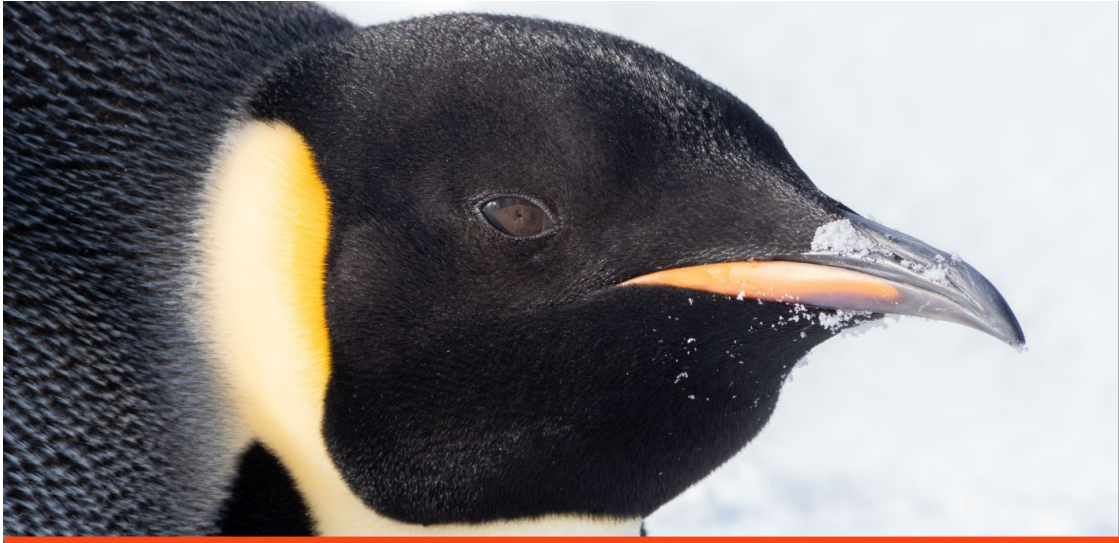

NEW ZEALAND - AUSTRALIA ANTARCTIC SCIENCE CONFERENCE 2023

25 - 28 JULY
THE MAJESTIC
ŌTAUTAHI CHRISTCHURCH

LATITUDES OF CHANGE

PROUDLY SUPPORTED BY:

GNS SCIENCE
TE PŪ AO

AUSTRALIAN ANTARCTIC PROGRAM

Antarctica New Zealand

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CONTENTS

FOREWORD

Tēnā Koutou, haere mai ki Ōtautahi. Antarctica New Zealand and the Australian Antarctic Division warmly welcomes you to the 2023 New Zealand - Australian Antarctic Science Conference, Latitudes of Change.

New Zealand and Australia are, in many ways, natural partners in Antarctic science. We both share long associations with the continent to our south and our geographic proximity to the Southern Ocean, sub Antarctic islands, and the Antarctic continent means we are both well placed to deliver globally significant science in the region. Our neighbouring interests in East Antarctica and the Ross Sea also provides some outstanding opportunities for scientific and operational collaboration. We understand that Antarctica holds the key to understanding many of the Earth's most pressing issues, most notably climate change. This New Zealand and Australia Antarctic Science Conference is an opportunity for us to workshop important issues around diversity, equity and inclusion, share knowledge on how the Antarctic ecosystem is changing, celebrate our scientific achievements and discover new opportunities to work together.

Prof. Nicole Webster
Chief Scientist
Australian Antarctic Division

Tena koutou katoa, Antarctica New Zealand is delighted to welcome you to the 2023 New Zealand - Australia Antarctic Science Conference, Latitudes of Change, here in Ōtautahi, Aotearoa.

Change is our unifying theme, and understanding that the rate, magnitude and impact of the change is not equal across Antarctica we use the geographic concept of latitude, both in Antarctica and between New Zealand and Australia to build our collective knowledge. I look forward to a productive week of presentations, posters, and robust discussions. This is also an opportunity to connect and build a deeper appreciation of our respective strengths, identify gaps, and explore opportunities to collaborate to address the big science questions in Antarctica for our World. On behalf of the team at Antarctica New Zealand and the whole conference organising team, we wish you an enjoyable and productive conference.

