct climate change spanning human settlement in New Zealand. This will enable us to control for effect of background climate variability on environmental change in wetlands in cleared catchments.

References:

Woodward C., Shulmeister J., Larsen J., Jacobsen G.E., Zawadzki A. (2014) The hydrological legacy of deforestation on global wetlands. Science 346: 844-847

Glacial chronology and Holocene environmental history of Lake Tennyson, North Canterbury, New Zealand

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Lake Tennyson lies at the boundary between regional climate districts and is sensitive to atmospheric circulation changes. This site can provide evidence to help test hypotheses about what drives glacier activity. However, few detailed studies on the late glacial and post glacial history exist there, despite well-defined end moraines marking the southern margin of the basin. We addressed this knowledge gap by establishing the timing of the glacial sequence emplacement at Lake Tennyson. Our work employed geophysical, stratigraphic and geomorphic approaches that included pedology, tephrostratigraphy, cosmogenic analysis and radiocarbon dating. The most recent maximum ice extent was achieved close to ~18.6ka at Lake Tennyson. However, an older advance of similar extent, limited by local accommodation space, is likely for MIS4 at ~64ka. Kawakawa Oruanui Tephra is also inferred as a cryptotephra within a well-developed podzolised soil capping the moraine that marks maximum local ice extent at Lake Tennyson. Inboard recessional moraines mark glacier (and presumably climate) variations during the early part of the last termination through to ~17.1ka. Replicated cosmogenic ages on the cirque sill of Princess Bath suggest ice had mostly evacuated the catchment by 11.2ka. Sediment cores change from inorganic to organic sedimentation following small tree and shrub expansion at the expense of herbs prior to 10.5ka cal BP. Beech (Fuscopora) pollen has been present since prior to 10.5ka, and has been elevated for at least the last 1000 years. Relatively high sedimentation over the last millennium suggests a bi-decadally resolved record could be obtained at this site.

Auckland lakes as climate dipsticks: unique insights into the nature and drivers of the past 117,000 years of climate change

Valerie van den Bos

Rewi Newnham, Andrew Rees, Paul Augustinus

The response of past terrestrial ecosystems to abrupt climate change is central to the debate surrounding the consequences of future climate change. Many centennial to millennial-scale episodes of rapid change have been reported to occur over the past 117,000 years, notably the Dansgaard-Oeschger events of Greenland and the North Atlantic, and Antarctic Isotope Maxima. However, the timing, amplitude and duration of these changes appear to be variable on a global scale and it is unclear how these events are generated and transmitted to cause such asynchronous patterns. They are best expressed in past climate records from the polar and tropical regions, but the southern mid-latitudes form a poorly understood part of the global climate system. The general goal of our project is to increase our understanding of the New Zealand climate system over the last 117 kyr by developing a high-resolution climate record from the lake sediments contained in Auckland's maars. A multiproxy approach has been adopted that combines data from biotic, molecular biomarker isotope and geochemical analyses. The remit of my doctoral study within this Marsden-funded project is to produce two independent, but complementary, temperature reconstructions from chironomid remains (mean summer temperatures) and pollen (mean annual temperatures) from Lake Pupuke sediments. This approach will eventually help us to address whether abrupt climate change events influenced climate and biota over the past 117,000 years in northern New Zealand, and whether these changes were driven by triggers from the Northern Hemisphere, Antarctica or the tropics.

The rate of landscape transformation following Polynesian and European arrivals in the Makenzie Basin, South Island, New Zealand

Marcus Vandergoes

Li, X., Howarth, J., Dunbar, G., Roop, H., Levy, R., Maxwell, J.

