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Canterbury

Book of Abstracts

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[N.B. Unless otherwise noted, the authors of these abstracts are based at the University of Canterbury.]

POSTERS

Southern Hemisphere dispersion of volcanic aerosol from two notional major eruptions of Mt. Agung

Yusuf Bhatti, Graham Mann (University of Leeds), Sandip Dhomse (University of Leeds), Sarah Shallcross (University of Leeds), Lauren Marshall (University of Cambridge), Anja Schmidt (University of Cambridge), Nicolas Bellouin (University of Reading) and Ken Carslaw (University of Leeds)

There have been 5 major volcanic eruptions since 1850 which exerted periods of strong surface cooling in decadal surface climate trends. Tropical eruptions cool the climate by injecting sulphur dioxide into the stratosphere, creating a long-lived, optically thick volcanic aerosol cloud. Mt. Agung and Mt. Pinatubo had a major eruption in 1963 and 1991 respectively, both identifiably reducing global surface temperatures for several years. Agung magmatically reactivated in 2017 presenting the possibility for a new climate perturbing volcanic eruption.

The aim of this project is to explore the stratospheric dispersion of volcanic aerosol and radiative forcing effects, had Agung progressed to a major eruption in October 2017, using two scenarios emitting 20 Tg and 10 Tg SO₂. This project utilised the composition-climate model UM-UKCA with the interactive stratospheric aerosol module to predict the progression of the volcanic aerosol cloud in the weeks and months after the hypothetical October 2017 eruption.

The model predictions suggest the 20 Tg eruption would have had a much greater hemispheric asymmetry than the 10 Tg eruption, confined mostly to the southern hemisphere, as a result of perturbed dynamics in the tropics from enhanced aerosol-radiation warming. The aerosol burden in the southern hemisphere, for the larger eruption, is more than 4 times that of the counterpart, whereas in the northern hemisphere, 20 Tg is only 0.4 times more. Aerosols from 20 Tg dispersed out the tropics much faster than the 10 Tg, as the vertical velocity in the tropical upwelling demonstrates an increase, rapidly ascending to more than 35 km, followed by the meridional dispersion, below 25 km.

Sea spray aerosol forcing of the Southern Hemisphere Westerly Jet

Ollie Jones, Ngaire Wotherspoon and Laura Revell

The Southern Ocean is the windiest region on Earth. Here, the westerly jet exerts an important influence on surface climate via heat and moisture transport. In recent decades the westerly jet has strengthened and shifted pole-ward due to the evolution of the Antarctic ozone hole and associated phase of the Southern Annular mode. Future changes in the position and strength of the jet will be determined by ozone recovery and greenhouse gas forcing. The position of the jet has a strong influence on sea spray aerosol production, which is predominantly wind-driven. Sea spray aerosol exerts a negative climate feedback via

activation to cloud condensation nuclei, which alter cloud properties and lifetime. By comparing atmosphere-only and coupled simulations performed with the New Zealand Earth System Model, we show that sea spray aerosol forcing can influence the position of the westerly jet and its own production. In simulations with scaled up sea spray aerosol forcing, the westerly jet weakens and moves equator-ward. The results demonstrate that future changes in the Southern Ocean westerly jet will be sensitive to aerosol forcing, along with ozone recovery and greenhouse gas forcing.

Antarctic English: Investigating Possible Dialect Emergence at Scott Base

Stephanie Kaefer

Traditional studies of rapidly emerging dialects, also known as new dialect formation (Kerswill and Trudgill, 2005), highlight that certain conditions facilitate this particular event, such as [LIST THEM]. Examples of NDF include New Zealand English, which emerged early in New Zealand's colonial history (Trudgill, 2004; Hay, Maclagan and Gordon, 2008), or the rapid emergence of a dialect in the newly constructed town of Milton Keynes in England (Kerswill, 2002; Kerswill and Williams, 2000). Since some of these conditions are also found in the situation of the Antarctic bases, an analysis of speakers from these bases could indicate that NDF might also be occurring in these locations.

Presently, only one study of language change in Antarctica has been undertaken, and the results of this study hint at the possibility of a New Dialect emerging on the ice. Harrington et al. (2019) assessed the effects of the isolated nature of a "winter-over" at one of the bases of the British Antarctic Survey on the speech of 11 participants. Their study found that by the end of the winter season, vowel in words like GOAT was produced in a more fronted position in the mouth than in mainstream English varieties (either American or British English). They also found that two of the three vowels tested in the study (in words like GOOSE & GOAT), and the consonant-vowel combination in words like FEW converged between the participants (i.e. the differences between different speakers decreased over time. As a result, Harrington et al. (2019) highlight the possibility that these changes could indicate the first stage in the development of a new dialect. The implications of this study suggest that further study with a larger participant group and an analysis of the relationships between participants and their roles on the base could provide more insight into the possibility of dialects developing in Antarctica.

This present study aims to further investigate these areas by collecting speech data from staff and visitors residing at Scott Base. The author travelled to Scott Base during the 2019/2020 summer season and compiled a corpus of Antarctic speech to inform a PhD about language in Antarctica and the possibility of an Antarctic dialect emerging at the base.