Prof. Jordy Hendrikx
Chief Scientific Advisor,
Antarctica New Zealand

CONFERENCE ORGANISATION

Conference Host

Antarctica New Zealand and Australian Antarctic Division

Conference Committee

Annalise Robertson (co-lead), Antarctica New Zealand

Jenevieve Peacock (co-lead), Antarctica New Zealand

Esme Robinson, Antarctica New Zealand

Bridget Rutherford, Antarctica New Zealand

Rhonda Bartley, Australian Antarctic Division

Damien Stringer, Australian Antarctic Division

Alanah Smith, Antarctica New Zealand

Digital Management

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Royal Society National Committee on Antarctic Sciences

LATITUDES OF CHANGE

Change is our unifying theme. However, we acknowledge that the rate, magnitude and impact of the change is not equal across Antarctica and therefore seek to explore these changes further, and also identify gaps in our understanding. Using the geographic concept of latitude, both in Antarctica and between New Zealand and Australia we were seeking abstracts that will strengthen our ties and improve our understanding about current and future change.

GENERAL INFORMATION

CONFERENCE VENUE

The conference is being held at the impressive Majestic on Durham street, **189 Durham Street South Central City**.

The Majestic Health and Safety polices apply to all those in attendance. Delegates are asked to follow any instructions provided by the venue / event staff. Smoking is not permitted inside the venue.

CODE OF CONDUCT

Our conference is dedicated to providing a harassment-free conference experience for everyone, regardless of gender, gender identity and expression, age, sexual orientation, disability, physical appearance, body size, race, ethnicity, religion, or technology choices.

We do not tolerate harassment of conference participants in any form.
We expect conference participants to:

- be considerate and respectful to all community members.
- refrain from demeaning, discriminatory, or harassing behaviour, materials, and speech.
- speak up if they observe anything at an event that conflicts with this Code of Conduct.

If you are being harassed, notice that someone else is being harassed, or have any other concerns, please contact Annalise Robertson or Jenevieve Peacock immediately (021 764 682). Do not report harassment via social media.

Conference participants whose behaviour is unacceptable may be sanctioned or expelled from the conference without a refund at the discretion of the conference organisers.

TAXIS / SHUTTLE

The airport is a 18 drive from the Majestic. A taxi fare to the city centre is approximately $50 one way, a shuttle bus $25 or airport bus $8.50.

Taxis

Blue Star taxis 0800 379 9799

Gold band taxis 03 379 5795

Corporate Cabs 03 379 5888

Shuttle

Super shuttle – 0800 748 885

REGISTRATION AND INFORMATION

The registration desk will be open throughout the conference. Name badges can be collected from here on arrival and should be worn at all times.

RECORDING OF SESSIONS

Sessions will be recorded by a professional videographer, at the consent of presenters. Recording of presentations by individuals is not permitted.

POSTERS

All posters will be on display Wednesday - Thursday in the poster room

WIFI

Will be given at the registration desk

EMERGENCY CONTACTS

Emergency: Dial 111
Medical Centre: 24 Hr Surgery, 401 Madras Street
Phone: (03) 365 7777

LOST & FOUND / MESSAGES

Please check the registration desk.

SUSTAINABILITY

Careful consideration has been given to reducing the environmental footprint of this conference. Key initiatives are focused on catering and waste. Delegates will notice that catering at the conference is vegetarian and vegan (and delicious!). Waste reduction and management has also been top of mind in the planning of the conference. Delegates are requested to assist in waste management initiatives by using the appropriate bins provided for waste and recyclables.

LIABILITY

In the event of any disruption or event leading to losses or added expenses being incurred in respect of the Conference, there shall be no liability attached to Antarctica New Zealand, Australian Antarctic Division, the Organising Committee, The Majestic or Composition Ltd. The programme is correct at time of printing; however, the Organising Committee reserves the right to amend any component as necessary.

SOCIAL FUNCTIONS

ICEBREAKER FUNCTION - POSTER SESSION

When: Wednesday 26 July
Where: The Majestic
Time: 17:30 - 19:30

Inclusions: Complimentary drinks and canapés

STUDENT AND EARLY CAREER RESEARCHER

An opportunity for researchers early in their career or new to Antarctic science a chance to chat, share stories, and meet with our key researchers and leaders in the Antarctic science community.

When: Tuesday 25 July
Where: Botanic on Oxford Terrace
Time: 18:00

CONFERENCE DINNER

The conference dinner is being held at the Christchurch Art Gallery | Te Puna o Waiwhetū on the corner Worcester Boulevard and Montreal Street.