New Zealand anthropogenic deforestation is rapid compared to world-wide landscape transformations. An annually resolved sedimentary sequence from Lake Ohau, New Zealand provides an opportunity to refine the rates of change associated with human impact and explore the question of whether humans persisted in the surrounding landscape. High resolution pollen and charcoal records from Lake Ohau indicate a significant change in fire regime at 1400 A.D., that we interpret as the Initial Burning Period (IBP) following the arrival of Polynesians. Fire frequency increased up to 3 fold over pre-human values after the IBP. Significant deforestation occurred within 50 years of the increase in fire frequency and vegetation in the Ohau catchment never recovered to the pre-human status. One of our project goals is to take advantage of the multi-faceted nature of the emerging Lake Ohau climate and human impact record to examine in detail the relationships between initial and ongoing human impact in the region and hemispheric shifts in climate regime at annual-decadal resolution.

Lake Ohau Climate History (LOCH) project: A 17,000 year-long annually-resolved paleoclimate record and its potential to decipher the phasing of high frequency climate modes in Southern New Zealand

Marcus Vandergoes

Dunbar, G., Levy, R., Howarth, J., and the LOCH team

Geological records that span millennia yet still capture paleo-environmental information at seasonal-annual resolution can make an important contribution to understanding the spatial and temporal variability of climate processes that vary at high frequency, such as the El Niño Southern Oscillation (ENSO) and the Southern Annular Mode (SAM). However, such records are scarce and are particularly rare in the southern hemisphere. In February/March 2016 two sites were double-cored by hydraulic piston corer (HPC) in Lake Ohau, New Zealand (44o17'S, 169 o55'E) as part of the Lake Ohau Climate History (LOCH) project. Both sites yielded mm-scale laminated sediments representing annually-resolved accumulation in the lake basin from ~17,000 years before present to today. We outline LOCH project developments to date, including the first usage of a globally transportable HPC system. This system uses principles established by the Ocean Drilling Program and is capable of coring >100 m of unconsolidated sediment. We also report the initial results of physical properties core scanning, including computed tomography (CT) which yields whole-volume core density data at 600 micron resolution, as well as paleomagnetic and micropaleontological studies. We provide preliminary time-series analysis of annual to centennial-scale climate variability reconstructed for the past 1,300 years and highlight the potential of the complete 17,000 year long record to decipher the phasing of high frequency climate modes in southern New Zealand and the mid-latitudes of the Southern Hemisphere.

Overview of Late Quaternary-aged fossil sites from the Nepean Peninsula, Victoria

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David Pickering, Lisa Nink

The Nepean Peninsula is located at the western end of the Mornington Peninsula in Victoria, Australia. The area is dominated by dunes and cliffs composed of laterally extensive aeolianites, unconsolidated dune sand and palaeosols. It also features localised calcretes, dissolution chimneys, arches, stacks and rhizoconcretions. The dune and cliff sequences are part of the regionally extensive Late Pleistocene-aged Bridgewater Formation that stretches along the coast from South Australia to Victoria. The first recorded marsupial fossil find from the area was a partial lower incisor of Palorchestes azael, from Fowlers Beach in 1900. Since then other finds include: An insitu emu (Dromaius sp) egg and probable emu footprint at Diamond Bay (approximately 200ka OSL). An insitu skeleton of Zygomaturus trilobus, fallen from an eroding arch at the Bay of Islands (OSL date pending). A locally transported partial skull and maxillae of Simosthenurus occidentalis in the intertidal zone at Gunnamatta Beach (OSL date pending). The deposition of the fossils within the palaeosol/aeolianite sequence covers the period between MIS 7 and MIS 5e.