Ground-based lidar processing and simulator framework for comparing models and observations

Peter Kuma, Adrian J. McDonald, Olaf Morgenstern (National Institute of Water & Atmospheric Research (NIWA)), Richard Querel (NIWA), Israel Silber (Pennsylvania State University), and Connor J. Flynn (Pacific Northwest National Laboratory)

Atmospheric lidar measurements are a well-established tool for remote sensing of clouds. For over a decade, spaceborne lidar measurements produced by the CALIOP instrument on the CALIPSO satellite and CATS on the International Space Station have proven invaluable for model cloud evaluation in general circulation and numerical weather forecasting models. They have revealed the vertical structure of clouds, particularly in combination with radar instruments, which is impossible to obtain with passive remote sensing instruments. However, the measurements are limited by rapid attenuation of the lidar signal in thick clouds. Ground-based lidar measurements are becoming more common due to greater availability of instruments such as ceilometers installed on a wide scale globally. They can provide much needed lidar measurements of clouds "from below", but processing of lidar data and model evaluation using this data is not well-developed compared to satellite measurements. We present an open source tool called the Automatic Lidar and Ceilometer Framework (ALCF) which implements common lidar processing steps such as resampling, noise removal, cloud detection, calculation of statistics, as well as model—observation intercomparison by bundling the COSP/ACTSIM lidar simulator and allowing it to produce "curtain" lidar pseudomeasurements from model output of various models (MERRA-2, AMPS, CMIP5) corresponding to ground-based and shipborne instruments (Vaisala CL31, CL51, Lufft CHM 15k, Sigma Space MiniMPL). These pseudo-measurements can be compared in an "apples to apples" comparison with observations. We hope this tool will enable ground-based lidars to be used more commonly for model evaluation and improvement efforts.

A comparative analysis of regulatory instruments for managing marine-based tourism in Arctic Canada and the Ross Sea

Daniela Liggett and Emma J. Stewart

Human activities, including tourism, in the Polar Regions are increasing and diversifying. The most common mode of transport in support of polar tourism is by cruise ship. At the same time, we are witnessing a rapid increase in the number of small vessels, such as yachts, exploring the Polar Regions. From a political and legal perspective, operating cruises to the Arctic and Antarctic is highly complex. In order to better understand whether the current regulatory mechanisms are sufficient for the rapidly changing nature of Polar marine tourism activities, this poster presents the results of a desk-based analysis of the regulatory landscape in two contrasting case studies. Our first case study focuses on Arctic Canada, where significant regulatory complexity currently represents significant barriers to entry for new tourism operators. The second case study we explore is marine tourism to the Ross Sea region, where a short season and the destinations remoteness limit the number of operators. Tourism here, and across the entire Antarctic region, is subject to high-level regulation under the Antarctic Treaty System as enacted by national jurisdictions. The

interplay of international regulation through, e.g., the IMOs Polar Code or UNCLOS, with national policies is the focus of our examination.

Coupling of WRF and a large eddy simulation model for atmospheric modelling

Dongqi Lin, Marwan Katurji and Laura Revell

Besides small-scale wind fluctuations simulated in Large-Eddy Simulation (LES) models, large-scale meteorological disturbances significantly characterise the highly variable and complex phenomena of atmospheric flows. A tool has been developed to couple large-scale dynamic forcing from the Weather Research and Forecasting (WRF) model to the Parallelized LES Model (PALM). This tool is directly applicable to any region of the globe for high-resolution LES studies. The ongoing WRF-PALM numerical evaluation shows good agreement between model outputs and the observations in case studies while further research is still required to investigate whether PALM has a better performance than WRF.

Beyond Visual Line of Sight operation of Unmanned Aerial Vehicles for Antarctic Sea Ice Data Collection

Campbell McDiarmid

Satellites in orbit can measure sea-ice extent and area. However, a lack of reference data means these satellite measurements alone cannot be used to distinguish between snow and sea-ice, which have vastly different physical properties. In recent years snow radar technology has been developed to measure the depth of snow resting on sea-ice in a non-intrusive manner. This project aims to improve the data collection process by equipping snow radars to Unmanned Aerial Vehicles (UAVs) operating Beyond the Visual Line of Sight (BVLOS). Accurate snow depth data requires measurements to be taken at very low altitudes (<10m). Therefore, in order to maintain reliable communications between the ground control station (GCS) and data collection UAVs at BVLOS distances (>10km), a high-altitude UAV acting as an airborne communications relay is utilised. A prototype network architecture and radio configuration has been developed and tested. Large scale field trials will commence in January 2020. Ultimately this project, combined with future iterations of the snow depth radar, will lead towards the mass collection of reference data for enabling future sea-ice research with satellite measurements.

Historians in the Digital Age Answer Complex Research Questions in a Fast-Changing World

Ursula Rack

The profile of a historian has changed in the digital age. Working together with many other disciplines to do their research answers complex historical questions for a better understanding of the future such as impacts of climate change.

However, historians still work in archives and libraries going back to original sources and extending their database. To get the most out of it, historians work increasingly with digital support. Especially climate scientists have recognised the contributions historians are able to provide, but it works also the other way around. Such a collaboration, as an example, benefits all involved researchers to advance knowledge.

The poster highlights former achievements and what it holds for the future.