When: Thursday 27 July
Where: Christchurch Art Gallery | Te Puna o Waiwhetū
Time: 18:30 - 22:00

ANTARCTICA AFTER DARK

Antarctica New Zealand supports world-leading scientists with their ground-breaking research, New Zealand's iconic Antarctic Heritage Trust, and the construction of a brand-new research facility in the highest, driest, windiest place on Earth!

'Antarctica After Dark' offers an opportunity to learn about Antarctica – kanohi ki kanohi - right from the researchers, conservators and Scott Base Redevelopment Project team.

Antarctica holds centuries of secrets frozen in its icy depths – secrets that New Zealand scientists are beginning to unravel. In this public event, nine presenters will inform and entertain in succinct, bite-sized talks. The two-hour experience will leave you in awe of the great southern continent.

Come and join us in the Antarctic gateway city, Ōtautahi Christchurch!

When: Friday 28 July
Where: The Majestic, 189 Durham st Sth
Time: 1900-2100
Cost: $5.62 per person. Buy yours here: https://bit.ly/antarcticaafterdark

Image: Al Chapman

WORKSHOPS

Tuesday 26 July

Indigenous voices

9:00am - 10:30am

This workshop explores Māori relationships with the Southern and Antarctic Oceans; followed by an interactive session on the importance and value of indigenous knowledge systems when paired with western science.

Gender Equity and Inclusion

11:00am - 12:30am

Through a combination of presentations, interactive discussions and engaging activities, this workshop aims to provide some valuable insights into harmful behaviours, biases and barriers that exist in our workplaces. With a focus on gender equity, the goal is to create a safe and inclusive space to foster meaningful dialogue, challenge norms and decide on how we can create a psychologically safe environment where everyone has an opportunity to thrive.

Technology and Innovation

Novel Technologies for Earth Observation and Marine Science

13:30 - 15:00

This exciting and informative event brings together innovation entrepreneurs and Antarctic scientists to explore the potential of cutting-edge technologies in the realm of contemporary observational science. Esteemed speakers such as Mark Rocket from Kea Aerospace, Kurt Jansen from Orbica, and Wolfgang Rack from Gateway Antarctica will provide valuable insights and expertise in the field. The primary objective of the workshop is to foster knowledge sharing, collaboration, and synergies, driving us toward a brighter and more sustainable future for Antarctic Science. The event will serve as a platform for fruitful discussions, encouraging participants to share their expertise and explore potential collaborative opportunities between the scientific community and technology innovators.

Early Career Researchers

15:30 - 17:00

This workshop is targeted at early career researchers (ECR's) and aims to dive into the interests, barriers and needs of Antarctic ECR's. It will focus on key themes highlighted by ECR's including funding, fieldwork, career pathways and the science-policy space. The workshop will begin with a panel discussion and Q&A, followed by round-table discussions in breakout groups. This session is being jointly run by the Association of Polar Early Career Scientists (APECS) Oceania and the conference team and encourages early career researchers from all areas of Antarctic research to attend.

PRESENTATION THEMES

Atmosphere,Weather and Climate

Abstracts will provide insights from observations of atmospheric, space weather and climate processes and highlight their value in detecting, monitoring and understanding environmental change.

Ice and Earth System Dynamics

Investigations of the ice and Earth system dynamics, and the impact of past, present and future changes.

Sea-Ice Interactions

Abstracts will investigate sea ice and ocean processes, interactions of the ocean with ice shelves and sea ice, as well as the influence of sea ice on a global climate system.

Ecosystems in a Changing World

Abstracts will characterise marine, aquatic and terrestrial ecosystems and assess the impacts of environmental change on diversity, function, and resilience.

Southern Ocean and the Marine Protected Area

Abstracts will provide insights from observations, and understanding, of the Southern Ocean voyages and the assessment of the effectiveness of the Ross Sea Marine Protected Area.

Human Connections and Impacts

Connections, interactions, and impacts of humans, including mātauranga Māori, remediation activities and connections between research and policy.

Data and Instrumentation

Abstracts will provide advances and investigation of data management and novel instrumentation.