Unravelling possible climatic and/or tectonic signals preserved in Holocene coastal geomorphology around Lake Wairarapa

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Coastal sand dunes evolve in response to environmental changes such as fluctuations in sea (or lake) level, sediment availability, climate, and human disturbances of the environment. By mapping and dating phases of sand dune activity it is therefore possible to reconstruct past changes in the environment; for example, sand dunes in New Zealand have previously been found to record large-magnitude earthquakes producing pulses of sediment delivered to the coast, and changes in sea-level and climatic conditions. This ongoing research project is the first to investigate and unlock the archive of palaeo-environmental changes preserved in a curious sequence of five relict dune ridges located along the south-eastern shore of Lake Wairarapa. The dunes adjacent to Lake Wairarapa have received surprisingly little attention: a single study has mapped the dunes and analysed the degree of soil development, but almost nothing is known on the source of the sands (e.g., coastal or lake) or the precise timing of dune building phases. We explore the formation and timing of these dunes and test two alternative hypotheses. The first hypothesis is that the dunes record earthquake-triggered sediment pulses delivered to Lake Wairarapa ('Wairarpa Bay' during higher sea-levels) by rivers draining the surrounding ranges. Lake Wairarapa lies immediately adjacent to the Wairarapa Fault that is capable of producing earthquakes of considerable magnitude approximately every 2,200 years. In addition to the Wairarapa Fault, the lake is surrounded by dozens of smaller active faults. The second hypothesis is that the dunes record climatic signals expressed through changes in the level of Lake Wairarapa, or changes in the wind regime of the area, that result in periodic phases of dune-building activity.To test these hypotheses a number of different lines of evidence are being evaluated. Detailed geomorphic mapping of the dunes has been undertaken using existing high-resolution LiDAR and aerial imagery coupled with extensive field mapping and ground-truthing. The internal structure of the dunes will be imaged using Ground Penetrating Radar (GPR). Sedimentological analysis of the dune sands collected in cores will be used to explore the wind regime and climate responsible for the formation and evolution of dune ridges. A chronology of dune development will be established using a combination of luminescence dating and radiocarbon dating. The latter has been applied extensively to the dating of sand dune activity in the Manawatu-Otaki area. These four lines of enquiry will be synthesised and compared with existing records of seismic activity and past climate to test the competing hypotheses and for the first time elucidate the environmental changes responsible for the formation of the dunes and the geomorphic evolution of the lower Wairarapa Valley.

In Search of Wild Rices

Loraine Watson-Fox

James Shulmeister, Patrick Moss

Investigating the effects of past climate fluctuations on savannah-to-wetland plant communities in the Atherton Tablelands, far north Queensland.Australian wild rice species form part of fragile ecosystems in far north Queensland that are currently under threat from agricultural weeds as well as domestic and feral animal encroachment. This fragility is exacerbated by a changing climate, heralded by more extreme fluctuations in precipitation and temperature affecting the intransience of savannah-to-wetland environments. Gaining an insight into the past distribution and palaeohistory of the wild rices and their associated plant communities is the best way to obtain a measure of their adaptive fitness to a changing environment. If we hope to maintain a sustainable level of species and genetic diversity within our wilderness communities, it is important to understand the effects climate changes might have on such specialised ecosystems. Many of the species within these savannah-to-wetland communities have potentially robust silicon dioxide storage systems. Phytoliths (solidified siliceous plant cells) therefore provide an ideal vegetation proxy to add to existing pollen records. Our research project will contribute a significant knowledge base to studies of climate, vegetation and geochemistry in the Atherton Tablelands region of far north Queensland by isolating and classifying the phytolith records from a number of savannah-to-wetland sites. The information obtained has cross-disciplinary applicability and should hold special relevance for the arenas of agricultural science, archaeology, palaeo-botany and geochemistry. Here, we present an outline of the project aims and preliminary results from two sites under investigation.

