

Gateway Antarctica
Centre for Antarctic Studies and Research



Annual Review 2009



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From the Advisory Board



In 2009 our Board has worked closely with the Director and staff of Gateway Antarctica to review progress and provide focus with respect to the medium to long-term strategic direction of the Centre. Gateway is now well established and recognized as an academic unit at University of Canterbury.

It offers an excellent multi-disciplinary range of undergraduate and postgraduate courses which are popular with students across the full range of disciplines encompassed by the Gateway “hub-and-spoke” model. This model is particularly effective in bringing academic staff and students together in a multi-disciplinary pan-university environment, and represents a key point of difference for the Centre. The interdisciplinary learning and research approach is vital in order to address critical and complex research questions requiring innovative approaches.

A key achievement for our centre in 2009 was the transfer of the International Secretariat of the Council of Managers of National Antarctic Programs (COMNAP) to the University of Canterbury for the next six years. The secretariat is co-located with Gateway Antarctica, and Michelle Rogan-Finnemore, formerly centre manager for Gateway, has been appointed to the role of COMNAP Executive Secretary. The Board join me in congratulating Michelle on her appointment, and we also acknowledge the huge contribution she has made through her role with Gateway over the last decade or so. Fortunately, Michelle will still be on site and we are also very pleased to have been able to continue her involvement by way of co-opting her onto the Advisory Board.

As we look forward to 2010 and beyond, there remain significant challenges, especially the need to secure long-term research funding to allow our researchers to fulfill their potential. The board has been engaged through focused discussions to support this crucial goal for Gateway’s future.

In this 2009 Annual Report you will again find an excellent overview of the diverse range of research and teaching related activities and achievements of staff, students and research associates of Gateway Antarctica.

A handwritten signature in black ink, appearing to read 'J. Pettinga', written in a cursive style.

*Professor Jarg Pettinga
Chair – Gateway Antarctica Advisory Board*

From the Director



2009 was a significant milestone for Gateway Antarctica in that we celebrated in style our 10 year anniversary. It was great to see so many of our alumni, colleagues and friends join us for a weekend of celebrations, the highlight of which was a stroll around Quail Island under the guidance of Antarctic historian Baden Norris.

We look forward to the next ten years with the confidence that we have high quality teaching and research programmes in place for a sustainable future, although I have to say that research funding for Antarctic research remains a significant issue for us. However, our funds did receive a boost this year with a donation of \$50k from Antarctica New Zealand to kick start our Antarctic Foundation fund. We are very grateful to Antarctica New Zealand for this donation and are obliged to match this figure through future donations in support of the next generation of Antarctic researchers. We will be asking our alumni, friends and colleagues to help us reach this target.

By coincidence 2009 was also a year of change for Gateway Antarctica. I am delighted to report that we were successful in our bid to host COMNAP, an international secretariat of the Council of Managers of the National Antarctic Programs for the next 6 years at Gateway Antarctica. And, I would like to congratulate Michelle Rogan-Finnemore on being appointed Executive Secretary of COMNAP also for the next six years. Michelle has been our dynamic Centre Manager since Gateway Antarctica was set and I take this opportunity to acknowledge and thank her for her significant contribution over the past 10 years. The good thing is that Michelle will continue to be in our office complex and has agreed to serve on our Board in an advisory capacity.

None of our Centre activities over the past year would have been possible without the support and commitment of Gateway Antarctica staff and associate researchers, both from within and outside of the University of Canterbury. I greatly appreciate and thank you for your support, together with the advice and guidance that I have received from our Advisory Board under the excellent leadership of its chair Professor Jarg Pettinga.

Thank you.

A handwritten signature in black ink that reads "Bryan Storey". The signature is written in a cursive, slightly slanted style.

*Professor Bryan Storey
Director, Gateway Antarctica*

Gateway Antarctica

Centre for Antarctic Studies and Research, University of Canterbury

Purpose Statement

“Gateway Antarctica” will contribute to increased understanding and more effective management of the Antarctic and the Southern Ocean by being a focal point and a catalyst for Antarctic scholarship, attracting national and international participation in collaborative research, analysis, learning and networking.

Advisory Board

Jarg Pettinga (Chair)	Department of Geological Sciences, UC
Clive Howard-Williams	NIWA
Shirley Johnson	Christchurch City Council
Dean Peterson	Royal Society
Lou Sanson	Antarctica New Zealand
Karen Scott	School of Law, UC

Gateway Antarctica Research Committee

Kari Basset	Department of Geological Sciences
John Bradshaw	Department of Geological Sciences
Bill Davison	School of Biological Sciences
Wendy Lawson	Department of Geography
Adrian McDonald	Department of Physics and Astronomy
Bryan Storey (Chair)	Gateway Antarctica

Gateway Antarctica Board of Studies: Antarctic Studies

Margaret Bradshaw	Department of Geological Sciences
Paul Broady	School of Biological Sciences
Peter Cottrell	Dean of Science
Bill Davison	School of Biological Sciences
Daniela Liggett	Gateway Antarctica
Ian Owens	Department of Geography
Andrew Phillips	Student Representative, Student Recruitment & Development
Michelle Rogan-Finnemore	Gateway Antarctica
Patrick Shepherd	School of Literacies & Arts in Education
Bryan Storey (Chair)	Director, Gateway Antarctica

Gateway Antarctica Staff

Bryan Storey	Director and Professor of Antarctic Studies
Michelle Rogan-Finnemore	Centre Manager
Wolfgang Rack	Senior Lecturer
Daniela Liggett	Lecturer July-December 2009
Yvonne Cook	Research Assistant
Irfon Jones	GIS Technician
Susannah Hawtin	Administrator (half-time)

Adjunct Appointments

Michael Bentley	Adjunct Professor, Durham University, United Kingdom
Regina Eisert	Adjunct Fellow, Washington DC, United States of America
Alan Hemmings	Adjunct Associate Professor, Canberra, Australia
David Hopkins	Adjunct Professor, Scottish Crop Research Institute, Scotland
Ashley Sparrow	Adjunct Associate Professor, CSIRO, Australia
Gary Steel	Adjunct Senior Fellow, Lincoln University
Peter Webb	Adjunct Professor, Ohio, USA



Research

Gateway Antarctica has a broad range of multi-disciplinary research that involves many Departments within the University. The research involves national and international collaboration and is consistent with the research themes of the New Zealand Antarctic Science Strategy 2004–2009.



Antarctic physical environments

Dynamics and change of the Darwin-Hatherton glacial system

Bryan Storey & Wolfgang Rack, Gateway Antarctica

Wendy Lawson, Peyman Zavar Reza, Justin Harrison & Nick Key, Department of Geography

External collaborators

Brian Anderson & Cliff Atkins, Victoria University of Wellington

Mark Stevens, University of Adelaide, Australia

David Fink, Australian Nuclear Sciences and Technology Organisation (ANSTO), Australia

James Shulmeister, University of Queensland, Australia

Students

Mette Riger-Kusk PhD, The Darwin Hatherton glacial system

David Hood MSc, The Pleistocene glacial history of the Lake Wellman area,
Darwin Mountains, Antarctica

Kurt Joy PhD, A late Quaternary ice sheet history from cosmogenic dating,
South Victoria land, Antarctica

The Darwin-Hatherton glacial system offers a unique opportunity to investigate the response of the Antarctic Ice Sheets to future climate change. As well as draining the East Antarctic Ice Sheet into the Ross Ice Shelf, there is plenty of evidence of its past glacial history preserved in marginal moraine sequences. Earlier research has produced differing estimates of the amount and rate of recent change in the system, partly because of the absence of measurements of key controlling parameters including ice thickness, mass balance and climate. This project, which is part of the New Zealand led Latitudinal Gradient Project, takes an integrated earth systems approach by combining glacial, geomorphological and climatological methodologies to obtain a set of information that will enable the system to be characterised and understood.

Fieldwork for this project was completed in 2009-10 with a short field season in the Dubris Valley area of the Hatherton Glacier. A complex set of lateral moraines were sampled for cosmogenic dating to constrain the extent of ice at the last glacial maximum 10 to 20 thousand years ago. New data from previous field work in the Lake Wellman area of the Hatherton Glacier suggest that ice volume at the last glacial maximum was not as large as previously estimated and constrains ice elevation to be at most 50 m above current ice surface elevation - effectively little different from what is observed today. This has significant implications for how the Antarctic ice sheets may respond in a future warming period.

Presentations

Storey, B., Hood, D., Fink, D., Shulmeister, J. & M. Riger-Kusk. The size of the West Antarctic ice sheet at the last glacial maximum: New constraints from the Darwin-Hatherton glacial system in the Transantarctic Mountains. 2009 Annual Antarctic Conference, University of Auckland, p14.

Riger-Kusk, M., Lawson, W., Rack, W., Anderson, B. & B. Storey. Results from a ground penetrating radar (GPR) survey of the Darwin-Hatherton glacial system, Antarctica. 2009 Annual Antarctic Conference, University of Auckland, p19.

Joy, K., Storey, B., Fink, D. & J. Shulmeister. Glacial geomorphology and its links to ice sheet thicknesses, Diamond Hill, Transantarctic Mountains. 2009 Annual Antarctic Conference, University of Auckland, p81.

Remote Sensing of land and sea ice from satellite, air, and ground

Wolfgang Rack & Irfon Jones, Gateway Antarctica
Wendy Lawson, Department of Geography
David Park, Geospatial Research Centre

External collaborators

Pat Langhorne, University of Otago
Tim Haskell, Industrial Research Limited (IRL)
Mike Williams, National Institute for Water and Atmosphere (NIWA)
Christian Haas, University of Alberta, Canada
Bob Bindshadler, NASA Goddard Space Flight Centre, Greenbelt, United States of America

SCAR Fellow

Wilhelmina Roa Clavano (PhD), University of Alberta, Canada: Snow property measurements and analysis based on infrared photography and radar.