Day 1 – Tuesday, 25 July 2023	
0800	**Registration Desk Opens** *(Tea and Coffee Service available)*
0900	**Indigenous Voices Workshop**
1030	*Morning Tea*
1100	**Gender Equity and Inclusion Workshop**
1230	*Lunch*
1330	**Technology and Innovation Workshop**
1500	*Afternoon Tea*
1530	**Early Career Researchers Workshop**
1700	*End*
1800	***Early Career Researcher Event*** *(Invitation Only – Botanic on Oxford Terrace)*

Day 2 – Wednesday, 26 July 2023	
0730	**Registration Desk Opens** *(Tea and Coffee Service available)*
0830	**Mihimihi *Whakatau*** *(Welcome)*
0930	**Keynote Speaker** *(Neil Gilbert - Board of Directors, Antarctica New Zealand)*
1000	**Keynote Speaker** *(Steven Chown - Biological Sciences, Monash University)*
1030	***Morning Tea***
1100	**Human Connections and Impacts I** *(Opening and Talks)* ***Session Chair - Tanya O'Neill University of Waikato***
1115	**Ceisha Poirot - Antarctica New Zealand** A New Zealand Antarctic Environmental Assessment: a staged approach
1130	**Tim Spedding – Australian Antarctic Division** A Cleaner Antarctica – Comprehensive Contaminated Site Assessments and Remediation design for Australia's Antarctic and sub-Antarctic stations
1145	**Madison Farrant – University of Waikato** The role of glacial meltwater streams in the transfer of contaminants from penguin colonies to the Southern Ocean
1200	**Bianca Sifiligoj, – Australian Antarctic Division** Environmental remediation and research addressing fuel spills and improved environmental protection at Casey Station, Antarctica
1215	**Natasha Gardiner – University of Canterbury** Stakeholder perspectives on science-policy knowledge exchange practices in the Antarctic context
1230	**Indi Hodgson-Johnston – Australian Centre for Excellence in Antarctic Science** Where does the science go? Tracing and understanding the uptake of scientific publications into policy-related forums
1245	***Lunch*** *Australian Antarctic Division (AAD) Lunch Session (1300 – 1330)*
1345	**Human Connections and Impacts II** ***Session Chair – Damien Stringer, Australian Antarctic Division***
1345	**Thomas Lord – Gateway Antarctica, University of Canterbury** Constructing Antarctic Security: An analysis of Antarctic security discourses
1400	**Hanne Nielsen – Institute for Marine and Antarctic Studies, UTAS** Perceptions of Citizen Science in the Antarctic
1415	**Elizabeth Leane – University of Tasmania** Public Awareness of Australia's Activities in Antarctica: Results from Recent National Surveys
1430	**Ursula Rack – University of Canterbury** Operation Deep Freeze I – how the USA used arts to create their narrative in the Antarctic
1445	**Holly Winton, Ayla Hoeta – Victoria University of Wellington** Maramataka ki te Tiri o Te Moana: What could a Maramataka of Antarctica look like?
1500	**Gabriela Roldan – Antarctic Heritage Trust** Step inside Sir Ed Hillary's Hut in Antarctica: bringing Antarctic cultural heritage to the public through Virtual Reality
1515	***Afternoon Tea***

Day 2 Continued – Wednesday, 26 July 2023	
1545	**Atmosphere, Weather and Climate** *(Opening and Talks)* ***Session Chair – Liz Keller - GNS***
1600	**Eva Bendix Nielsen – University of Canterbury** Extreme temperature events for the past 19 years in the Ross Sea Region, Antarctica
1615	**Yaowen Zheng – Antarctic Research Centre, Victoria University of Wellington** Statistically parameterizing and evaluating a positive degree-day model to estimate surface melt in Antarctica from 1979 to 2022
1630	**Tamara Pletzer – University of Otago** Simulating spatial variability in streamflow using a distributed hydrometeorological model in the McMurdo Dry Valleys
1645	**Jocelyn Turnbull – GNS Science** Latitudinal Distribution of Atmospheric Radiocarbon over the Southern Ocean
1700	**Philipp Sueltrop – Kea Aerospace** Observing Antarctica from the Stratosphere - Identifying Future Opportunities
1730	**Icebreaker – Poster Session Event** *(Majestic – Conference Venue)*
1930	*End*

