IceSked

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A New Captain at the Helm

I am honoured to be the new Director of the Antarctic Research Centre (ARC). It is an exciting time to take on the Directorship, given the recent government announcement that a further $21M will be invested in Antarctic research over the next three years. We plan to make the most of this opportunity by developing and leading new research programmes that advance science and influence policy makers in New Zealand and internationally (e.g. within the Intergovernmental Panel on Climate Change). Having worked at Victoria University since 2002, and with the ARC since 2007, I have a good appreciation of the range and quality of our science team, and what we can contribute. My own background is in glaciology and modelling, but I have enormous respect for the geological and ice-drilling science that the Centre is also well known for, including our technical capability. We are united by a common purpose of understanding the effects of climate change on the world's ice sheets and glaciers, and I will continue to foster the culture of strong collegiality that exists within our centre. I'd like to thank Tim Naish for his many years of service as Director. Tim is taking a two-year break to focus on research, supported by a prestigious James Cook Fellowship. I didn't appreciate until recently how much interruption one receives as Director, and I look forward to relieving Tim of the day-to-day aspects of this role so that he can focus on what really matters. Of course we will continue to work together on strategic opportunities that have potential to make our centre even more successful in the future.

Andrew Mackintosh

Andrew Mackintosh

S.T. Lee Lecture in Antarctic Studies

The 14th annual S.T. Lee Lecture in Antarctic Studies presented by Professor Eric Rignot was rescheduled from its original date in October 2016 to 14 February 2017. The lecture, *Future sea-level rise from warming of polar ice sheets,* focussed on sea-level rise.

The ice sheets in Greenland and Antarctica are contributing faster, sooner and more significantly than expected to global sea-level rise. Predicting the future rates of ice sheet mass loss with deterministic models is a formidable challenge. Observations and physics principles suggest a sea-level rise of more than 1 metre by 2100, and geological information from the Last Interglacial period (125,000 years ago) suggests a potential 6–9 metre sea-level rise with 1–2°C warming above pre-industrial levels. Eric reviewed the current knowledge of ice sheet mass balance and its potential to raise global sea level by many metres. He addressed the question, "Have some of the marine-based sectors already passed a point of no return, and if so, what is the magnitude of sea-level rise we are committed to?" He also explored the emission mitigation pathways that can limit the amount of sea-level rise by the end of the century and beyond.

Prof. Eric Rignot presenting his lecture at Rutherford House
Photo: ©Gerry Keating, Image Services, VUW

During his visit, Eric was also involved in a round table meeting discussing the latest science around sea-level rise, he had a meeting with the Green Party Co-Leader, James Shaw, as well as media interviews including one with Radio NZ presenter Kim Hill.

Eric is the Donald Bren Professor of Earth System Science, School of Physical Sciences at the University of California, Irvine, and a senior research scientist/joint faculty appointee at NASA's Jet Propulsion Laboratory. Eric's research group focuses on understanding the interactions of ice and climate, ice-sheet mass balance, ice sheet–ocean interaction in Greenland and Antarctica and current and future contributions of ice sheets to sea-level change. He has received NASA Exceptional Scientific Achievement Medals, NASA Outstanding Leadership and was a member of the IPCC team awarded the Nobel Peace Prize in 2007. He is a fellow of the American Geophysical Union and a lead author of the IPCC 5th Assessment Report. His research has been covered by the Los Angeles Times, Washington Post, BBC, CNN, National Geographic, Rolling Stone and the New York Times Magazine and has been featured in Naked Science (2004), Chasing Ice (2012) and HBO series VICE (2015).