Students

Nikolai Kruetzmann PhD, Application of Complexity Measures to Geophysical Systems
Mette Riger-Kusk PhD, Ice discharge of an Antarctic outlet glacier:
Darwin-Hatherton glacial system
Bob Noonan Summer Scholarship 2009, Climate history in Antarctic snow -
analysis of ice radar data from Ross Island
Jessie Herbert Summer Scholarship 2009, Flow speed of ice streams and
glacier tongues in the western Ross Sea region

Focus in 2009 was on the McMurdo Ice Shelf, at Ross Island, and on sea ice in McMurdo Sound (Haskell Strait). Our validation experiments for the CryoSat-2 satellite (due to launch in 2010 by the European Space Agency – ESA) were conducted in close collaboration with the sea ice group of Otago University, the University of Alberta (Canada), and the Geospatial Research Centre. Satellite data provide key information to understand the response of the Antarctic ice to climate change and the impact on sea level. Deriving high quality products of snow accumulation and surface height depends on ground data as input for calibration or validation. We investigated the properties of sea ice and the upper layers of polar snow using standard glaciological tools, ground penetrating radar, and airborne measurements to bridge the gap from the potentially unrepresentative point measurements on the ground to the normally much larger satellite foot print.

On land ice, information on snow morphology was collected at three 1x1 km sites, corresponding to the size of the CryoSat-2 radar altimeter footprint and along a planned satellite track. Gateway Antarctica Postgraduate Certificate in Antarctic Studies (PCAS) students were included in the project and re-measured stake heights at one site. Ground penetrating radar was used to detect snow layers, which are correlated to density profiles from snow pit and ice core measurements. Surface properties were mapped using a laser profiler mounted on a skidoo and, as a highlight, using an optical camera mounted on a small unmanned aircraft developed by the Geospatial Research Centre. Another highlight was the deployment of the ‘EM bird’, a helicopter-borne electromagnetic sounder. It is the only existing remote sensing device to measure sea ice thickness from air. The bird, which was flown for the first time in this area, also measures sea ice freeboard using a laser altimeter. Ground validation along helicopter flight tracks included continuous radar measurements to determine snow thickness on sea-ice, a major uncertainty to determine sea-ice thickness from freeboard. The study is complemented by the acquisition and analysis of satellite imagery, provided by ESA. The data provide the basis to construct the first complete sea-ice thickness map of the McMurdo Sound.

Publications

Draws, R., Rack, W., Wesche, C., & V. Helm. (2009). A Spatially Adjusted Elevation Model in Dronning Maud Land, Antarctica, Based on Differential SAR Interferometry. *IEEE Trans. Geosc. Rem. Sens.*, 47 (8), 2501-2509, doi: 10.1109/TGRS.2009.2016081.

Kerr, T., Owens, I., Rack, W. & R. Gardner. (2009). Using ground-based laser scanning to monitor surface change on the Rolleston Glacier, New Zealand, *J. Hydrol. New Zealand*, 48 (2), 59-72.

Technical report

Rack, W., Langhorne, P., Lawson, W., Haskell, T. & C. Haas (2009) Validating CryoSat measurements on land and sea ice in the western Ross Sea Region, Antarctica. European Space Agency. 10.

Presentations

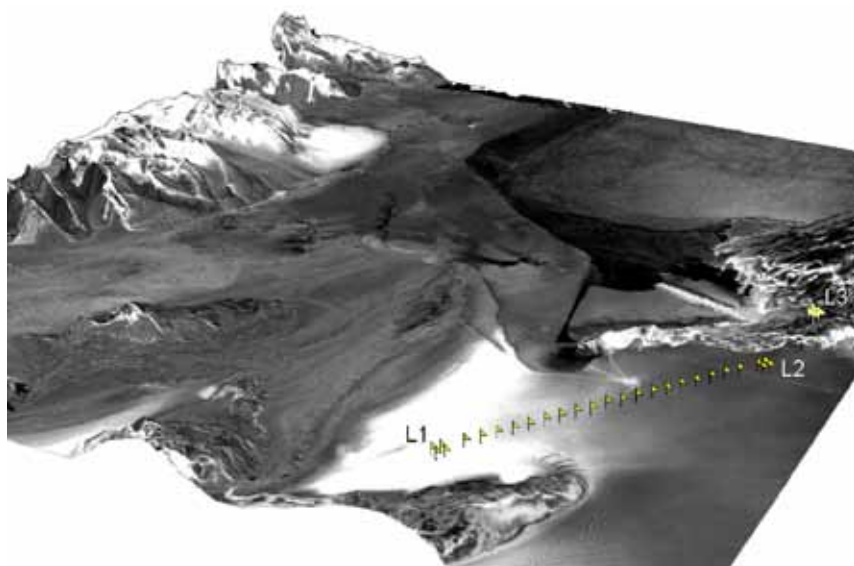
Rack, W., Kruetzmann, N., Riger-Kusk, M., Langhorne, P., Haas, C. & D. Park. (2009) Satellite Remote Sensing of the polar cryosphere in the western Ross Sea region. University of Auckland, Auckland, New Zealand: 2009 Annual Antarctic Conference, 2 Jul 2009.

Rack, W. (2009) Mass balance from GPR and satellites - Detecting change in the Antarctic cryosphere. GNS Science, National Isotope Centre, Lower Hutt, New Zealand: Ice Core Symposium 2009, 8 Oct 2009.

Rack, W. (2009) The view from space - global climate change monitoring. University of Canterbury, New Zealand: Climate Change: Science, Solutions and Consequences, 21 May 2009.

Awards

The 6th Bernd Rendel Prize of the German Research Foundation (DFG) was awarded to Reinhard Drews (University of Goettingen, Germany) for quality and originality of previous and current research. Reinhard spent 6 months for his MSc studies at Gateway Antarctica. He is currently studying towards a PhD at the Alfred Wegener Institute for Polar and Marine Research in Germany. Using electromagnetic reflection methods Reinhard is investigating how ice dynamics and atmosphere impact on the internal structure of ice sheets. Parts of his PhD study will be conducted at Gateway Antarctica.



A radar satellite image of measurement sites near Scott Base (image courtesy of European Space Agency).

Tectonic evolution and provenance analysis of the West Antarctic Rift System: Links between climate, uplift and volcanism

Kari Bassett, Department of Geological Sciences
Bryan Storey & Yvonne Cook, Gateway Antarctica

External Collaborators

ANDRILL SMS international team

This research project is part of the ANDRILL Southern McMurdo Sounds Drilling Project. Operating from a floating sea-ice platform in Western Ross Sea (October-December 2007), the ANDRILL drilling system recovered an excellent quality core with 98% sediment recovery through the 1138.54 meter cored interval. Lower and middle Miocene shallow marine sediments, deposited in the subsiding Victoria Land Basin on the coastal plain seaward of the rising Transantarctic Mountains, record repeating lithological changes that reflect variations in sea-level, glacial proximity, and climate. Fossils suggest non-polar climate conditions similar to southwestern New Zealand today. Younger sediments record Pleistocene maximum glacial conditions in a shallow water environment. The youngest deposits record a newly discovered basaltic volcanic vent related to the Dailey Islands. An excellent chronostratigraphy provides age control for the drillcore and network of seismic lines in the western Ross Sea. These results will enable the international team to integrate geological and paleoclimatic data into climate and ice sheet models to constrain estimates of ice volume variability and terrestrial and marine paleotemperature.

In 2009, we have been using geochemical analysis of clasts and zircon grains from within the core to constrain the source of the glacial material within the drill core and reconstruct the glacial history of the area during the Miocene period. Geochemical analysis of separated dolerite clasts derived from the widespread Ferrar dolerite sills suggests local derivation from the adjacent Dry Valleys region. This result is in contrast to an investigation of a larger clast assemblage from within the core which suggests changing source regions through time. Future age analysis of zircon grains separated from sandstone horizons may help resolve these inconsistencies.

Publications

Acton, G., Crampton, J., Di Vincenzo, G., Fielding, C.R, Florindo, F., Hannah, M., Harwood, D.M., Ishman, S., Johnson, K., Jovane, L., Levy, R.H., Lum, B., Marcano, M.C., Mukasa, S., Ohneiser, C., Olney, M., Riesselman, C., Sagnotti, L., Stefano, C., Strada, E., Taviani, M., Tuzzi, E., Verosub, K.L., Wilson, G.S., Zattin, M., and the ANDRILL-SMS Science Team, (2010), Preliminary integrated chronostratigraphy of the AND-2A core, ANDRILL Southern McMurdo Sound Project, Antarctica. *Terra Antarctica*, 15, 10p.,

Acton, G., Florindo, F., Jovane L., Lum B., Ohneiser C., Sagnotti, L., Strada E., Verosub K.L., Wilson G.S., & the ANDRILL-SMS Science Team, (2008-2009). Palaeomagnetism of the AND-2A Core, ANDRILL Southern McMurdo Sound Project, Antarctica, *Terra Antarctica*, 15, 191-208.

Fielding, C.R., Atkins, C.B., Bassett, K.N., Browne, G.H, Dunbar, G.B., Field, B.D., Frank, T.D., Panter, K.S., Pekar, S.F., Krissek, L.A., Passhier, S. and the ANDRILL-SMS Science Team (2009). Sedimentology and stratigraphy of the AND-2A core, ANDRILL Southern McMurdo Sound, Project, Antarctica. *Terra Antarctica*, 15.

Panter, K.S., Talarico, F.M., Bassett, K., Del Carlo, P., Field, B., Frank, T., Hoffmann, S., Kuhn, G., Reichelt, I., Sandroni, S., Taviani, M., Bracciali, I., Cornamusini, G., von Eynatten, H., Rocchi, S. & the ANDRILL-SMS Science Team, (2008-2009). Petrologic and Geochemical Composition of the AND-2A Core, ANDRILL Southern McMurdo Sound Project, Antarctica. *Terra Antarctica*, 15 (1/2), 46 pp.