Day 3 – Thursday, 27 July 2023	
0800	**Registration Desk Opens** *(Tea and Coffee Service available)*
0830	*Announcements*
0845	**Data and Instrumentation** *(Opening and Talks)* ***Session Chair – Aleks Terauds, Australian Antarctic Division***
0900	**Simon Cox – GNS Science** A continent-wide detailed geological map dataset of Antarctica
0915	**Johan Barthelemy – NVIDIA** Development of an AIoT platform for long term and near real-time monitoring of remote environments in Antarctica
0930	**Erik Behrens – NIWA** Tropical teleconnections through the Amundsen Sea Low impact Antarctic toothfish recruitment
0945	**Rob King – Australian Antarctic Division** RSV Nuyina's Wet Well Sampling System
1000	**Clive McMahon – Sydney Institute of Marine Science** Seals mapping the East Antarctic continental shelf
1015	**Anna MacDonald – Australian Antarctic Division** Best practice guidelines for eDNA biomonitoring in Australia and New Zealand
1030	**Stephen Craig Cary – University of Waikato** Hauwai 20: An autonomous biosampler for year-round, under-sea ice biological collection and physical measurements in the Antarctic
1045	***Morning Tea***
1115	**Ice and Earth Dynamics I** *(Opening and Talks)* ***Session Chair – Nancy Bertler, Antarctic Science Platform***
1130	**Tim Naish – Victoria University of Wellington** The Uncertain Future of Antarctica's Melting Ice: A New Research Initiative
1145	**Elizabeth Keller – GNS Science** Sensitivity of climate and ocean circulation to West Antarctic Ice Sheet extent in past interglacials
1200	**Tessa Vance – Australian Antarctic Program Partnership, Institute for Marine and Antarctic Studies, University of Tasmania** Implications of varied Pacific decadal variability over the last 2000 years to Australian and New Zealand climate risk
1215	**Daniel Lowry – GNS Science** What caused Late Holocene advance of the West Antarctic Ice Sheet at the Siple Coast?
1230	**Matt King – Australian Centre for Excellence in Antarctic Science (ACEAS), University of Tasmania** Climate variability as a major forcing of recent Antarctic ice-mass change
1245	***Lunch*** *Antarctic Science Platform (ASP) Lunch Session (1300 - 1330)*

Day 3 Continued – Thursday, 27 July 2023	
1345	**Ice and Earth Dynamics II** ***Session Chair – Gary Wilson, GNS***
1345	**Robert McKay – Victoria University of Wellington** West Antarctic Ice Sheet history from International Ocean Discovery Program (IODP) Expedition 374 geological drilling in the Ross Sea
1400	**Frank Mackenzie – Victoria University of Wellington** Modelled ocean and atmosphere feedbacks associated with the West Antarctic ice sheet during the last interglacial period
1415	**Kathryn Gunn – CSIRO Environment** Oceanic ridges impact the strength and location of deep ocean warming and sea level change
1430	**Matt Tankersley – Antarctic Research Centre** Addressing bathymetry uncertainty beneath the Ross Ice Shelf
1445	**Maren Elisabeth Richter – University of Otago** Interannual variability of fast-ice thickness in McMurdo Sound: drivers and trends
1500	**Ryan North – University of Wollongong** Magnitude and rate of ice loss from debuttressed glaciers on the Antarctic Peninsula since the pre-satellite era
1515	***Afternoon Tea***
1545	**Ice and Earth Dynamics III** ***Session Chair – Tim Naish, Victoria University of Wellington***
1545	**Gary Wilson – GNS Science** Permafrost degassing in Taylor Valley, Antarctica
1600	**Nancy Bertler – Antarctic Research Centre, Victoria University of Wellington and GNS Science** Early onset of the Antarctic Cold Reversal in the Ross Sea region – Potential Drivers and Implications
1615	**Shelley MacDonell – Lincoln University and University of Canterbury** Hydrological system controls on the Müller Ice Shelf, Antarctic Peninsula
1630	**David Prior – University of Otago** Kinematics and dynamics of the lateral shear margin of the Priestley Glacier: implications for understanding ice sheets
1645	**Andrew Gorman – University of Otago** Speeding up seismic reflection surveying of the seafloor below the Ross Ice Shelf with a towed streamer and surface detonations
1700	*Announcements*
1830	***Conference Dinner*** *(Ticketed Event)* ***Christchurch Art Gallery | Te Puna o Waiwhetū,*** *Corner Worcester Boulevard and Montreal Street*
2200	*End*