K001-A: Friis Hills

A remarkable sequence of ancient glacial drifts, lake and river deposits bearing fossil evidence of small beech trees, beetles and moss, preserved in the Transantarctic Mountains at Friis Hills, is believed to represent the last time Antarctica supported trees, 15 million years ago. It has been argued that widespread cooling

Tim Naish taking samples while the drilling team work in the background, Friis Hills, Antarctica

and expansion of the East Antarctic Ice Sheet about 14 million years ago terminated higher plants, and has kept the landscape frozen and arid to this day. Previous work by Adam Lewis and Alan Ashworth (University of South Dakota), has documented numerous cycles of advance and retreat of an alpine glacier system in the Friis Hills. While their stratigraphy was based on careful mapping of the surface geology, they believed that the deposits were preserved as continuous layers in a basin up to 50 m deep. In November 2013, Adam joined our team Richard Levy (GNS Science), Tim Naish, Warren Dickinson, Nicholas Golledge (ARC) and Andrew Gorman (University of Otago) to conduct a seismic survey to evaluate the extent and thickness of the Friis Hills deposits.

In October 2016, Tim and Richard returned to Friis Hills with Alex Pyne, his daughter Rebecca Pyne (GNS Science), ARC PhD student Hannah Chorley and Webster Drilling & Exploration drillers Tony Kingan and Adam Rutten. Over six weeks we recovered 200 m of permafrosted geological cores from three sites with the longest drill hole reaching a depth of over 50 m. The drill system, people and camp gear was flown in by 16 helicopter flights by Antarctica New Zealand's contractor Southern Lakes Helicopters, and the US National Science Foundation. The system utilised an innovative compressed air system to flush cuttings from the hole. The compressor unit alone was 600 kilograms!

The cores are simply spectacular and revealed 10 cycles of advance and retreat of a temperate alpine glacier system across a vegetated landscape dominated by small glacial lakes and glacier-fed rivers and streams, between 19-14 million years ago when Earth's average temperature was 3-4ºC warmer and atmospheric CO_2 was 400-600 ppm. Preliminary results suggest a number of datable volcanic ashes have been recovered within the cores and may allow age and timing of the glacial oscillations to be established.

Hannah will spend the next three years analysing the cores and reconstructing the climate and glacial history for her PhD thesis. She will also work with Nick Golledge to develop an ice sheet model to simulate the glacial history and to provide insights into East Antarctic ice sheet behaviour in a warmer world. *Tim Naish*

K001-C: Commissioning a New Drill

The biggest effort for the ARC's Science Drilling Office this year has been the development of a Hot Water Drill (HWD) system, initially for the Ross Ice Shelf project. The drill is based on a British Antarctic Survey modular design and we purchased similar major components from the UK and Italy. A lot of development was still required in New Zealand and we employed mechanic, Jeff Rawson, for six months who has several season's Antarctic experience to help with the design and development of the system, especially the

The HWD drill team (L-R) Jiwoong Chung, Hedley Berge, Alex Pyne, Darcy Mandeno and Jeff Rawson, Windless Bight, Antarctica

power generation and fuel components. During August and September 2016 we also hosted Jiwoong Chung from the Korean Antarctic Program (KOPRI) who helped with preparation of the HWD. KOPRI are also considering acquiring a hot water drill and Jiwoong has been tasked to scope out suitable systems.

The HWD development was especially challenging, with a short time line to get equipment ready for commissioning in Antarctica for the 2016-17 field season. Electrician, Hedley Berge, joined the team of Alex, Darcy, Jeff and Jiwoong to commission the drill at a site in Windless Bight. A hole drilled through 224 m of ice shelf was finally achieved in mid-December, only a few days before the team was due to return to New Zealand. The commissioning was a success and has not only shown us which parts of the system work well but allowed us to identify components that require more work to make them reliable in Antarctica. This will be our major focus for the coming year and the team will head back to Antarctica in October 2017 when they will drill holes through the Ross Ice Shelf for the first leg of the Ross Ice Shelf Project. *Alex Pyne*