Warny, S., Askin, R., Hannah, M., Mohr, B., Raine, I., Harwood, D.M., Florindo, F., and the SMS Science Team, (2009). Palynomorphs recovered from sediment core reveal a remarkably warm Antarctica during the Mid Miocene. *Geology*, 37(10): 955–958; doi: 10.1130/G30139A.1.

IceCube: A neutrino window to the universe

Jenni Adams, Department of Physics and Astronomy

External Collaborators

IceCube collaboration: PI: Francis Halzen, University of Wisconsin-Madison, USA

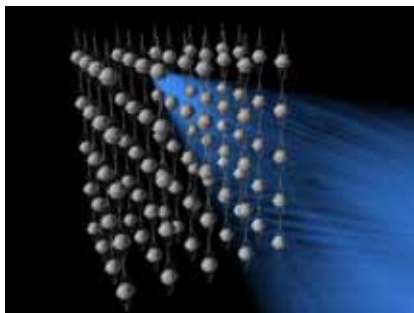
Students

Kahae Han	PhD, Search for Dark Matter signal
Stephanie Hickford	PhD, Simulations of particle interactions in ice
Sarah Bouckoms	MSc, Analysis of ice optical properties

Post Doctoral Fellow

Andreas Gross

The goal of our research is to detect astrophysical neutrinos using the IceCube neutrino observatory. This will provide information on the physics of the underlying engines of high-energy astrophysical objects like gamma-ray bursts and active galactic nuclei. Detection of these neutrinos will provide unambiguous evidence for cosmic acceleration of protons and



IceCube Array

nuclei, and the neutrino arrival direction will point to the location of the accelerators providing a resolution to the puzzle of the origin of the highest energy cosmic rays.

The IceCube detector is nearly complete and with each increase in size the probability for discovery increases. The 2009-10 construction season was very successful, finishing ten days ahead of schedule after twenty holes were completed, bringing the detector total to 79.

When a neutrino interacts in the ice, it can transfer its energy to a single long-range particle or it can initiate a cascade of many particles resulting in a localized deposition of energy and a bright, nearly point like, source of light in the IceCube detector. Our search exploits this latter “cascade” channel.

Approximately 20 billion events trigger the IceCube telescope during one year of operation. Of these only around 20 000 are expected to be neutrino-induced cascades while the vast majority of events are due to muons produced when cosmic rays interact in the atmosphere above the South Pole. There is therefore significant challenge involved in extracting the cascade signal from the muon background. Our students are developing filtering strategies to isolate the signal events from the background. We hope that our filtering will result in the first cascade signal discovery later this year.

Publications

Abbasi, R., Adams, J., Han, K., Gross, A., Hickford, S. et al. (2009) Search for High-Energy Muon Neutrinos from the “Naked-Eye” GRB 080319B with the IceCube Neutrino Telescope. *Astrophysical Journal* 701 (2009) 1721-1731, 20 August 2009 e-print: arXiv:0902.0131 astro-ph.HE

Abbasi, R., Adams, J., Han, K., Gross, A., Hickford, S. et al. (2009) First Neutrino Point-Source Results From the 22 String IceCube Detector. *Astrophysical Journal Letters* 701 (2009) L47-L51, 10 August 2009 e-print: arXiv:0905.2253 astro-ph.HE

Abbasi, R., Adams, J., Han, K., Gross, A., Hickford, S. et al. (2009) Determination of the Atmospheric Neutrino Flux and Searches for New Physics with AMANDA-II *Physical Review D* 79 (2009) 102005, 29 May 2009 e-print: arXiv:0902.0675 astro-ph.HE,

Abbasi, R., Adams, J., Han, K., Gross, A., Hickford, S. et al. (2009) Limits on a Muon Flux from Neutralino Annihilations in the Sun with the IceCube 22-string Detector *Physical Review Letters* 102 (2009) 201302, 21 May 2009 e-print: arXiv:0902.2460 astro-ph.CO

Abbasi, R., Adams, J., Han, K., Gross, A., Hickford, S. et al. (2009) The IceCube Data Acquisition System: Signal Capture, Digitization, and Timestamping *Nuclear Instruments and Methods A* 601 (2009) 294-316, 1 April 2009 e-print: arXiv:0810.4930 physics.ins-det

Abbasi, R., Adams, J., Han, K., Gross, A., Hickford, S. et al. (2009) Point Sources of High Energy Neutrinos with Final Data from AMANDA-II *Physical Review D* 79 (2009) 062001, 18 March 2009 e-print: arXiv:0809.1646 astro-ph.

Abbasi, R., Adams, J., Han, K., Gross, A., Hickford, S., et al. (2009) Extending the Search for Neutrino Point Sources with IceCube above the Horizon. I. *Physical Review Letters* 103 (2009) 221102, 24 November 2009. Ref.: [arXiv:0911.2338 [astro-ph.HE]]

Dynamics in the Antarctic Atmosphere

Adrian McDonald, Department of Physics and Astronomy

External Collaborators

Martin Jarvis and Rob Hibbins, British Antarctic Survey, United Kingdom
Gonzalo Hernandez, University of Washington, United States of America
Scott Palo and Xinzhao Chu, University of Colorado, United States of America
Damian Murphy and Simon Alexander, Australian Antarctic Division, Australia

Students

Andolsa Arevalo-Torres PhD, The role of clouds in the Antarctic middle atmosphere
Nikolai Krützmänn PhD, Application of complexity measures to geophysical systems
Jack Coggins PhD, A wireless sensor network for Antarctica
Robert Ward MSc

The research work carried out by the K055 event began to expand into research which covers both the Antarctic middle atmosphere and surface climate processes this year. The measurements made by the Scott Base MF radar still provide an excellent middle atmosphere climate record and also provides significant potential for understanding coupling processes between the mesosphere and the stratosphere, but the focus this year has been to add 'value' to these observations by combining the data with other instruments around Antarctica, notably British Antarctic Survey measurements at Halley and satellite measurements made with the EOS MLS and COSMIC/FORMOSAT-3 instruments. The installation of an NSF funded Fe Boltzmann lidar at the Kiwi Arrival Heights Laboratory has also been arranged and should provide significant synergies with the MF radar data when it is installed in the 2010/2011 Antarctic season.



We have also developed designs to form an Environmental Wireless Sensor Network, this system allows a number of distributed environmental measurements systems (similar to simplified Automated Weather Stations) to communicate and synchronise measurements at a number of locations simultaneously. The spatial measurements will provide the possibility of better satellite validation studies than previously possible and also have the potential to determine 'gaps' in the current climate monitoring networks. Deployment of a 'Proof of Concept' system will occur in January 2011 between Scott Base and Windless Bight. This measurement system will allow us to examine spatial scales that have been difficult to measure with previous systems and test the robustness and ability of a small (20 node) network. By developing this technology we hope to gain a greater understanding of the local environment around Ross Island and determine how atmospheric processes at a number of scales may impact surface climate.

Publications

Murphy, D.J., Aso, T., Fritts, D.C., Hibbins, R.E., McDonald, A.J., Riggin, D.M., Tsutsumi, M. & R. A. Vincent (2009) Source regions for Antarctic MLT non-migrating semidiurnal tides, *Geophysical Research Letters*, 36, L09805, doi:10.1029/2008GL037064.

McDonald, A.J., George, S.E. & R. Woollands (2009) Can gravity waves significantly impact PSC occurrence in the Antarctic? *Atmospheric Chemistry and Physics*, 9, 8825-8840.

Arevalo-Torres, A. & A.J. McDonald (2009) PSC area in the Antarctic Polar Vortex derived from EOS MLS observations and NCEP/NCAR analyses, Annual Antarctic Conference, Auckland, New Zealand P.

Kruetzmann, N.C., Rack, W., George, S.E. & A.J. McDonald (2009) GPR Analysis of Annual Accumulation and Internal Layers of the Snow Cover in the Ross Island Region, Annual Antarctic Conference, Auckland, New Zealand P.

Kruetzmann, N.C., Rack, W., McDonald, A.J. & S.E. George (2009) Initial Analysis of Internal Layers in the Snow Cover of the Ross Island Region using GPR Measurements, EGU2009, Vienna, Austria.

McDonald, A.J., George, S.E., & A. Arevalo-Torres (2009) An examination of the satellite temperature record over the Southern Hemisphere, International Conference on Southern Hemisphere Meteorology and Oceanography, Melbourne, Australia.

Kruetzmann, N.C., Rack, W., Riger-Kusk, M., McDonald, A.J. & S.E. George (2009) Snow morphology and radar characteristics in the Ross Sea Region, SIRG Workshop, Wanaka, New Zealand.

McDonald, A.J., Tan, B. & Xinzhaohu (2009) An Examination of Spatial and Temporal Variability using COSMIC/FORMOSAT-3 and Rayleigh Lidar Observations, Fourth Formosat-3/COSMIC Data Users Workshop, Colorado, USA.

Antarctic ecosystems

Understanding, valuing and protecting Antarctica's unique terrestrial ecosystem: Predicting biocomplexity in Dry Valleys ecosystems

Bryan Storey, Irfon Jones & Yvonne Cook, Gateway Antarctica

External Collaborators

Craig Carey, Allan Green, Lars Brabyn, Ian Hogg, Jonathan Banks & others, University of Waikato

Mark Stevens, South Australian Museum, Australia

Ashley Sparrow, CSIRO, Australia

David Hopkins, Scottish Crop Research Institute, Scotland

Michael Bentley, Durham University, England

Students

Nicholas Carson MSc, Glacial geomorphology and out-of-phase glaciation
of the Denton Hills, Antarctica

The third and final field season of the IPY funded biocomplexity project was completed in 2009-10 involving scientists from six different countries with researchers from Canterbury and Waikato Universities. The project has focused on describing and predicting biodiversity of terrestrial habitats in the Ross Dependency, Antarctica. The aim is to produce a GIS/biodiversity database that links biodiversity with environmental factors such as geology, geomorphology and soil moisture content, to produce a model that is easily understood and useable by non-specialists and end-users. This will provide New Zealand with an improved capacity to meet its obligations under the Antarctic Treaty to manage and protect Antarctic terrestrial ecosystems.