Day 4 – Friday, 28 July 2023	
0800	**Registration Desk Opens** *(Tea and Coffee Service available)*
0830	*Announcements*
0845	**Sea-Ice Interactions** *(Opening and Talks)* ***Session Chair – Tim Spedding Australian Antarctic Division***
0900	**Natalie Robinson – NIWA** An unprecedented season for sea ice: a view from the ocean
0915	**Julia Martin – Antarctic Research Centre, Victoria University of Wellington** The Influence of Snow on Antarctic Sea Ice Evolution: Drone-based Mapping of the Snow Surface Temperature
0930	**Wolfgang Rack – Gateway Antarctica, University of Canterbury** Sea ice thickness in the western Ross Sea and a vision for beyond
0945	**Alena Malyarenko – NIWA** The Terra Nova Bay Polynya activity in the new coupled modelPolar-SKRIPSv1
1000	**Fabien Montiel – University of Otago** Does the floe size distribution in the marginal ice zone follow a power law?
1015	**Denise Fernandez – NIWA** Heat and water mass distributions in the Ross Sea from observations and model simulations
1030	**Sarah Thompson – Australian Antarctic Program Partnership** The stability of the Denman Ice Shelf System
1045	***Morning Tea***
1115	**Ecosystems in a Changing World I** *(Opening and Talks)* ***Session Chair – Craig Cary University of Waikato***
1130	**Steven Chown – Monash University** Securing Antarctica's Environmental Future – Outcomes and Opportunities
1145	**Georgia Watson – Securing Antarctica's Environmental Future, University of Wollongong** ANTOS Biodiversity Monitoring: the need for standardised protocols for long-term monitoring across Antarctica, a case study from the moss beds of East Antarctica
1200	**Alexis Marshall – University of Waikato** Illuminating Ross Ice Shelf ecosystem connectivity through the lens of the benthic microbial communities
1215	**Gemma Collins – Manaaki Whenua Landcare Research** Biogeography and Genetic Diversity of Terrestrial Mites in the Ross Sea Region, Antarctica
1230	**Barbara Bollard – University of Wollongong** Reviving the Past: A Temporal Analysis of Moss Distribution in Antarctic Specially Protected Areas (ASPAs) through Historical Photographs and Modern Drone Imagery
1245	***Lunch*** *Scott Base Redevelopment (SBR) Lunch Session (1300 - 1330)*

Day 4 Continued – Friday, 28 July 2023	
1345	**Ecosystems in a Changing World II** ***Session Chair – Michelle La Rue University of Canterbury***
1345	**Jacqui Stuart – Cawthron Institute, Victoria University of Wellington** A glimpse into the future: Changing Sea Ice Environments and Microalgae Communities in McMurdo Sound, Antarctica.
1400	**Emilija Reuter – University of Canterbury** Foraging in a Changing Climate: Assessing the Energetic Viability of Adélie Penguin Prey Switching
1415	**Melanie Borup – Institute for Marine and Antarctic Studies** Effects of temperature on life history of several Antarctic terrestrial bdelloid rotifers and drivers of species distribution
1430	**Leonie Suter – Australian Antarctic Division** Using environmental DNA (eDNA) for monitoring in the Southern Ocean: understanding limitations and opportunities
1445	**Melinda Waterman – University of Wollongong** Moss cores as indicators of past Antarctic terrestrial microclimates
1500	***Afternoon Tea***
1530	**Southern Ocean and the Marine Protected Area** *(Opening and Talks)* ***Session Chair –Barb Hayden NIWA***
1545	**Brian Miller – Australian Antarctic Division** The Antarctic blues, marine mammals on MARs, and the rise of AI: lessons learned and future directions from nearly two decades of listening to the high-latitude Southern Ocean
1600	**Lynda Goldsworthy – Institute for Marine and Antarctic Studies, University of Tasmania** Conservation challenges for the Commission for the Conservation of Antarctic Marine Living Resources
1615	**Helen Macdonald – The National Institute of Water and Atmospheric Research, New Zealand** High-resolution physical-biogeochemical modelling in the Ross Sea
1630	**Sally Garrett – Defence Technology Agency, New Zealand Defence Force** Science data collection by the New Zealand Defence Force during the 2022 Antarctic Resupply Mission.
1645	**Lana Young – NIWA** Protecting the Ross Sea MPA: Science and Filmmaking Working Together
1700	***Announcements and Closing***
1715	*Conference End*
1900	***Antarctica After Dark*** *(Antarctica New Zealand Public Event – Majestic)*

KEYNOTE ADDRESS

PROFESSOR STEVEN CHOWN

The Science Society Needs from Antarctica

Our world is congested, contested and continually changing. Reliable knowledge that inspires, informs and sustains society is now more critical than ever. The Antarctic research community has a crucial role in this endeavour. Where should we focus our efforts? What messages should we convey from the resulting knowledge? How can we retain our reputation for reliability in the face of growing need for advocacy? Using recent evidence syntheses, new data, and experience from policy forums and civil society engagement these questions are addressed here, for further exploration over the course of the meeting.