K041-A: Tucker Glacier

A team of four comprising Kevin Norton and Cliff Atkins (SGEES) and ARC PhD students Ross Whitmore and Jamey Stutz, headed to Northern Victoria Land, around 600 km north of Scott Base, in November 2016 to collect ~100 samples of glacial erratics and bedrock from the Tucker Glacier and surrounding area. The aim of this study is two-fold 1) to understand the local retreat history of Tucker Glacier and 2) to constrain the hypothesised extent of grounded ice in the western Ross Sea during the Last Glacial Maximum. Currently samples from two vertical transects are being evaluated prior to physical and chemical processing for beryllium-10 cosmogenic exposure dating. Each of these sample transects will allow us to constrain changes in glacier thickness for Tucker and Ironsides glaciers over the last several thousand years. This work will complement previous seasons on the Mackay and Mawson glaciers as well as upcoming work on the David Glacier. *Kevin Norton*

Ross Whitmore and Jamey Stutz collecting a glacial erratic cobble from the flanks of the Tucker Glacier, Antarctica

A Science Story: Explaining New Zealand's "Unusual" Growing Glaciers

The world is warming and glaciers are retreating. Why then, did many of New Zealand's glaciers advance between 1983 and 2008? There was a spectacular readvance of 1.4 km in the case of Franz Josef Glacier, almost half of the total length lost during the 20th century. With no satisfactory explanation for the advance, we turned to a mathematical model of the physical relationships between the atmosphere and glacier mass balance.

We discovered that lower temperatures caused the glaciers to advance, rather than increased precipitation as previously thought. Periods of reduced temperature affected the entire New Zealand region, and they were significant enough for the glaciers to re-advance in spite of human-induced climate change.

The temperature changes were a result of variability in the climate system that is specific to New Zealand but still consistent with human-induced climate change. We found that the strongest driver of glacier mass changes were anomalous southerly winds and cool sea surface temperatures in the Tasman Sea. These changes were linked more broadly to the large-scale atmospheric waves (specifically the Zonal Wave 3 and Pacific South American patterns).

But the future does not look so rosy for the glaciers – since 2008 Franz Josef has retreated 1.5 km, losing more ground than was gained in the entire 25 year advance period. *Brian Anderson*

More information:

Mackintosh, A.N., Anderson, B.M., Lorrey, A.M., Renwick, J.A., Frei, P., Dean, S.M., (2017). Regional cooling caused recent New Zealand glacier advances in a period of global warming. *Nature Communications* 8:14202. doi:10.1038/ncomms14202

Radio New Zealand interview: http://www.radionz.co.nz/national/programmes/ninetonoon/audio/201834991/the-mystery-of- growing-glaciers
Carbon Brief article: https://www.carbonbrief.org/cluster-cold-years-behind-new-zealand-glacier-growth

Slip Sliding Away

In the global competition for fastest ice cube Tasman Glacier, New Zealand is a major contender. Tasman's motivator is water, and lots of it, with deluges of rainfall setting the glacier hydrosliding at speeds upwards of 2 metres per day. The filling of subglacial cavities is the secret behind Tasman's extreme speed, but the complete picture of this acceleration has remained relatively unknown.

Enter me, right lateral moraine, wondering whether scrambling around the icy landslide that caps Tasman Glacier will lead to great discovery for my MSc research, or a speedy ride down-valley at the bottom of a crevasse. What did I find? That the glacier lurches forward sequentially as subglacial water migrates down-valley, causing surficial crevasses to open in the lee of the cavitating zone. But wait, there's more: crevasses appear to sometimes open en-masse following rainfall without any change in glacier velocity, suggesting a direct, although complex relationship exists between supraglacial water inputs and crevasse opening. *Sam Taylor-Offord*

Sam Taylor-Offord and supervisor Huw Horgan preparing the sensors for their next six months on Tasman Glacier, New Zealand

OTHER ACTIVITIES

International Symposium on the Cryosphere

Between the 12-17 February around 250 delegates from more than 25 countries attended the International Symposium on the Cryosphere in a Changing Climate conference, which brought together three of the leading international snow and ice associations; the International Association of Cryospheric Sciences (IACS), the International Glaciological Society (IGS) and the World Climate Research Programme Climate and Cryosphere Project (WCRP CliC). It was hosted by Victoria University, and sponsored by Antarctica New Zealand, NIWA, GNS Science, and the University of Otago.