Using existing data together with high resolution satellite imagery, the Miers, Marshall and Garwood valleys were divided into over 500 domains based on geology, geomorphology, aspect, elevation, and availability of water. In previous field seasons soil samples were taken from over 450 of the domains. The latest field season, 09-10, completed the sampling. At each location up-to-date molecular techniques have been used to describe the biota from visible lichen, mosses and invertebrates to hidden microbes in the soil samples. DNA fingerprinting techniques will allow rapid assessments of biodiversity and degree of relationship between sites. Organic matter and nutrients have been measured and the sources of the organic matter (i.e., the subsidies) determined by stable isotope ration and molecular identity. All existing data are currently being entered in to a GIS data base to provide a comprehensive picture of systematic and functional biodiversity, which will help resolve the drivers of biodiversity in the environment. Initial results have shown the heterogeneous distribution of the biodiversity with distinct biological hotspots within the sampled valleys.

Presentations

Green, T.G.A., Cary, C., Storey, B., Hogg, I., Brabyn, L., Sparrow, A. & D. Hopkins. Predicting biocomplexity in Dry Valley Ecosystems (TABS): An IPY project. 2009 Annual Antarctic Conference, University of Auckland, p42.

Carson, N., Storey, B., Shulmeister, J. & M. Bentley. Glacial history of Denton Hills. 2009 Annual Antarctic Conference, University of Auckland, p80.

Management, conservation and human interest

Antarctic Law and Policy

Alan D. Hemmings & Michelle Rogan-Finnemore¹, Gateway Antarctica
Karen Scott, School of Law

External collaborators

Donald R. Rothwell, Australian National University, Australia
Tim Stephens, University of Sydney, Australia
Lorne Kriwoken, University of Tasmania, Australia

Students

Andrew Phillips	LLM, Legal responses to the Unintentional Introduction of Alien Invasive Species into the Antarctic Environment
Melissa Idiens	MA, Identifying the Intentions of EU and European National Policy Agenda towards the Southern Polar Region

This programme explores existing international law, governance and state practice in the Antarctic and Southern Ocean, and seeks to advance the development of thinking, policy and legal options in the region. 2009 was the 50th anniversary of the adoption of the Antarctic Treaty, and whilst this stimulated analysis of the past achievement of the Antarctic Treaty System, it also provided a context within which to assess current issues of interest to this programme.

During 2009, a Trans-Tasman Antarctic Security Project was initiated. This project which adopts a broad conception of “security”, held a Colloquium – *Responding to Contemporary Challenges and Threats to Antarctic Security: Legal and Policy Perspectives* at the University of Canterbury involving leading scholars from New Zealand, Australia, India, the United Kingdom and the United States. A second Colloquium will be held at the Australian National University in June 2010.

Research continued on Antarctic bioprospecting including participation in the intergovernmental meeting convened by the Governments of the Netherlands and Belgium in Baarn. and the development of ideas on some ethical aspects of bioprospecting. Research also focused attention on Antarctic extended continental shelf (ECS) issues, with examinations of the outcomes of Australia’s submission to the Commission on the Limits of the Continental Shelf, and the matter of ECS from subantarctic islands extending into the Antarctic Treaty Area. In December 2009, programme members participated in the international *Antarctic Treaty Meeting of Experts on the Management of Ship-borne Tourism in the Antarctic Treaty Area*, convened by the Ministry of Foreign Affairs and Trade in Wellington.

¹ Michelle Rogan-Finnemore was appointed Executive Secretary of the Council of Managers of National Antarctic Programs (COMNAP) in July 2009

Publications

Dodds, K. & A.D. Hemmings, (2009) 'Frontier Vigilantism? Australia and Contemporary Representations of Australian Antarctic Territory'. *Australian Journal of Politics and History* 55(4): 513-529.

French, D & K.N. Scott, (2009) 'International Legal Implications of Climate Change for the Polar Regions: Too Much, Too Little, Too Late?' *Melbourne Journal of International Law* 10(2): 631 - 654.

Goldsworthy, L. & A.D. Hemmings, (2009) 'The Antarctic Protected Area Approach'. 105-128 (Chapter 7) in Sharelle Hart (ed) *Shared Resources: Issues of Governance*. IUCN Environmental Policy and Law Paper No 72. Gland: IUCN.

Hemmings, A.D. (2009) 'From the new Geopolitics of Resources to Nanotechnology: Emerging Challenges of Globalism in Antarctica'. *Yearbook of Polar Law* 1: 55-72.

Hemmings, A.D. (2009) 'Beyond Claims: Towards a Non-Territorial Antarctic Security Prism for Australia and New Zealand'. *New Zealand Yearbook of International Law* 6 (2008): 77 - 91.

Hemmings, A.D. & T. Stephens, (2009) 'Australia's Extended Continental Shelf: What Implications for Antarctica?' *Public Law Review* 20 (1): 9-16

Hemmings, A.D. & T. Stephens, (2009) 'Reconciling Regional and Global Dispensations: The Implications of Subantarctic Extended Continental Shelf Penetration of the Antarctic Treaty Area'. *New Zealand Yearbook of International Law* 6 (2008): 273 - 291.

Rothwell, D.R. (Convenor), Stephens, T. (Rapporteur), Hemmings, A.D., Kaye, S., Mossop, J. & G. Triggs, [The Canberra Panel] (2009) Japan's 'Scientific' Whaling Program and the Antarctic Treaty System: Independent Panel of Legal and Policy Experts. 12 January 2009. 19pp.

Scott, K.N. (2009) 'Maritime Security in the Southern Ocean'. 117-137 (Chapter 7) in Natalie Klein, Joanna Mossop and Donald R. Rothwell (eds) *Maritime Security: International Law and Policy Perspectives from Australia and New Zealand*. Routledge.

Scott, K.N. (2009) 'Marine Scientific Research and the Southern Ocean: Balancing Rights and Obligations in a Security Related Context'. *New Zealand Yearbook of International Law* 6 (2008): 111 - 134.

Presentations

Hemmings, A.D. (2009) 'Biological Prospecting in the Antarctic Treaty Area'. Invited Opening paper: Intergovernmental Meeting of Experts on Biological Prospecting in the Antarctic Treaty Area. Baarn, The Netherlands, 3-5 February.

Hemmings, A.D. (2009) 'Beyond Claims: Towards a Non-Territorial Antarctic Security Prism for Australia and New Zealand'. Responding to Contemporary Challenges and Threats to Antarctic Security: Legal and Policy Perspectives. University of Canterbury, 6-7 July.

Hemmings, A.D. & J. Jabour, (2009) 'Already a Special Case? Australian Foreign Policy regarding Antarctica in the First Decade of the Antarctic Treaty'. Australia and the Antarctic Treaty System. Australian National University, Canberra, 30 November – 1 December.

Hemmings, A.D. & D.R. Rothwell, (2009) 'Military Operations within the Antarctic Treaty Area'. Responding to Contemporary Challenges and Threats to Antarctic Security: Legal and Policy Perspectives. University of Canterbury, 6-7 July.

Huiskes, A. (Presenting author) & M. Rogan-Finnemore, (2009) 'Scientific Perspective on Biological Prospecting in the Antarctic Treaty Area'. Invited Paper: Intergovernmental Meeting of Experts on Antarctic Biological Prospecting in the Antarctic Treaty Area, Baarn, The Netherlands, 3-5 February.

Scott, K.N. (2009) 'Managing Sovereignty and Jurisdictional Disputes in the Antarctic'. The State of Sovereignty, 20th Anniversary Conference of the International Boundaries Research Unit, April, Durham, UK.

Scott, K.N. (2009) 'Marine Scientific Research in the Southern Ocean: Balancing Rights and Obligations in a Security Related Context'. Responding to Contemporary Challenges and Threats to Antarctic Security: Legal and Policy Perspectives. University of Canterbury, 6-7 July.

Scott, K.N. (2009) 'Exploring the Status of the Antarctic Continental Shelf'. School of Law, University of Tasmania, Hobart, Australia, August (invited lecture).

Tin, T. & A.D. Hemmings, (2009) 'Challenges in protecting the wilderness of Antarctica'. WILD9 – Science and Stewardship to Protect and Sustain Wilderness Values: Ninth World Wilderness Congress Symposium. Meridan, Yucatan, Mexico. 6-13 November.



Michelle Rogan-Finnemore, Karen Scott and Alan Hemmings at the Antarctic Treaty Meeting of Experts

The Politics of Antarctica

Anne-Marie Brady, Political Science

External collaborators

Guo Peiqing, China Oceanic University, China

Sanjay Chaturvedi, Punjab University, India

Azizan Abu Samah, University of Malaya, Malaysia

Students

Lara Hawke

Militarisation in Antarctica

Seungryeul Kim

Korea's Polar Strategy

The Antarctic Treaty was a product of the Cold War and the rivalry between the United States and the Soviet Union. The Cold War is long over, but does the Treaty fit the needs of the new world order? Although Antarctic affairs are highly politicised, political scientists have somewhat neglected Antarctica. Utilising the methodologies, frames, and theoretical perspectives of political science this project aims to create a fresh set of paradigms to enhance understanding of Antarctica politics in the current period and to find a way to better manage the challenges facing this unique territory and its surrounding seas.

Conference

An international symposium on the Politics of Antarctica, 8-9 July 2010, bringing together political scientists working on the topic of Antarctica and those involved in various aspects of the "politics of Antarctica", will be held in Christchurch 8-9 July 2010.

http://www.saps.canterbury.ac.nz/Symposium_on_the_Politics_of_Antarctica.shtml

The Polar Journal

The Polar Journal is a new multi-disciplinary social sciences and humanities journal published by Taylor and Francis, London. Associate Professor Anne-Marie Brady, University of Canterbury, is the Executive Editor with the first issue planned for September 2011.