Tectonic drivers for river disequilibria in the south-eastern highlands of Australia

Duanne White

Dan Clark, Steven Binnie

Uplift rates on faults within intraplate Australia are low compared to plate margin settings, and in most areas are comparable to, or less than, long term rates of erosion and deposition. Potential exceptions to this rule are faults within the south-eastern highlands, which are commonly associated with significant ranges. Disequilbria along rivers in the region have long been recognised (e.g. Jennings, 1972) in association with the faults. Such disequilibria have the potential to constrain the rate and timing of fault movements, and so provide insight into the contested topic of the timing and maintenance of uplift of the south-eastern highlands. In this presentation, we map the presence of river disequilibria along the major drainages across a 30,000 square kilometre region of the south eastern highlands, and classify their location with respect to known faults and fault escarpments. As a first step towards quantifying the rates of landscape change processes we present new cosmogenic dating of strath terraces along a reach of the upper Murrumbidgee River proximal to the Murrumbidgee Fault. We argue that this reach has been influenced by tectonic disturbance on the fault during the past 200 ka. Rates of river incision allow for Pliocene-Quaternary relief generation along the fault escarpment in the order of several hundred metres. This is similar to the nearby Lake George fault, raising the intriguing possibility that much of the relief along the major fault escarpments in this region is the product of neotectonic fault movements. This work provides a framework for better understanding a range long standing problems relating to the southeast highlands, including seismic hazard, landscape modification & evolution, and the production of disconnectivity along rivers that may affect biotic evolution.

Extracting a primary Holocene crytoptephra record from Pupuke maar sediments, Auckland, New Zealand

Aleksandra Zawalna-Geer

Jan M. Lindsay, Paul Augustinus, Siwan Davies, Sarah Davies

The city of Auckland is built on and around a potentially active, basaltic, intraplate volcanic system, the Auckland Volcanic Field (AVF). The field hosts around 55 small volcanoes and has been active for the last 200,000 years. The most recent eruption occurred from Rangitoto 550 years ago. Auckland may also be impacted by ash from distal eruptions in the Taupo Volcanic Zone, 250 km to the south. Over the past decade five AVF craters have been drilled to extract cores containing tephra layers interbedded with laminated lake sediments to gain insight into the timing and frequency with which Auckland has been impacted by eruptions in the past. In the Holocene, at least five eruptions (three distal, two local) are preserved as macro-tephra, reflecting an average frequency over this time period of 1 per 1,780 years. Recently, we carried out a detailed study of crypto-tephra, using geochemical fingerprinting, stratigraphic correlation and other proxies to filter out reworked tephra and thus establish a new Holocene tephrochronological framework for the region. In addition to five primary macro-tephra layers, 18 primary crypto-tephra were identified. Geochemical characterization of well-dated rhyolite tephra in the record was used to establish tephra ages. To account for uncertainties, confidence levels were attached to the newly identified crypto-tephra. Our results suggest that Holocene tephra fall from both local and distal volcanoes affected Auckland more frequently than previously documented, with a frequency of at least once every 424 years.

Exploring historical moisture availability in south-eastern Australia

Xianglin Zheng

Scott Mooney, Geoff Hope

The recent drought period from 1997-2009 is considered the driest period in the last 110 years, even surpassing the extreme drought period from 1933-1945 (Timbal, 2009). However, it is argued that the recent drought might be a natural cycle in the climate of south-eastern Australia (CSIRO, 2010). Without long-term moisture records, it is fortuitous to associate the recent drought to global warming. Hence it is essential to conduct an investigation on certain proxies to look at historical moisture availability. Testate amoebae, a group of unicellular protists ubiquitous in aquatic and moist environments, have been used extensively in European research for the derivation of quantitative estimates of past depth to water table (and hence moisture availability) and soil moisture (Mitchell, et al., 2008) Due to a high sensitivity to moisture, the depth to water table and soil moisture are strongly correlated to the community composition of testate amoebae. The use of modern training sets allows development of a transfer function to estimate the depth to water table. Application of these statistical relationships to fossil testate amoebae, for example preserved in accumulating sediments, means that past moisture conditions can be reconstructed. Although a suite of different proxies have been utilized to reconstruct palaeohydrology in Australia, such as humification, pollen, diatoms, phytoliths, etc., to date testate amoebae has not been studied to explore the past moisture availability. This research is the first study to use testate amoebae to reconstruct DWT in Australia, aiming to exploring the past moisture availability in the long term.