Reframing Christchurch's Antarctic connections in the 21st century

Gabriela Roldan

As one of the five worldwide-recognized Antarctic gateways, Christchurch has a long and varied association with the White Continent. For the past century, the city leveraged on its British heritage and links with explorers of a bygone era. Yet, Christchurch's cultural identity and the current diversity of Antarctic stakeholders go beyond the colonial legacy. This poster presentation focuses on past and present Christchurch Antarctic connections, and suggests opportunities to re-examine its association with Antarctica.

What is APECS? A success story and the future of a volunteer organization for polar early career researchers

Gabriela Roldan and Rodrigo Gomez Fell

The Association of Polar Early Career Scientists (APECS) is the largest and most developed network of upcoming polar researchers with over a decade of experience, and growing strong. Born as one of the major legacies of the International Polar Year (IPY) 2007-09, APECS is a multidisciplinary and international organization that provides career development opportunities and a safe environment for early career researchers to share ideas and work collaboratively in a multidisciplinary setting. APECS has an international and culturally diverse community, with more than 7,000 members worldwide organized in National Committees. This paper will introduce APECS Oceania, the committee for Australia and New Zealand's polar early careers, and the opportunities to get involved in training sessions and education and outreach events within the polar international community.

The role of Weather, Water, Ice and Climate (WWIC) Information for Antarctic Tourism

Emma J. Stewart (Lincoln University), Daniela Liggett

The tourism sector in Antarctica has witnessed considerable growth and diversification over the last decade. To help facilitate safe travel in remote and dynamic polar environments more detailed and specialised weather, water, ice and climate (WWIC) information services are required. However, there is not a sufficiently detailed understanding of what such specialised polar environmental forecasting services should look like, to ensure that tourism operators receive timely and targeted information that can assist them in decision-making.

Given the paucity of research, this poster seeks to explore the following overarching question: What is known about the role of WWIC information in Antarctic tourism (i.e. how is WWIC information used, and what are the WWIC needs of the sector?) This poster is the result of an extensive literature review coupled with three years of collective brainstorming, focus-group discussions and a number of workshops involving researchers and representatives of the WWIC user community.

This research is part of the World Meteorological Organization (WMO) Polar Prediction Projects (PPP) Societal and Economic Research and Applications (PPP-SERA) working group. The primary goal of the PPP is to advance scientific knowledge such that society may benefit through improved services. The authors of this presentation are members of PPP-SERA.

Presentations

What and who is an Antarctic ambassador?

Karen Alexander (University of Tasmania)

The term 'Antarctic ambassadorship' is increasingly used to represent an individual's connection to Antarctica and their subsequent advocacy. However, there is little clarity regarding the concept. To address this, we combined a literature review with an expert elicitation workshop. We argue that i) the concept of Antarctic ambassador has been understood in myriad ways; ii) Antarctic ambassadors have a connection to, knowledge of and passion for Antarctica; iii) they also have a commitment to defending and advancing Antarctic values; and iv) Antarctic ambassadorship is about more than advocacy. We propose the first comprehensive definition of Antarctic ambassadorship. We hope this will provide a cornerstone upon which future research, and a more informed governance of Antarctic tourism, can be built.

Investigating ice shelf and sea ice interactions with field validated electromagnetic induction and satellite remote sensing techniques

Gemma M. Brett, Wolfgang Rack, Daniel F. Price, Christian Haas (York University, Canada; Alfred Wegener Institute, Germany), Pat J. Langhorne (University of Otago), A. Irvin (York University, Canada), and Greg H. Leonard (University of Otago)

Sea ice growth near an ice shelf is enhanced as the upper ocean is stabilised by ice shelf meltwater or by freezing of ice platelets formed within supercooled Ice Shelf Water into the sea ice base. Ice Shelf Water outflow can thus be inferred from anomalously thicker sea ice with an incorporated platelet ice fabric, and by the presence of an unconsolidated sub-ice platelet layer. Here, we assessed spatial and temporal variability in the distribution of ice shelf-influenced land-fast sea ice and the sub-ice platelet layer in McMurdo Sound using a combination of field-validated electromagnetic induction surveying and satellite remote sensing techniques. The variability observed indicated that a combination of the tides, wind-driven polynya-activity and the presence of multi-year ice influences the circulation of Ice Shelf Water and consequently the evolution of the sub-ice platelet over a range of timescales.

A New Reagent-free Battery-powered Remotely-deployable Water Quality Monitoring System

Deb Crittenden

We are currently developing a novel mechanical, spectroscopic and electrochemical water quality monitoring system that is designed to be remotely deployable; robust and

maintenance free. It will monitor turbidity, oxygen saturation, nitrate levels, temperature, and water flow rate, along with microbial and algal loads. The purpose of this talk is twofold: to provide an update on available functionalities (and progress towards the complete device), and obtain feedback on other features that may be desirable in the Antarctic context – or features that could be omitted to improve battery life and decrease costs and device complexity.