Background

Antarctica and the Arctic are of crucial importance to global security. Their governance and the patterns of human interactions there are increasingly contentious; mining, tourism, bioprospecting, and fishing are but a few of the many issues of contention, while environmental concerns such as melting ice sheets have a global impact. The *Polar Journal* is a multi-disciplinary social sciences and humanities scholarly journal which will help to create a community among the considerable number of specialists and policy makers working on these crucial regions. Despite the importance of the issues, there is no comparable scholarly journal being published at present. The issues faced by the polar regions have global implications and require global solutions. Hence, the journal will feature an international panel of specialists on its editorial board and reach out to an international readership of specialists and practitioners.

The *Polar Journal* receives administrative support from Gateway Antarctica.

The Arts and Antarctica

Patrick Shepherd, School of Literacies and Arts in Education

In 2009 presentations were given at two major music conferences – *Il est bel et bon* (Akaroa) and *Music 09* (Christchurch). The Akaroa conference was run in association with the Australian and New Zealand Association for Research in Music Education (ANZARME) and MERC (National Centre for Research in Music Education and Sound Arts). The presentation focussed on four New Zealand composers who have travelled to Antarctica as part of Antarctica New Zealand's artist programme. The paper compared comments by the different composers, Chris Cree Brown, Phil Dadson, Gareth Farr and Patrick Shepherd, showing how the experience had shaped their work and what the Antarctic experience meant in a broader creative sense. The conclusion examined how such a unique stimulus could be viewed in an educational context and what lessons there were for the teaching of composition.

The research presented at *Music 09* (in association with Music Education New Zealand Aotearoa) built on an earlier paper delivered in Perth in 2007 by using Antarctic work as a basis for a study into synaesthetics and its ramifications in arts education. It was, paradoxically, Patrick Shepherd's Antarctic work that has led him to make a closer study of synaesthetics and particularly colour theory in art. The lack of colour in Antarctica has certainly proved an interesting starting point when approaching "colour" in a musical composition. This also led to a painting of *cryosphere*, an acrylic counterpart to a symphonic poem of the same name written in 2005/6. The painting was exhibited in Rangiora in 2009 at the same time as Shepherd's music was played.

Antarctic-related compositions continue on large-scale works, such as the opera based on the life of Captain Scott and an Antarctic "cantata".

Artefact/Art work

Shepherd, P. (2009) *cryosphere*. Painting: acrylic on canvas 30" x 40"

Presentations

Shepherd, P. (2009) A Different Perspective. Philip Carter Auditorium, Christchurch Art Gallery: University of the Third Age Music Series, 9 October, 2009.

Shepherd, P. (2009) Creative Artists in Antarctica. Faculty of Law, University of Canterbury: Empty Horizon: The Frozen Frontier of Antarctica - Golden Key Youth Forum 2009, 8 July, 2009

Shepherd, P. (2009) Sounds of Antarctica. Akaroa, Christchurch, New Zealand: *Il est bon et bel* - Centre for Music Education Research (MERC) in association with ANZARME, 3-6 July. ANZARME

Shepherd, P. (2009) Synaesthetics - a basis for meaningful musical learning and cross-curricular connections in the arts. Grand Chancellor Hotel, Christchurch, New Zealand: *Music 09* Modulations Conference in association with MENZA, 6-10 July 2009

Antarctic Tourism: A Study of potential environmental impacts

Daniela Liggett, Gateway Antarctica

External collaborators

Neil Gilbert & Ceisha Poirot, Antarctica New Zealand
Committee on Environmental Protection (CEP) Project Management Group (Argentina, Australia, Chile, France, Germany, India, Japan, Netherlands, Norway, Romania, UK, USA)
Kim Crosbie & Steve Wellmeier, International Association of Antarctic Tour Operators (IAATO)
Ricardo Roura, Antarctic Southern Ocean Coalition (ASOC)

The rapid increase in the number of Antarctic tourists and the diversification of tourist activities in the Antarctic Treaty area have caused some concern for a number of years, especially with regard to the potential environmental impacts of these developments. However, in the political realm, the Antarctic tourism debate was held largely without any substantial information on the status and anticipated trends of Antarctic tourism development or on the environmental impacts of tourist activities to base decisions on.

In recognition of this information gap, the Committee on Environmental Protection (CEP) to the Antarctic Treaty recommended, initiated and coordinated a study on the current status of Antarctic tourism and potential environmental impacts arising from observed developments in the Antarctic tourism sector.

Data on the past development and current status of Antarctic tourism was obtained from the Antarctic Treaty System's Electronic Information and Exchange System (EIES), the International Association of Antarctica Tour Operators, academic papers and various national authorities. Due to great inconsistencies and considerable gaps in the records, the study that was scheduled to be concluded within 12 months will continue for another year during which the focus will be on environmental impacts of tourism. A first report on the status of tourism will be presented to the Antarctic Treaty Consultative Meeting in Punta del Este, Uruguay in May 2010.



Antarctic Tourist Ship (Marco Polo)

Publications

Liggett, D., McIntosh, A., Thompson, A., Storey, B. & N. Gilbert, (in Press). Stakeholder perspectives on the governance of Antarctic cruise tourism. In Lück, M., Maher, P., & E. Stewart, (Eds.). *Cruise Tourism in Polar Regions: Promoting Environmental and Social Sustainability*. London: Earthscan.

Liggett, D.H. (2009). *Tourism in the Antarctic: Modi Operandi and Regulatory Effectiveness*. Saarbrücken, Germany: VDM Verlag.

Haase, D., Lamers, M. & B. Amelung, (2009). Heading into uncharted territory? Exploring the institutional robustness of self-regulation in the Antarctic tourism sector. *Journal of Sustainable Tourism*, 17 (4), 411-430.

SCAR Social Science Action Group

Daniela Liggett, Gateway Antarctica (co-chair)

External collaborators

Gary Steel, Lincoln University, New Zealand (co-chair)

Kees Bastmeijer, Universiteit van Tilburg, The Netherlands

Paul Berkman, Scott Polar Research Institute, UK

Bernard Herber, University of Arizona, USA

Elizabeth Leane, University of Tasmania, Australia

Sanjay Saturvedi, Panjab University, Chandigarh, India

Emma Stewart, Lincoln University, New Zealand

Other Collaborators

Alan Hemmings, Gateway Antarctica

Project overview

SCAR's Executive Committee recently approved a proposal submitted by Gary Steel and Daniela Liggett to create a SCAR Social Science Action Group (SSAG). The motivation behind the creation of this group is the importance of the human side of aspects of Antarctica, which complements and interrelates with research currently conducted from a natural science perspective. In addition, a wide range of humanities researchers and social scientists currently work on projects with an Antarctic focus, but due to the lack of a formal network and funding, this work is not as prominent as many physical science projects. The role of the SCAR SSAG will be to create greater transparency among Antarctic social scientists and humanities researchers, establish a formal network to share ideas and form collaborations and to bring the "human perspective" of Antarctica more to the forefront. As an initial project, the SCAR SSAG intends to encourage and coordinate an investigation of the range of values that human beings place on Antarctica taking a multi-disciplinary approach. Values placed on Antarctica by human beings affect policy decisions and as such, on an international scale, have an impact on global systems, which cannot be neglected. Consequently, it is imperative that a better understanding is gained of these value systems and their characteristics.



PhD Candidates



Andrew Atkin, Gateway Antarctica and University of Technology, Australia

Factors regulating the success of scientific programs on Heroic era expeditions in Antarctica, 1897-1914.

Supervisors

Bryan Storey, Gateway Antarctica

Robert Clancy, Hunter District Health Service, Newcastle, Australia

Mark Pharaoh, Australian Polar Collection Manager, Mawson Centre, South Australian Museum, Adelaide, Australia

The scientific program of the British National Antarctic Expedition (Scott's 1901-1904 *Discovery* expedition) was one element of a coordinated international collaboration (that involved other Antarctic expeditions and national observatories) to gather data in the physical sciences of meteorology and terrestrial magnetism. The expedition ship *Discovery* was designed and built specifically as an ice-capable exploring and research vessel. It spent two full years frozen in the sea ice in McMurdo Sound near Ross Island, during which time the scientific and naval staff collected zoological, bacteriological and geological specimens as well as data for the physical sciences of meteorology and terrestrial magnetism.

Opinion varies regarding the success of the scientific program on the *Discovery* expedition. The scientific achievements have always been overshadowed by the dramatic events of Scott's second (*Terra Nova*) expedition and it is puzzling that the scientific staff of the *Discovery* slipped into relative obscurity after their return. Analysis of the factors regulating the success of scientific programs on Edwardian era expeditions will provide context for the discussion of scientific achievements of the *Discovery*. Scientific leadership is clearly one of those factors. At the risk of fuelling the debate about Scott's leadership and organisational skills, it would be revealing to consider what might have happened if Scott had not replaced Professor Gregory prior to embarkation. Gregory was the original nominee for scientific directorship and was an experienced expedition leader and scientist.

Evaluations of the scientific outcomes of the expedition are the centrepiece of my project, especially with respect to International collaborations in the physical sciences of meteorology and terrestrial magnetism. My research question can be simplified to:

"What factors contributed to the outcomes of scientific research on Scott's *Discovery* expedition and, by comparison to similar Antarctic expeditions of the time, did the *Discovery* expedition maximise its opportunities for scientific success?"

Presentations

Atkin, A., New Light on the British National Antarctic Expedition (Scott's *Discovery* Expedition) 1901-1904 "Imagining Antarctica" Conference, Christchurch, 2008.

Atkin, A., A Review of Criteria for Rating the Success of a Century of Antarctic Science, from the Heroic Era to the IPY, 2009 Annual Antarctica Conference, University of Auckland, p29.

Tim Hay, Department of Physics and Astronomy

Bromine explosions and ozone depletion in McMurdo Sound

Supervisors

Adrian McDonald, Department of Physics and Astronomy

Peyman Zawar-Reza, Department of Geography

External Supervisors

Karin Kreher, NIWA

Robyn Schofield, Alfred Wegener Institute, Germany

Springtime ozone depletion events in the polar marine boundary layer were first observed in the mid 1980's. It is now widely accepted that the main mechanism for these tropospheric ozone depletion events involves autocatalytic release of bromine from sea-salt, referred to as bromine explosions. The conditions that trigger these events are not yet fully understood, but the presence of first-year sea ice and an inversion layer, which acts as a barrier permitting little exchange with the air above, are known to be important.