The conference consisted of a mix of plenaries and talks from experts on ice sheets, sea ice, glaciers and sea-level change, which helped to inform researchers in New Zealand about the cutting edge of science. It also allowed our own world-class researchers (and particularly students) in the ARC to present their work to an international audience.

A forum on sea-level rise, chaired by Tim Naish (ARC) and Dan Zwartz (MfE) was held in association with the conference. This provided an opportunity for government representatives and other end users (e.g. MBIE, MfE, regional councils and other regional authorities) to interact with local and visiting sea-level experts.

Michael White (Senior Editor, *Nature*) and Bronwyn Wake (Chief Editor, *Nature Climate Change*) attended the conference, providing opportunities for Victoria-based researchers to learn more about *Nature* journals, and to build personal relationships with these editors.

Andrew Mackintosh was the lead organiser of this meeting, with strong support from a New Zealand team including James Renwick (SGEES), Shaun Eaves (ARC), Heather Purdie (University of Canterbury) and Natalie Robinson (NIWA). Ian Allison (University of Tasmania) chaired the international steering committee that developed the scientific programme. Olya Albot (ARC MSc graduate) provided outstanding administrational assistance. *Andrew Mackintosh*

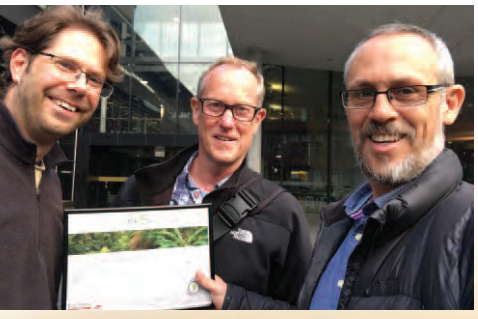
S.T. Lee Alaska Exchange - Trading Liquid for Frozen Seawater

Eva Sutter

After arriving in Fairbanks, my PhD colleague Marc Oggier picked me up (dressed in shorts – it was only -15°C after all), ready to work on a project investigating how oil leaks and spills under sea ice migrate through the ice. We were interested in seeing if this migration could be detected using the geophysical spectral induced polarization (SIP) method, whereby an alternating current gets induced at different frequencies between two current electrodes embedded in the sea ice and the potential difference is then measured between two electrodes at a larger depth.

After determining an optimal measuring protocol and the evolution of the SIP curves looked promising with continuing ice growth in tanks we decided to release crude oil underneath the ice to observe changes in the measurements as the oil percolated vertically up through the ice. Unfortunately at this point the device decided to stop working and any attempts to revive it were unsuccessful. Sure that the SIP method would work we will repair the instrument at VUW and ship it back for Marc to do the final measurements. If these expected SIP curve distortion occurs, we will be able to contribute to the pressing topic of oil spill detection in sea ice before surfacing – something that currently none of the known methods is capable of doing.

I also gave a talk on my own PhD project on the processes and dynamics of seawater intrusion into coastal aquifers in New Zealand. The research exchange to Alaska was a gain both professionally and personally, and I am grateful to have been given this opportunity to make new connections. I look forward to seeing how the experiment in the ice tanks will evolve. *Eva Sutter*



Andrew Wilkes (VUW Sustainability Manager), Tim Naish and Sean Weaver (Ekos)

ARC Walks the Talk - Becoming Carbon Neutral

The Antarctic Research Centre carries out world-class research in the field of climate change. Maintaining our status as world leaders requires us to travel widely, and air travel in particular creates significant CO_2 emissions. One accessible way to re-claim this CO_2 is through a rainforest protection, carbon-offsetting scheme.

In May, the ARC became the first institute at Victoria University to go carbon neutral when it purchased rainforest offsets from Ekos, a boutique CO_2 management company run by Sean Weaver. All Ekos CO_2 offsets come from the international voluntary carbon market and certified rainforest protection carbon projects, which is not simply reforestation.

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