Biography

Steven L. Chown is Professor of Biological Sciences at Monash University and Director of Securing Antarctica's Environmental Future, an Australian Research Council Special Research Initiative. His research concerns biodiversity variation through space and time, and the conservation implications of environmental change, including the means to mitigate and adapt to it. In the Antarctic, his research has covered many aspects of biodiversity variation and its conservation. Owing to his capability in the science-policy interface, for many years he has represented the international Scientific Committee on Antarctic Research (SCAR), of which he was also President (2016-2021), at the Antarctic Treaty Consultative Meetings, providing scientific advice on a broad range of environmental and science policy matters. Steven is a Fellow of the Australian Academy of Science, an International Honorary Member of the American Academy of Arts and Sciences, inaugural winner of the Tinker-Muse Prize for Science and Policy in Antarctica, and recipient of the French Republic's Medal of the 30th Anniversary of the Madrid Protocol.

KEYNOTE ADDRESS

DOCTOR NEIL GILBERT

Science and the Antarctic Treaty system: So Far, So Good

Scientific investigation and international cooperation toward that end are the bedrock of the Antarctic Treaty System. For more than sixty years a growing number of nations have invested in Antarctic research to support understanding of Earth systems as well as for reasons of international diplomacy. On the back of scientific advice the Antarctic Treaty System has evolved to provide a suite of agreements that prioritise conservation over resource use and place high value on research in the region. The Antarctic Treaty System has withstood the test of time and there is much to acknowledge in its past achievements. But new challenges both environmental and political now need to be actively addressed. Are our research and policy communities attuned to these challenges? Do we need to identify new approaches to ensure future success of the Antarctic Treaty System?

Biography

Dr Neil Gilbert has a strong interest in environmental monitoring and the science-policy nexus, aiming to maximise the utility of Antarctic research for environmental management and policy-making. Neil has worked in policy and management roles for central government in the UK and New Zealand and has spent many years developing and implementing environmental protection measures in Antarctica. Neil has represented both the UK and New Zealand at many international Antarctic fora and is a former Chair of the Antarctic Treaty System's Committee for Environmental Protection. He is a past editor of the Antarctic Environments Portal, now run by the Scientific Committee on Antarctic Research. Neil is a member of the Antarctica New Zealand Board of Directors.

HUMAN CONNECTIONS AND IMPACTS

Connections, interactions, and impacts of humans, including mātauranga Māori, remediation activities and connections between research and policy.

HUMAN CONNECTIONS AND IMPACTS

Session Chairs: Tanya O'Neill, University of Waikato
Damien Stringer, Australian Antarctic Division

ORAL PRESENTATIONS

A New Zealand Antarctic Environmental Assessment: a staged approach

Ceisha Poirot[1], Neil Gilbert[2], Ian Hawes[3], Clive Howard-Williams[4]

[1] Antarctica New Zealand, Christchurch, NZ, [2] Constantia Consulting, Christchurch, NZ , [3]Antarctic Science Platform, Tauranga, NZ, [4]NIWA, Christchurch, NZ

New Zealand has obligations under the Antarctic Treaty System to provide advice on the state of the Antarctic environment. Despite repeated calls over decades for systematic environmental reporting there has been slow progress. Antarctica New Zealand produces regular 'Initial Environmental Evaluations' (IEEs) covering operational activities, allowing some metrics of potential stressors to be developed. However, descriptions of environmental state are very brief, with no systematic, science-based focus and are potentially insufficient to be considered an environmental assessment. Antarctica New Zealand, in consultation with other policy and management stakeholders, is exploring how to develop a New Zealand Antarctic Environment Assessment (NZAEA) focused on our primary areas of interest. The purpose is to facilitate reporting and enhance understanding of environmental vulnerability and cumulative impact to improve planning. There are many challenges include the identification of core environmental indicators, and a current lack of funding for long-term targeted observational networks outside of the few existing programmes (e.g. penguin and seabird census, ozone concentrations, fisheries data). Furthermore, our activities in the Ross Sea region overlap those of other nations so a regional State of the Environment Report would not be possible without input from these partner nations. Consultation with policy and management stakeholders has recommended a start to discussions with our Ross Sea partner nations and through SCAR's Ant-ICON project, but to date, there has been no opportunity, until this conference, to introduce the concept of an NZAEA to the science community. We hope to generate feedback on the purpose, content, science needs and way forward.