The aim of this research is to observe these events using portable instrumentation at various sites on the sea ice in McMurdo Sound. Atmospheric BrO (bromine monoxide) and IO (iodine monoxide) were measured using a spectrometer, while surface atmospheric ozone and meteorology were also monitored. Several ozone depletion events along with elevated boundary layer BrO were observed during the 2006 and 2007 measurement periods. Enhanced IO was also observed at Cape Bird. Air mass back trajectories indicate that these relatively small events were locally produced rather than involving transport across extensive sea ice regions to the North. A new radiative transfer model and modified optimal estimation retrieval code has been developed. This enables more accurate information on diurnal variation and vertical concentration profiles to be obtained from the spectrometer measurements. This research is part of a NIWA project.

Publications

Hay, T.D., Kreher, K., Johnston, P., Thomas, A., Riedel, K., Schofield., R., & A. McDonald, (2008). 4th International DOAS workshop for Environmental Research and Monitoring, Springtime MAX-DOAS measurements of bromine explosion events on the sea ice in Antarctica, Hefei, China, April 2008.

Hay, T.D., Kreher, K., & K. Riedel, (2007). Bromine explosions and Antarctic ozone. *Water and Atmosphere* 15(2), 12-13.

Stephen Hicks, Gateway Antarctica

The TAE and the IGY – Turning Points in the history of Antarctica

Supervisors

Bryan Storey, Gateway Antarctica

Philippa Mein-Smith, School of History

It is over half a century since the Trans-Antarctic Expedition (TAE) achieved its goal of an overland crossing of the Antarctic continent and since the world scientific community gathered during the IGY to continue the quest for nature's secrets with a focus on the polar regions. The record however is fragmented across a multitude of accounts, some 'official', some not, some emphasising the TAE and some, the IGY, and some treating the two as if they were one. No account has yet treated these two distinct yet closely related 'super-projects' in a historically rigorous manner. Misconceptions have arisen and the populist objectives of the commercial media together with the layered recounting of anecdotes has led to either an incorrect or at least to an incomplete understanding of these key events from that pivotal decade in polar history.

My thesis is an attempt to update the record with new material as well as to correct misconceptions that have been promulgated regarding the British and the New Zealand parties, and also the role of the United States Antarctic Program before and after the crossing of the continent. Using diaries, archival material and largely primary sources my thesis will seek to clarify the issues that arose before, during and after the TAE achieved its goal. This will be presented in the political, scientific and social context of the period.



Transantarctic Expedition

Linda Kestle, Gateway Antarctica and Unitec-NZ

Remote Site Design Management – a multi-disciplinary management model

Supervisors

Bryan Storey, Gateway Antarctica

Pat Bodger, Electrical and Computer Engineering

Regan Potangaroa, Unitec-NZ

The main objective of this doctoral research was to develop and validate a conceptual design management model for remote site international collaborative projects. Researching into design management and remote sites had rendered no previously documented empirical examples, or theoretical models from published literature that related to this specific topic, from an integrated design and management perspective. The multi-case studies selected to test the conceptual model included a retrospective historical case study of the Cape Roberts Drilling Project in Antarctica, and a case study of the Sudanese Humanitarian Aid Project in West Darfur. In addition the management model/framework has been tested on post-disaster projects such as the tsunami relief project in Banda Aceh, and a post earthquake reconstruction project in Pakistan. The research also demonstrated the potential portability of the model, in terms of offering a basis for a relevant management framework for a range of remotely sited international collaborative projects in the Built Environment, International Science, International Humanitarian Aid and Post-disaster Reconstruction disciplines.

The PhD thesis was submitted for examination at the beginning of September 2009, and successfully defended in late December 2009 at the University of Canterbury.

Publications

Kestle, L., (2009) Unpublished PhD thesis. Remote Site Design Management, University of Canterbury, New Zealand.

Nikolai Krutzmann, Department of Physics and Astronomy

Complexity Analysis of Geophysical Systems

Supervisors

Adrian McDonald, Department of Physics and Astronomy

Wolfgang Rack, Gateway Antarctica

Steve George, Department of Geography

This project aims to utilise recently developed methods from the science of complex systems for studying and analysing the Earth's atmosphere, cryosphere, and potentially other geophysical domains.

The starting point of this project is the Rényi entropy (RE) statistical measure, which was previously established as a useful tool for identifying atmospheric transition regions associated with barriers to horizontal mixing. Having successfully applied this measure to data from climate-model simulations, the first goal of the PhD project is to use the RE measure to study the properties and behaviour of mixing barriers in more detail using satellite observations. One such barrier is the Antarctic polar vortex, a strong circumpolar stratospheric wind that occurs every Austral winter and spring. It separates the cold polar air masses from more temperate mid-latitude air, and thereby creates the extremely cold conditions, which lead to the formation of the ozone hole in spring. Accordingly, understanding this transition region is essential for predicting Antarctic ozone chemistry.

Given that many geophysical processes exhibit enhanced complexity at transition regions, this PhD research aims to extend the application of the RE methodology to other geophysical systems, and particularly to the cryosphere. In snow and ice, transition regions can be associated with internal layers created by changes in the ambient conditions at the time of deposit. By identifying and tracing internal layers in ground penetrating radar (GPR) measurements of the Antarctic snow cover, the layers can be used to measure snow accumulation over time. This is particularly relevant for determining the Antarctic mass balance, as the areal coverage can be greatly expanded from the common, but unrepresentative, point measurements, e.g. firn-core drilling or snow pits. However, conventional signal processing methods have major shortcomings in identifying the layers observed in GPR data. This project aims to use the RE and possibly other complexity measures to better identify the transitions between different snow layers, which will improve our understanding of the spatial variability of the Antarctic snow cover. Two high resolution datasets of GPR measurements of the top 10-20 meters of snow were acquired in the Ross Island region in consecutive seasons (2008/09 and 2009/10). A plethora of internal reflections can be found in both datasets. By identifying the same layers in data from both years, annual accumulation and compaction rates can be calculated over a large area. Additionally, this data and its analysis will contribute to the validation of the Cryosat-2 satellite (launch date in 2010). A more detailed analysis and comparison of the identified layers with density profiles from firn cores is ongoing. The combination of modern remote sensing technology with innovative analysis techniques will allow a large-scale analysis of the cryosphere in unprecedented detail.

Crystal Lenky, Gateway Antarctica

Utilising osmolyte biomarkers to determine feeding in the Weddell seal

Supervisors

Victoria Metcalf, Lincoln University

Bryan Storey, Gateway Antarctica

Regina Eisert & Olav Oftedal, Smithsonian Environmental Research Center,
United States of America

Marie Squire, Chemistry Department

Michael Lever, Canterbury Health Laboratories



The aim is to assess whether certain osmolytes found in Antarctic marine fauna serve as dietary biomarkers of feeding in high level Antarctic predators. The osmolytes trimethylamine oxide (TMAO) and arsenobetaine (AsB) have proved useful for determining food intake in Weddell seals, but our understanding of osmolyte distribution within prey species and trophic accumulation is limited. A key issue is whether specific osmolytes vary sufficiently among taxa that they might be useful as indicators of the consumption of particular types of prey. Many osmolytes can be quantified in blood plasma of mammals and thus serve as mammalian dietary biomarkers, providing information on recent food intake. Female Weddell seals appear to need to forage in order to complete lactation successfully. Large females rely on stored fat reserves and fast for all of the lactation period ('capital' breeding), while smaller females feed at

some point during lactation ('income' breeding). I am investigating feeding habits of Weddell seals during lactation using the dietary biomarker approach. This involves analysing key prey species of Weddell seals using ^1H Nuclear Magnetic Resonance (NMR) Spectroscopy to ascertain the typical concentrations of osmolytes (e.g. TMAO, AsB, homarine) across different taxa in order to develop taxon-specific biomarkers. These same osmolytes will then be measured in plasma samples taken from Weddell seals during various stages of lactation in order to determine what the seals have been eating and when they have eaten.

Bryan Lintott, Gateway Antarctica

The Antarctic Huts of Scott and Shackleton: significances, conservation and interpretation

Supervisors

Bryan Storey, Gateway Antarctica

Eric Pawson, Department of Geography



The Antarctic huts of Captain Robert Falcon Scott and Ernest Shackleton on Ross Island are now ranked among the most important human heritage sites on the planet. Built as utilitarian structures, in the early 20th century, to support British science and exploration in Antarctica, since the 1950s they have been ascribed the status of secular shrines; associated with scientific and geographical enquiry, endurance and sacrifice.

How the huts are perceived and presented has heavily influenced by 19th century British concepts of the polar regions as unique places in which physical decay can be halted and, maybe, even time, in a sense, is 'frozen'. How British polar related concepts, and New Zealand and American perceptions of the huts have intersected and interplayed is a central research theme.

This project will consider how the heroic-era huts of Scott and Shackleton have been ascribed a range of significances, managed, conserved, interpreted, experienced and utilised - geopolitically, politically, financially and personally - and, from this, what can be learnt about dealing with the huts and other polar historic sites and monuments in future.

During 2009 research was undertaken as a visiting scholar at the Scott Polar Research Institute (SPRI), University of Cambridge, and the British National Archives. During the year, the opportunity arose to assist as a member of the three person team undertaking research and curation for the institute's Polar Museum redevelopment. Having the privilege of working with the world's premier collection of polar artefacts has greatly enhanced my technical and historical understanding of how the huts were utilised, and polar history in general.