Land of the Foehn: Spatial and temporal characteristics of Foehn events in the Dry Valleys of Antarctica

Rajasweta Datta, Marwan Katurji, Peyman Zawar-Reza

Antarctica's complex topography and its interaction with the circumnavigating low-pressure weather systems over the Southern Ocean make Foehn a persistent feature of the boundary-layer climatology. The influence of the Foehn on boundary-layer warming has been demonstrated for the Antarctic Peninsula's mountain range where the descending warm and dry airflow sustains widespread surface snow melt, even in winter. Roughly 3800 km away, near the tip of Victoria Land, the influence of Foehn in localized warming has been studied with numerical weather models and will be the focus of field observations in the future. In the past two decades, the climatology of the boundary-layer of the McMurdo Dry Valleys (MDVs) has been under investigation since they are the largest permanently snow/ice free region in Antarctica and logistically easier to access. The MDVs are a series of glacially excavated valleys located between the Polar Plateau and the Ross Sea. In winter, persistent valley cold pools (VCPs) were common, lasting up to 2 weeks. The VCPs are typically eroded by strong Foehn which erodes the cold pool from aloft increasing the temperature of the valley by as much as 25 K in matter of minutes. It has been estimated that an increase of 1% in Foehn frequency can increase average winter temperatures by 1°C. There is also a significant spatial variation in the observed warming events, 14% increase for every 10 km up valley toward the ice sheet. In this study we characterise the spatial and temporal nature of the Foehn episodes in the MDV using the Land Surface Temperature (LST) parameter derived from the Moderate Resolution Imaging Spectroradiometer (MODIS) dataset from Terra and Aqua satellites. The steep rise in LST values over the region during Foehn events elucidate the spatially complex nature of the dynamic intrusion of gravity wave breaking in the MDV for episodes investigated, highlighting the utility of MODIS LST in augmenting the in situ and modelling studies for this phenomenon.

Past and Present: Can we use historical research to assess current Arctic trends and challenges?

Ron Doel (Florida State University)

What made it possible for researchers in the physical and biological environmental sciences to gain information about the current state of natural conditions in the Arctic? Were scientific research programs in the years since World War II a rational response to increased understanding of a vulnerable, fragile, and valued part of our planet? Or were other driving factors—including concerns over national sovereignty, determination to control economic resources in the far north, and military anxieties—more important in persuading leaders of nation-states to fund environmental sciences research in the Arctic during the second half of the twentieth century? Historical sources—including recently-declassified documents from the U.S. National Archives as well as the U.S. Central Intelligence Agency—suggest an answer to this vital question. This presentation takes a careful look at how we learned what we now know (including climate change in the far north) and what these insights tell us about assessing policy options in our own time.

Hillary's Hut VR Project

Francesca Eathorne (Antarctic Heritage Trust)

Antarctic Heritage Trust partnered with Auckland University of Technology (AUT) to create a ground breaking virtual reality experience of Sir Edmund Hillary's Antarctic hut.

Launching in early 2020, people will be invited to step inside Hillary's (TAE/IGY) Hut and to explore the first building at what is now New Zealand's Scott Base.

A fully immersive experience, which includes a guided tour through the hut, it celebrates New Zealand's first presence in Antarctica as part of the Trans- Antarctic Expedition and International Geophysical Year.

The Trust recently finished conservation on the hut and is pleased to be able to share this iconic piece of Antarctic history. Stories of Hillary's 23 man team and their mission to further science and exploration in the world's most extreme environment will feature within the experience and through accompanying material.

This presentation will share more about this exciting opportunity and how being at the cutting edge of new technologies, such as VR, can bring important heritage sites and their stories alive for the public.

The virtual reality experience will be freely available at selected institutions around New Zealand, as well as being available online.

Wind-driven sea-ice drift estimation from high-resolution satellite images in the Ross Sea, Antarctica

Usama Farooq, Wolfgang Rack, Adrian McDonald

Sea ice drift is forced by winds and ocean currents and is an essential element in the dynamics of the polar oceans. Sea ice extent, concentration, and thickness are heavily influenced by ice dynamics. Satellite observations of sea ice drift provide valuable information about the governing dynamical processes of sea ice and its role within the Antarctic climate system. This study used the high resolution satellite images to calculate the sea ice deformation fields of the Western Ross Sea. The Ross Sea region has experienced a significant increase in sea ice extent in recent decades. This region includes three main polynyas; McMurdo Sound (MSP), Terra Nova Bay (TNBP) and the Ross Ice Shelf Polynya (RISP). For this study, we used sequential high resolution Advanced Synthetic Aperture Radar (ASAR) images from the Envisat satellite. We downsampled the Wide Swath (WS) mode (swath width of 400km) images from 75 m pixel resolution to 150m. The drift velocity is calculated in centimeters per second using phase correlation techniques. The calculated displacement vector field was compared with the available low resolution sea ice motion vector standard product. Average motion vectors will be correlated with wind velocity, which is one of the main forces responsible for driving sea ice motion. We used Antarctic Mesoscale Prediction System (AMPS) wind velocity data set having spatial resolution of 5km. Here we present preliminary results of sea ice drift fields and wind velocity correlation.

Secret life of seals: Using Seal-mounted Cameras to Assess Behavioural Ecology of Lactating Female Weddell Seals in McMurdo Sound, Antarctica

Rose Foster

Weddell seals (*Leptonychotes weddellii*) are amongst the world's most well-studied marine species and now, through the use of seal-mounted cameras, researchers can get an in-depth view of their secret lives under the ice. Seal-mounted camera footage has been analysed using behavioural analysis software BORIS to identify behavioural differences between mothers of different experience levels, ages, and at different locations within McMurdo Sound. This research will identify whether there is a statistically significant difference in behaviours displayed by females who have more successful breeding history and those who are less successful breeders, in addition to general behavioural traits observed during this critical pup-rearing period.