Kerry McCarthy, Gateway Antarctica and Canterbury Museum

Living in the ice (im)age: theorising photography at the margins of Antarctic exploration

Supervisors

Bryan Storey, Gateway Antarctica

Jacky Bowring, Lincoln University

Mike Pearson, University of Aberystwyth, Wales

This thesis draws on recent photography theory and the work of two seminal writers, Walter Benjamin and Roland Barthes, to propose a methodology for placing photographs at the centre of critical thinking. It links this theory with the rhetorical and motivational analyses of Kenneth Burke, using his pentad of dramatisic analysis to consider how photographs function to create, reinforce and potentially destabilise meanings, aspirations and responses.



It takes account of the photograph both as image and as enduring object, and will focus on the Ernest Edward Mills Joyce Collection at Canterbury Museum, compiled by Joyce in response to his participation in three 'heroic era' Antarctic expeditions. The project will consider the Antarctica that Joyce (re)constructed through these photographs and the responses that they elicit today.

Erin Neufeld, Gateway Antarctica

A Place on the Ice: exploring the images, stories, and experiences that make up New Zealand's Antarctica

Supervisors

Gary Steel, Lincoln University

Bryan Storey, Gateway Antarctica



When one thinks of Antarctica there are many images and ideas that might come to mind; ice, snow, penguins, cold, explorers, isolation, and the wild to name a few. Popular literature suggests that these are all common ways in which people envision and connect with Antarctica. It is important to note, though, that each person will have a unique connection due to their history, their experiences, and their culture. This latter aspect is, of course, of special interest in New Zealand. My research will explore

the many ways in which people develop a sense of 'place' for Antarctica.

The focus of this PhD will be the connections to Antarctica felt by New Zealanders; from researchers and staff who return year after year to live and work on the Ice, to people who have barely even thought of the far-off continent. Using semi-structured interviews, data will be collected from participants who represent a broad spectrum of experience with Antarctica. Theoretical development regarding sense of place, based on an interactionist framework, will take place via multiple case study analysis, with an emphasis on social, affective, identity, and physical feature themes of the data.

This development of 'sense of place' theory has been lacking for extreme and remote environments. Given that the polar environments are difficult to reach and difficult to know, but still carry a potentially serious effect on such global issues as climate change, information about people's perspectives of the continent is badly required. More importantly, this information must be grounded in properly defensible, scientific method. Beyond this, however, the analysis of perceptions and attachments to Antarctica gathered from across the experiential spectrum of New Zealand participants will be useful for management and policy development. Knowledge of the ways in which the icy continent is viewed will provide much-needed information to those whose decisions can have long-term and large impacts on Antarctica's natural and built environment.

Mette Riger-Kusk, Department of Geography and Gateway Antarctica

Ice discharge of an Antarctic outlet glacier: Darwin-Hatherton Glacial system

Supervisors

Wendy Lawson, Department of Geography

Wolfgang Rack, Gateway Antarctica

Brian Anderson, Antarctic Research Centre, Victoria University of Wellington



The Darwin-Hatherton (D-H) glacial system is located in the Transantarctic Mountains, where it drains from the East Antarctic Ice Sheet (EAIS) and into the Ross Ice Shelf. Evidence of past fluctuations in ice thickness is preserved in the glacial sediments deposited alongside the margin of the glacier ice. These fluctuations reflect both the dynamic behaviour of the EAIS and the West Antarctic Ice Sheet, which advanced into the Ross Embayment and blocked the outlet of the D-H glacial system during the last glaciations. Up until now, research has focussed on the larger and faster moving East Antarctic outlet glaciers whereas little is known about the smaller and slower outlet glaciers such as the D-H glacial system. Through my research I aim to better understand the current dynamics and past variations of the D-H glacial system. In doing so I hope to furthermore improve our understanding of the way in which the two Antarctic ice sheets have varied in the past.

In the Antarctic field season 2008/09 a team of researchers from Gateway Antarctica and the Department of Geography at Canterbury University set out to measure the thickness of the ice in the D-H glacial system using Ground Penetrating Radar (GPR). We successfully collected close to 300 km of radar measurements recording thicknesses of up to 1100 m towards the grounding zone of the glacier. The measurements were processed and combined with results from an airborne radar survey carried out as part of the IPY ICECAP project, and have now been turned into a 3D models of ice thickness and bedrock topography. The bedrock topography will feed into a numerical ice flow model, which will be used to simulate the changes in ice thickness since the Last Glacial Maximum (LGM). Results will be compared to dates of glacial sediments collected in the area, and if successful the model will be employed to simulate both variations prior to the LGM and possible future changes.



Teaching



ANTA 101: Antarctic Studies

ANTA 101 is a first year undergraduate course that provides a wide-ranging introduction to Antarctica and the Southern Ocean. The course covers three main areas: planet Earth and Antarctica, Antarctic plants and animals, and human aspirations and concerns for the Antarctic, including the early exploration of the continent, present day conservation issues, climate change and Antarctic law. It is a multidisciplinary full year course, which welcomes students from all backgrounds. The course attracted 82 students in 2009 and was taught by 12 different lecturers. Eleven lecturers came from 6 different departments at the University of Canterbury while the remaining 1 was an invited guest lecturer from an external organisation.

ANTA 102: The Cold Continent

ANTA 102 is the first semester portion of ANTA 101. It focuses on the Antarctic continent, ice and climate, issues and concerns for Antarctica including tourism, fisheries management, legal and environmental issues. 64 students enrolled for the course in 2009.

ANTA 103: Life in the Cold

ANTA 103 is the second semester portion of ANTA 101. It focuses on Antarctic, biology including: Antarctic and sub-Antarctic plants and animals, human interactions, aspirations and explorations of Antarctica. The course also includes a look at human polar psychology issues, such as what makes a good winter-over candidate. 51 students enrolled for the course in 2009.

ANTA 102SU2: The Cold Continent and ANTA 103SU2: Life in the Cold

ANTA 102SU2 and 103SU2 are the summer school equivalents of ANTA 102 and 103.

In 2009 the courses were offered over the four-week period between 16 November and 18 December. The summer courses had a total of 65 enrolments for ANTA102 SU2 and 54 enrolments for ANTA103 SU2. The courses were taught as flexible video-based delivery modules with four in-person tutorial sessions per course.

For 2009, first year Antarctic Studies courses attracted a total of 316 students.

ANTA 201: Antarctica and Global Change

ANTA 201 is a second year course that provides a multidisciplinary approach to understanding Antarctic science. The course takes a science system approach and investigates the linkages between the Antarctic atmosphere, climate, ice sheets, lithosphere and biosphere. It considers how Antarctica will respond to global change and what affect climate change might have on Antarctica in a future warmer world. This course builds on the introductory knowledge taught in ANTA 101. It had 31 students in 2009 and was taught by 5 UC staff members and one invited guest lecturer, Mike Williams from NIWA.

LAWS 336: Antarctic Legal Studies

LAWS336 provides a comprehensive introduction to the Antarctic Treaty System by examining the international legal system that governs the Antarctic and considers some of its most pressing problems concerned with the environment, biodiversity, resource extraction, fisheries, tourism, liability and the future of the deep south. The course is run by the School of Law. There were 22 undergraduate students enrolled in 2009.

ANTA 401: Antarctic Global Connections

ANTA 402: Antarctic Legal Systems

ANTA 401 and ANTA 402 are part of the Postgraduate Diploma in Antarctic Studies that aims to foster the interdisciplinary study of Antarctica and the surrounding Southern Ocean. The Diploma programme consists of one academic year for full time students. It is equivalent to Part 1 of the Masters of Antarctic Studies. Students undertake two compulsory core courses in Antarctic Studies (ANTA401 and ANTA402) equivalent to 0.5 course weight. ANTA 401 is seminar based and discusses the current and future issues surrounding Antarctica and the Southern Ocean and their global relevance. ANTA 402 examines the international legal system that governs Antarctica. As well as the above two compulsory courses, students will undertake existing university courses (equivalent to 0.5 course weight) within their specialist area of interest to continue to develop their own specialist skills within their proposed discipline. Three students completed the programme in 2009.

GEOL 480: Geological Evolution of New Zealand and Antarctica

GEOL 480 integrates many Earth Science disciplines to understand and interpret the geological and geotectonic development of the New Zealand-Antarctic region. The region is used as a framework to trace the development of the Gondwana continent and its margin from Late Precambrian times through to breakup and separation of New Zealand from Antarctica in the Cretaceous. The course had 10 students in 2009 and was taught by staff from the Department of Geological Sciences and Gateway Antarctica.

ANTA 601-604: Postgraduate Certificate in Antarctic Studies (PCAS)

In 2009 the Graduate Certificate in Antarctic Studies (GCAS) was upgraded based on an independent panel review. GCAS became the Postgraduate Certificate in Antarctic Studies (PCAS). This is a significant development for the programme as it rewards the quality of the teaching and assessment together with the quality of the participants that the programme attracts.

PCAS is an in-depth study over a fourteen week summer period of the history, science, political discourse, environmental concerns and future challenges of Antarctica and surrounding Southern Ocean. The course is for graduates of any discipline and professionals involved in Antarctic issues. PCAS is unique in that it includes a 10 day field study in Antarctica supported by Antarctica New Zealand. Projects undertaken in Antarctica included the geophysical investigation of the Ross Ice Shelf, a seal census, environmental and weather reports and a creative project documenting the participants' personal experience on ice.

The course had 16 students enrolled and was taught by 10 staff from the University of Canterbury and 31 guest lecturers from external organisations. Students came from throughout New Zealand, Australia, the Russian Federation, the United Kingdom, the United States of America and Germany. The course was co-ordinated by Michelle Rogan-Finnemore with Chris Dolder, Shannon Fowler and Michael Finnemore as field tutors.

We are very grateful to Antarctica New Zealand for their continued support of this programme and for enabling Sergey Tarasenko, environmental officer from the Russian Antarctic programme to participate in the course.

Aspects of Antarctica

Aspects is a general studies, evening course, run through Continuing and Bridging Education at the University of Canterbury. It consists of three modules run over the course of the year. Each module is based around a separate Antarctic theme. Each module is 5 – 6 weeks in length, usually every Wednesday evening.