Marine Protected Areas in the Southern Ocean: Reflections on an Evolving Web of Legal Mechanisms

Natasha Gardiner

Marine protected areas (MPAs) are a fundamental tool for effective marine conservation and areas beyond national jurisdiction prove the most challenging ocean spaces for their designation. Largely to blame is the current fragmented, sector-based overarching governance framework under the United Nations Convention on the Law of the Sea. In the face of rapidly deteriorating biodiversity, negotiations are now underway for a new global instrument mandated to promote the conservation and sustainable use of biodiversity beyond national jurisdiction using tools such as MPAs. The Southern Ocean is however a uniquely governed space, with a number of MPAs established in the high seas South of 60° to date, under the Antarctic Treaty System (ATS). The paper offers a critical analysis of the current state of operations for designating MPAs under the ATS and uses this to reflect on how the system might interact with the new ocean regime in the future. More specifically it draws on challenges currently facing the ATS such as conflicting geopolitical diversity among parties, fragmentation of its instruments and blurred definitions for terms central to conservation, to paint a picture for the future dialogue of two overlapping mechanisms. To help foster a complementary relationship, the paper concludes with a number of recommendations to aid Antarctic Treaty Parties in proactively and effectively engaging with progressions in international law.

Ice-Tongue stability in a changing world

Rodrigo Gomez Fell

In the extremely cold Antarctic climate some valley glaciers do not terminate at the coast but extend out to the sea by forming floating ice tongues. The Victoria Land Coast in the western Ross Sea has 34 outlet glaciers with a marine terminus and 32 of these have ice tongues, which is the highest proportion in Antarctica. As an ice tongue is a floating extension of the grounded glacier, and as such at the mercy of oceanic and atmospheric forcing, it is a perfect object to study environmental change. Although the climatic boundary conditions in this area are relatively well known, better information is needed to explore any climate related change.

David Glacier with Drygalski Ice Tongue extends impressively from the grounding line 120 km out to the sea, and at the terminus this ice tongue spreads 24 km across. To this end I used state-of-the-art satellite data to determine the critical processes which promote stability of Drygalski Ice Tongue. The methods I am developing here will then be applied to other ice tongues in the region. It is planned to complement the satellite study with field data and numerical model simulations. Here I present preliminary results based on the satellite remote sensing analysis from the first year of my PhD.

The Philosophy of Law and Geopolitics Interface in Antarctica¹

Alan D. Hemmings

An Antarctic bounded by the Antarctic Convergence is a gigantic area of ocean, continent and islands variously subjected to metropolitan legal codes, generic international law and international law elaborated at the Antarctic regional level by more than 50 states.² North of 60 degrees south, Coastal State jurisdiction is unimpeded; south of 60 degrees, unresolved territorial sovereignty and Antarctic Treaty constraints necessitate consensus decision-making beyond states' immediate jurisdiction over nationals. Unlike the Arctic,³ no issues of indigenous peoples' law arise; and notwithstanding the contemporary diversity of engaged states, given the formative period of Antarctica's international legal development the prevailing philosophy of law is Western (substantially Anglo) in orientation. The resulting normative framing of the Antarctic international legal regime is predicated on Antarctic exceptionalism, instrumentalisation of a purportedly politically neutral science, containment (without resolution) of both territorial contestation and (implicitly) the global order of the Post-War dispensation, restricted participation and activity, and (consequentially) minimalist regulatory development.

This situation has been challenged by various developments.⁴ Firstly, the technical enabling of resource exploitation required regulatory structures to adjudicate competing interests – entailing the development of the Antarctic Treaty System (ATS) and a slowly increasing cast of participants. Secondly with the transformations in the global order – including the ending of the Cold War, G77 and environmental challenges to ATS hegemony, the rise of new powers (most obviously China), and globalization.⁵ Thirdly with the multifarious and catastrophic effects and implications of anthropogenic climate change. And, finally, through the paradox of “success” – whereby the very longevity of the ATS sees it accumulate inconsistencies and increasingly divergent expectations and interpretations of purpose.

In the early 21st Century, the relationship between regional Antarctic and global law, institutions and norms is complex. Antarctic actors (whether states or other operators) pursue different legal goals, the foci and purposes of legal obligation are contested, and the historic dominance of Western conceptions of law is under challenge from emergent powers. So, *inter alia*, the historic focus of a few Western states on preserving their claims, or basis of claim, to Antarctic territory is challenged by doctrines of Common Heritage, or common interest,⁶ or skepticism on the part of post-colonial states that accidents of history have enduring validity. And, in a region where there may be fewer impediments to non-state entities conducting core activities than elsewhere

¹ Draws on Hemmings, 2020, 'Philosophy of Law in Antarctica' in Bunikowski & Hemmings, *Philosophies of Polar Law* (Routledge).

² Dodds & Hemmings, 2018, 'Arctic and Antarctic Regionalism' in Paasi et al *Handbook on the Geographies of Regions and Territories* (Edward Elgar).

³ Bunikowski, 2016, *Philosophy of Law in the Arctic* (UArctic)

⁴ Rothwell & Hemmings, 2018, 'Introduction: The Context of International Polar Law' in Rothwell & Hemmings *International Polar Law* (Elgar).

⁵ Hemmings, 2017, 'Antarctic politics in a transforming global geopolitics' in Dodds et al *Handbook on the Politics of Antarctica* (Elgar).

⁶ Wolfrum, 2017, 'Common interest and common heritage in Antarctica' in Dodds et al *Handbook on the Politics of Antarctica* (Elgar).

in a still largely Westphalian world order, there are profound and unresolved issues around whose rights and purposes do and should have standing in the Antarctic.⁷

History of Architecture in Antarctica through a biophilic lens

Katelyn Hudson (Bond University)

Architectural interventions in Antarctica started with the Huts of the Heroic Age of Exploration up to the Research Station today; they are an integral aspect of existence in the extreme environment. A design concept that builds upon the survival techniques utilised in early human structures is called biophilic design; fostering a connection with the natural environment for the benefit of the occupants. This research explores six cases that span the history of human occupation of the continent and are analysed based on the attributes of biophilic design to investigate how natural elements of Antarctica or the source country have evolved and been incorporated to support habitation.

Ross Sea Region Ecology in a Warming World: Terrestrial Hydro-climates

Marwan Katurji

The Ross Sea Region contains one of the most productive marine ecosystems in the Southern Ocean, encompassing open ocean, pack ice, and coastal habitats, including much of the world's largest marine protected area. On land, it harbours diverse terrestrial ecosystems ranging from iconic Antarctic lakes to ancient soils with high levels of unique biota. The goal of Project 3 of the Antarctic Science Platform is to determine how ecosystems within the Ross Sea Region may respond to environmental challenges associated with global climate change under the Paris Agreement scenario. The patterns and drivers of terrestrial biogeography in the RSR will be systematically synthesised and, combined with projected changes in habitat that accompany changes in meltwater generation, provide the basis of a process-inclusive biogeographical model capable of projecting RSR terrestrial ecosystem responses to a warming world. To project climate-driven changes in meltwater distribution across the RSR, we will develop surface meltwater generation and hydrological routing model simulations that incorporate dynamically and geo-statistically downscaled projections of regional climate in a warming world. This talk will introduce the terrestrial hydro-climate research component of the project that covers glacier systems, climate change modelling, and hydrometeorology.

⁷ Hemmings, 2012, 'Considerable values in Antarctica' in Liggett & Hemmings *Exploring Antarctic Values* (GA).

Toward a standardized monitoring program for ice-obligate predators in the Southern Ocean

Michelle LaRue

A monitoring plan for the Ross Sea MPA – and future protected areas in the Southern Ocean – is critically needed to evaluate success of the protected area. Distribution and abundance of indicator species is one of the four key elements of the CEMP, and the one that is most easily addressed by use of high-resolution satellite imagery (VHR). Here I will address the state of the science of using VHR to assess abundance and population change for ice-obligate predators in the Southern Ocean and discuss lessons learned and future plans.

30 Years of Korea's Antarctic Microbial Research

HongKum Lee (Korea-New Zealand Antarctic Cooperation Centre, Korea Polar Research Institute)

The Polar Regions are best place for understanding environmental changes on our planet and have plenty of living organisms waiting for unlock the secrets of adaptation and evolution. The inauguration of the Antarctic King Sejong Station in 1988 initiated national polar research program. The Arctic Dasan Station, the Antarctic Jang Bogo Station and the ice-breaking research vessel *ARAON* have been expanding the depth and breadth of the research on the Antarctic and the Arctic. It will be presented how we have been observing the biological changes and responses in the ecosystem. I will also introduce microorganisms showing unique biological phenomena, such as cold-active enzymes, antifreeze substances, natural antioxidants, etc., which can contribute to improvement of human well-being.

Impacts of Strong Surface Winds over the Ross Sea Polynya

Adrian McDonald

This study investigates the impacts of strong wind events on the sea ice concentration within the Ross Sea Polynya (RSP). In particular, this work quantifies the sensitivity of sea ice concentrations to surface winds and whether there are threshold wind speeds required for regions of the RSP to open up with subsequent impacts on heat fluxes. To analyse these processes, we examine the Bootstrap sea ice concentration (SIC) satellite data set derived from SSM/I brightness temperatures and how they are connected to the surface winds from the ERA5 reanalysis over the period 1979 to 2018. We also examine how strong wind events which impact SIC in the RSP are linked to Ross Ice Shelf Air Stream events. The hypothesis that the increase in Ross Ice Shelf Air Stream events, associated with a strengthening of the Amundsen Sea Low, has contributed to trends in sea ice production is then tested.

Combining satellite and ground based observations of cloud phase over the Southern Ocean

Cameron McErlich

A radiation bias exists in climate models such as the NZESM over the Southern Ocean, resulting in too much sunlight hitting the surface. Much of this bias can be attributed to the models incorrectly simulating cloud and their properties. This study has compared vertical profiles of cloud from both CloudSat and CALIPSO satellite data as well as ground based observations such as those taken during the 2016 AWARE field campaign over McMurdo station in Antarctica. The combination of space and ground based cloud measurements will be used to develop a picture of the complete vertical structure of cloud and its properties over the Southern Ocean. This will then be compared to NZESM model output to generate improvements to the model, specifically constraints on the formation of ice crystals and their shape.