ANTA On-Line

Gateway Antarctica delivered a series of 15 on-line lectures to students at University of Oregon and Iowa State, USA. The lectures were part of an Antarctic course that included a 10 day visit to the Antarctic Peninsula on a tourist vessel. 8 students were registered for the course. The lecture series was also delivered simultaneously to a group of 13 people who participated in the Antarctic Exploration cruise to Antarctica organised by the International Programme at UC Opportunity. The group was accompanied by Professor Bryan Storey, Gateway Antarctica.

PCAS 11: Project Reports 2008–2009

Student	Project Title
Martina Armstrong	Multichannel Analysis of Surface Waves (MASW) determined surface-wave velocity profile and its relation to observation of the near-surface polar firn layers.
Annette Bombosch	Marine Biology in Antarctica: Then and Now.
Sarah Bouckoms	Energy Simulation and Reconstruction in String 63 for the IceCube Neutrino Detector.
Anne-Marie Brady (Not Available)	China's Rise in Antarctica.
Philipp Emnet	The Interplay of Gaseous Chemical Species and the extent of the Ozone Hole.
Andrew Given	The South Polar Skua (<i>Gatharacta maccormicki</i>): A study of past research and future opportunity.
Elizabeth Holland	New Zealand's Antarctic Bilateral Diplomacy.
Melissa Idiens (Not Available)	Commercial Appeal: How state and capitalist sector involvement in Antarctica is mutually-reinforcing New Zealand's Antarctic identity component.
Belinda Jones (Not Available)	Updating Antarctica New Zealand's Critical Incident Management Systems (CIMS) to include the scenario of death of a staff member in the Ross Sea Dependency.
Marion Laird	Provenance Analysis of the Leap Year Group, Northern Victoria Land, East Antarctica.
Lorna Little	Lichen Life in Antarctica: A review on growth and environmental adaptation of Lichens.
Sinead Martin (Not Available)	Penguins don't have pockets: Investigating potential alternative funding for Gateway Antarctica.
Gregory O'Brien	Towards an Antarctic Tourism Policy: a framework for policy analysts.
Sergey Tarasenko	Wastewater Treatment in Antarctica.
Laura Taylor	Communicating Gateway Identity.

Projects

Gateway Antarctica contributed GIS research, analysis and mapping to a number of National Antarctic Programmes, researchers and students over the year.

Antarctic GIS

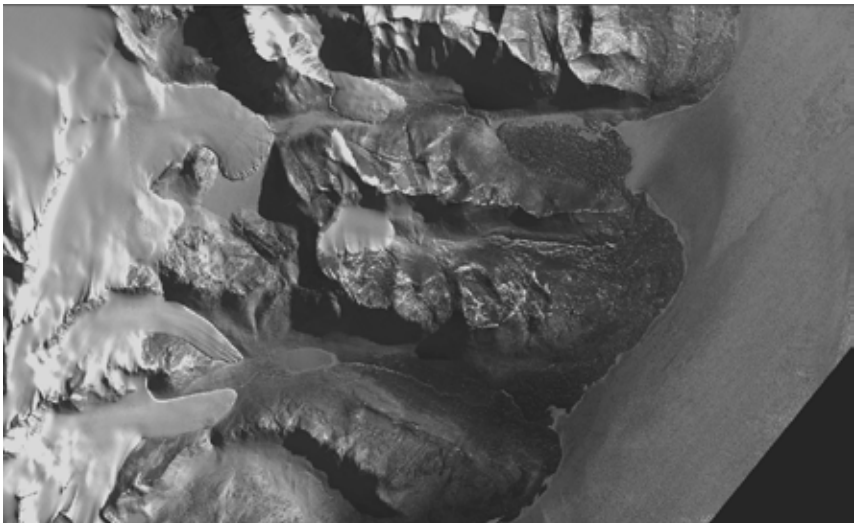
The online Antarctic GIS was maintained and updated with recent bibliographic information from New Zealand researchers. The GIS can be accessed at www.anta.canterbury.ac.nz by clicking on the “NZ Antarctic GIS” button.

Aerial Photograph Digital Catalogue

We continue to catalogue and scan the Antarctica New Zealand Aerial Photo Collection. Flight line and other spatial data are available in the Antarctic GIS which is updated regularly. Additionally, we have sourced zterabytes of aerial photography through Antarctic Geospatial Information Centre, which is being used by our PhD students.

Specially Protected Area Maps

Gateway Antarctica, in a project with Antarctica New Zealand, has updated the Specially Protected Area maps for Cape Adare, Cape Evans, Cape Royds and Beaufort Island. The Beaufort Island map involved purchasing additional satellite imagery to appreciate the change in snow cover on that island.



Denton Hills

Events and Other Information

Public Lecture Series

Mike Bentley, visiting Erskine Fellow, Durham University, UK,
“Antarctic ice sheets and climate change”

Mike Williams (NIWA),
“The Antarctic circumpolar current: how do you measure a river within an ocean?”

Andrew Clarke (Erskine Fellow),
“Climate change and Antarctica”. A discussion of global climate change in general.

Manfred Reinke, Executive Secretary, Antarctic Treaty Secretariat, Buenos Aires, Argentina, on
“Fifty years of the Antarctic Treaty: Revisiting a success story”.

Bryan Storey, Director, Gateway Antarctica,
“Antarctic exploration tour evening “

Antarctic Golden Key Event



Golden Key is an international honour society for the top 15 per cent of university students, which recognises academic achievement and excellence and promotes a strong community service ethos. On the 8 July 2009, 61 school leavers had a day devoted to Antarctica “Empty horizons: The frozen frontier of Antarctica” a taste, from nine presenters, of topics as diverse as tourist operations to art on the ice. The students then, facilitated by Golden Key members, got a chance to put together a presentation on what they had learned. The event was officially recognised by Golden Key Headquarters in Atlanta as the Best Intellectual Outreach Event in 2009.

PCAS Syndicate Presentations

As part of the Postgraduate Certificate Course, the students presented four hour-long public lectures on topics currently in the news or under debate in the Antarctic arena. The topics were:

- Antarctica Sub glacial Lakes - The Race to the Bottom
- Challenges of the Southern Ocean – “The Antarctic Beyond the Continent”
- Emerging/Developing Country Investment in Antarctica: What’s behind their interests and/or engagement in Antarctica?
- “The White Book” and Beyond: A look at the achievements of the ATS over the past 50 years, and what achievements we might expect over the next 50 years.

COMNAP Secretariat

On 1 July 2009, Gateway Antarctica's Centre Manager, Michelle Rogan-Finnemore, was appointed the COMNAP Executive Secretary. COMNAP is the Council of Managers of National Antarctic Programs, an organisation with membership from all 29 of the National Antarctic Programs which operate in Antarctica. COMNAP has observer status at Antarctic Treaty Consultative meetings and plays an active role in managing the support of Antarctic science. The COMNAP Secretariat, which is the physical location of COMNAP, will be hosted by Gateway Antarctica for 6 years. An official opening event was held at Gateway Antarctica, 24 September, 2009.

NZ MFAT Ross Dependency Scholarship

Andrew Phillips was the recipient of the NZ Ministry of Foreign Affairs and Trade Ross Dependency Scholarship for 2009. The Scholarship, worth \$5000 for one year, was established in support of research and teaching in Antarctic Studies in recognition of Antarctica being a natural reserve devoted to peace and science. His project is about the legal responses to the unintentional introduction of alien invasive species into the Antarctic environment.

Christchurch City Council Antarctic Scholarship

The Christchurch City Council Antarctic scholarship includes an annual stipend of \$10,000 as well as logistic support from Antarctica New Zealand. The recipient in 2009 was Phil Emnet from the Chemistry Department. His project is about the effect of endocrine disrupting chemicals on Antarctic and New Zealand ecosystems.

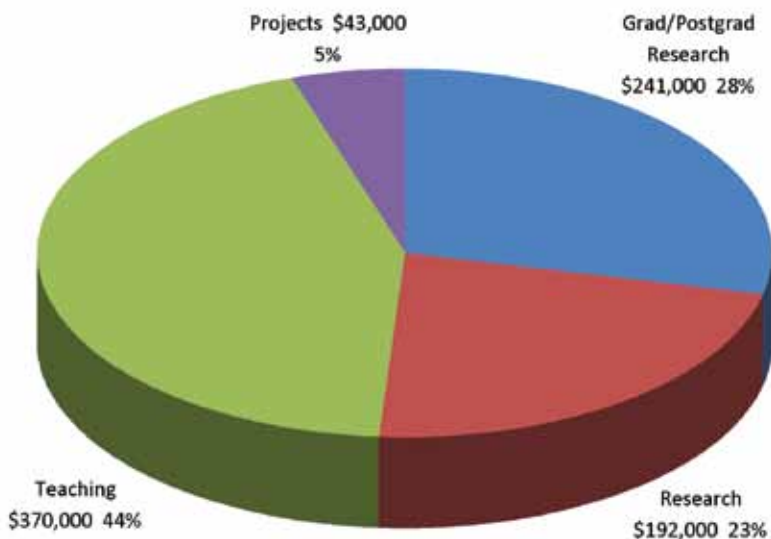
Erskine Fellow

Professor Andrew Clarke (British Antarctic Survey) was a visiting Erskine Fellow to Gateway Antarctic from 1st November to the end of December 2009 during which time he contributed to our Post Graduate Certificate in Antarctic Studies. Andy is a marine ecologist with particular interests in evolutionary adaptation to low temperature, the role of short-term environmental variability in marine ecology, and the influence of climatic and tectonic changes in determining global patterns of biological diversity.

Income Information

Gateway Antarctica receives its income from three primary sources – research, teaching and projects. In 2009, 51% of our total income came from research-related activities including postgraduate research. Total income for Gateway Antarctica was \$846,000. This does not include income generated by Antarctic teaching and research carried out throughout the other departmental units at the University of Canterbury.

2009 Gateway Antarctica Income Sources



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