Bedrock reconstruction from free surface data for unidirectional glacier flow with basal slip

Liz McGeorge

Glacier ice flow is shaped and defined by several properties, including the bedrock elevation profile and the basal slip distribution. The effect of these two basal properties can present in similar ways in the surface. For bedrock recovery this makes distinguishing between them an interesting and complex problem. The results of this study show that in some synthetic test cases it is indeed possible to distinguish and recover both bedrock elevation and basal slip given free surface elevation and free surface velocity. The unidirectional shallow ice approximation is used to compute steady state surface data for a number of synthetic cases with different bedrock profiles and basal slip distributions. A simple inversion method based on Newton's method is applied to the known surface data to return the bedrock profile and basal slip distribution. In each synthetic test case, the inversion was successful in recovering both the bedrock elevation profile and the basal slip distribution variables. These results imply that the steady state surface from the shallow ice approximation is not equifinal; there is a unique bedrock profile and basal slip which give rise to a unique combination of free surface velocity and free surface elevation.

Remote sensing of Southern Ocean phytoplankton blooms in a warming world

Shinae Montie

The Earth's oceans is inhabited by more than two million species represented by charismatic megafauna to microscopic unicellular algae. Unicellular algae are ubiquitous phototrophs of particular importance because they play an essential role in biogeochemical cycles which

mediate global climate, are at the base of food webs and fuel fisheries worldwide. Since 2006, it has been estimated that 60-90% of the increase in global ocean heat, associated with the burning of fossil fuels has occurred in the S.O. alone. Being unicellular, short-lived and fast growing, phytoplankton can respond rapidly to these changes in sea surface temperature. Concurrent with these long-term smaller increases in average temperatures, more dramatic increases in short term warming, that is marine heatwaves, are “very likely” (IPCC, 2019) to also be attributed to global warming. Little is known about how oceanic warming coupled with marine heatwaves will affect phytoplankton distribution and biomass in the S.O. This research aims to address this research gap by quantifying the effects of SST anomalies on chl-a concentration using satellite measurements of ocean colour and remote sensing applications.

The link between geophysics and earth observation - perspectives for polar remote sensing at UC

Wolfgang Rack

Snow accumulation and ice thickness are key variables in simulations of the cryosphere mass balance. We make use of field measurements to constrain the inversion of remotely sensed data to obtain these key variables over large and inaccessible areas. The availability of satellite data is rapidly improving, as is the technology for ground validation. In this presentation, I will highlight our significant successes over the recent past, as well as advocate a way forward for continued collaborations across colleges for the increased exploitation of satellite data.

In the Neighbourhood: Adélie Penguin Populations in the Ross Sea Region

Fiona Shanhun (Antarctica New Zealand), Kerry Barton (Barton Solutions), Phil Lyver (Manaaki Whenua Landcare Research), Rebecca Macneil (Antarctica New Zealand)

Adélie penguins (*Pygoscelis adeliae*) are an indicator species used to detect and monitor the effects of environmental change on Antarctic marine ecosystems. Since the early 1980s, New Zealand has conducted an annual census of Adélie penguins in the Ross Sea region, with data submitted to the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) Ecosystem Monitoring Programme (CEMP). The number of breeding pairs is determined through aerial photography of colonies, and subsequent image processing and penguin counting using semi-autonomous software. Changes in the number of breeding pairs can be considered in relation to environmental factors, allowing hypotheses about population responses due to natural versus anthropogenic changes to be tested.

The long record of Adélie penguin populations in the Ross Sea region provides opportunities for a range of collaborative research activities, such as assessing ecosystem resilience under changing environmental conditions, investigating the impacts of fishing and invasive species, and analyses of site-specific environmental relationships and species interactions.

Importantly, the data set also provides a baseline for research and monitoring associated with the Ross Sea region Marine Protected Area.

The New Zealand Antarctic Programme: What We Do and How You Can Contribute

Fiona Shanhun (Antarctica New Zealand)

New Zealand has been undertaking research in the Ross Sea region of Antarctica since the International Geophysical Year in 1957. Together with international partners, Antarctica New Zealand supports a collaborative, multidisciplinary science programme, underpinned by a unifying theme of global change. Researchers contribute to our collective understanding of Antarctic and Southern Ocean environments through a range of studies, from ice dynamics in a warming world, to biological resilience and adaptation to change, to Antarctica's connectivity with the rest of the world and future projections of change.

This presentation will provide an overview of Antarctica New Zealand's role, current research in Antarctica and the Southern Ocean, and the process for requesting Antarctic logistics support.

Exploring how musical compositions can reflect scientific, natural and historical phenomena as part of a broad picture of Antarctica

Patrick Shepherd

In 2004 I travelled to Antarctica as an artist educator with Antarctica NZ, returning in 2016/17 as a tutor with the PCAS programme. During that time, I have produced a substantial portfolio of original musical compositions, many of which relate directly to the science, natural environment and the history of Antarctica, furthering public understanding and providing a further lens through which to view the continent. In addition to presenting short musical extracts from several of my works (Cryosphere; Adeliesong; Fanfare for a Frozen Land and Pip the Penguin) I will also display two corresponding artworks (the acrylic paintings Cryosphere I & II) which are both visual representations of the orchestral score Cryosphere.

Fire and Ice - Looking for New Thermophilic Micro Organisms on Mt Erebus

Matthew Stott

In this presentation, I will discuss a Marsden-funded project to identify and cultivate new thermophilic bacteria and archaea from geothermal soils on Mt Erebus. Mt Erebus is the world's most southern active volcano and contains a globally-unique phonolite-based lava lake. Previous research has shown that the geothermally-heated soils on the flanks of Mt Erebus support unusual microbial communities with a number of bacterial and archaeal

species found nowhere else on Earth. Furthermore, metagenomic analysis of these communities have identified novel and possibly unique metabolic pathways employed to enable growth in Mt. Erebus's unusual geothermal setting. This presentation will show some historical data related to the microbial community diversity from Mt Erebus, plus the results from our first field season on Mt Erebus just completed (November 2019).

Maori Connections to Antarctica

Vincent van Uitregt (Massey University, Manaaki Whenua), Priscilla Wehi (Manaaki Whenua), Krushil Watene (Massey University)

Whales that migrate from Antarctic feeding grounds to more tropical calving grounds have linked the Antarctic landscape to southern hemisphere landscapes, people and cultures since time immemorial. For Polynesian voyagers those links were made more explicit with the exploration and discovery of Antarctica by Hui Te Rangiora around 650AD, and his naming the landscape Te-tai-uka-a-pia. For Māori of Aotearoa New Zealand those links have continued through subsequent voyaging, and participation in the heroic-age of Antarctic discovery and contemporary scientific programs. Our research aims to bring this narrative of the Māori relationship to Antarctica to prominence in Antarctic research circles and interrogate how Mātauranga Māori might be brought into and shape Aotearoa New Zealand's Antarctic science, policy and governance.

Antarctica and the Southern Ocean in South American imagination

Pablo Wainschenker

Analyses of English-language fiction have shown that Antarctica is often seen as a remote, oppositional and alien space. This type of representation works very well from a Northern Hemisphere and Anglocentric point of view. In fiction from South America, the image of Antarctica as an underworld, opposed to and cut off from the rest of the world seems to be contested. Rather than acting as a gateway to a different world, in Antarctic literary imaginings of Argentina and Chile the Southern Ocean connects landscapes with shared features. Although sometimes spatial continuity has been used in support of nationalistic rhetoric, at other times it is at the core of Spanish-language texts that naturalise Anglophone hegemony. This presentation looks at similarities and differences in the way that Antarctica is represented in English and Spanish fiction.

Satellite imagery and citizen science reveal the ecology of Crabeater seal distribution in the Weddell Sea

Mia Wege, Leo Salas (Point Blue Conservation Science), Michelle LaRue

Crabeater seals (*Lobodon carcinophaga*) are labelled as the most abundant seal species in the world. Native to Antarctica, with a circumpolar distribution, their population estimates range from 2-75 million (current best estimate = 8 million). Based on observations from shipboard and aerial surveys, crabeater seals prefer to live and breed on loose pack-ice – however, this potentially biases current knowledge about crabeater seal ecology given ship surveys are limited by sea ice conditions. Thus, much of the inaccessible and highly concentrated pack ice has been little explored for seal abundance. Here, we combine satellite images and citizen science to determine firstly the population size and density of crabeater seals in the Weddell Sea and secondly, to understand the abiotic factors that influence crabeater seal distribution. High-resolution satellite images covering an area of ~18,000 km² in the Weddell Sea (October 2018) were hosted on the crowd-sourcing platform Tomnod (DigitalGlobe). Citizen scientists marked maps where seals were present or absent, and experienced observers manually counted seals from the reduced number of images. About 2% of maps were open water, 60% were covered by extensive sea ice, and 17% of maps contained small or mixed ice floes. Crabeater seals were present on 71% of the mixed size ice floes at a density of 0.065 seals/km². Abiotic variables, such as ice concentration and floe size were used in habitat suitability models to understand seal abundance and distribution. Crabeater seals preferred small ice floes within the Marginal Ice Zone; the deep Weddell Sea with extensive year-round ice were almost devoid of seals. These new and comprehensive insights into the distribution and abundance of crabeater seals will provide a baseline to which future population estimates can be compared and allow us to predict how crabeater seals will respond changes in sea ice composition due to climate change.

Toward the Development of In Vitro Biofilm Model in Antarctica

Yilei Zhang

Biofilms are the most widely distributed and successful microbial lifestyle, which could also be found in cold environments, like Antarctic. Microbial activity on glacial surfaces could be linked to the biological darkening of cryoconite particles, affecting albedo and increased melt. However, the mechanisms of biofilm behaviours in Antarctic have been poorly investigated. Recently we developed a multi-channel microcalorimeter that can monitor heat genera/on during biofilmformation, which provides thermal signatures of biofilm behaviours in addition to morphological images. Furthermore, microfluidic chambers that could control the microenvironment of biofilms, such as oxygen availability, were also developed. Combination of the microcalorimeter array and microfluidic chamber would allow the development of an in vitro biofilm model to systematically study microenvironment effects on biofilm behaviours in Antarctica, such as biofilm formation on glacial surfaces, etc.