A Cleaner Antarctica - Comprehensive Contaminated Site Assessments and Remediation design for Australia's Antarctic and sub-Antarctic stations

Tim Spedding[1], Catherine King[1], Kathryn East[1], Brown KE[1], Wasley J[1], Richardson J[1], Wilkins D[1], Scott S[1]

[1]*Australian Antarctic Division, Kingston, Tasmania, Australia*

Antarctic terrestrial and marine ecosystems are subject to human disturbance at local, regional and global scales. As human activity in Antarctica increases alongside a changing climate, so does the potential for environmental impacts. Contamination sources include legacy waste disposal sites, abandoned stations, fuel spills, incinerators, wastewater and globally transported pollutants. In 2022, the Australian Government committed to deliver the 'A Cleaner Antarctica' science program over 5-10 years. The aim of this program is to undertake comprehensive risk assessments of all Australia's contaminated sites across the Australian Antarctic Territory (AAT) to characterise contaminant sources associated with past and present operations and the impact of contaminants on biological communities, and develop management strategies to minimise environmental damage. Contaminant sources, concentrations, fate and transport, and ecotoxicological effects on biota and impacts on local biodiversity will be assessed using a range of established and innovative field screening tools and data capture technologies. This will lead to site-specific risk assessments enabling an informed and prioritised approach for development of a suite of mitigation and, where necessary, remediation solutions, tools and technologies captured in a comprehensive actionable Cleaner Antarctica Strategy. This presentation will provide an overview of contamination issues in Antarctica and describe the approach we are taking to deliver 'A Cleaner Antarctica' to support best practice environmental stewardship of the continent.

The role of glacial meltwater streams in the transfer of contaminants from penguin colonies to the Southern Ocean

Madison Farrant[1], Tanya O'Neill[1], Dorisel Torres[1]

[1]*University Of Waikato, Hamilton, New Zealand*

Heavy metals, such as arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), and lead (Pb), have been recorded in increasing levels in Antarctica. The biological transport of anthropogenically derived contaminants is often ignored, but in the Arctic, has been shown to dwarf the atmospheric flux of contaminants. This research evaluated the role of penguin colonies and seasonal melt-water streams in the redistribution of pollutants. Meltwater and soil samples were collected from penguin-influenced and uninfluenced streams at Cape Bird, Antarctica. Elemental analysis conducted through inductively coupled plasma mass spectrometry (ICP-MS) determined increased As, Cd, Cr, Cu, and zinc (Zn) ($P<0.05$) in Adélie colony soils. Preliminary water ICP-MS results showed elevated As, Cd, Cu, Cr, Pb, and Zn ($P<0.05$). This suggests that seasonal melt-streams through colonies play important roles in the redistribution of metal contaminants between the terrestrial and marine environments. Non-essential heavy metals measured in meltwater can be toxic, even in trace concentrations and therefore, may have potentially adverse toxicological impacts on local biota.

Increased concentrations of growth-limiting nutrients within the Southern Ocean, including phosphorous, silicon and iron, were found in penguin-influenced meltwater. This suggests a potential for a localised influence in primary production surrounding colony stream discharge sites. With predicted climate-change induced temperature increases in parts of Antarctica, the transfer of contaminants will also likely increase, therefore future research on this is recommended.

Environmental Remediation and Research addressing fuel spills and improved environmental protection at Casey Station, Antarctica

Bianca Sifiligoj[1], Rebecca McWatters[1], Belinda Ferrari[2], Damian Gore[3], Greg Hince[1], King Catherine[1], Lagerewskij Greg[1], Kathryn Mumford[4], Gwilym Price[1], Jeremy Richardson[1], Kerry Rowe[5], Alison Rutter[5], Geoff Stevens[4], Daniel Wilkins[1], Kasey Williams[1], Tim Spedding[1]

[1]Australian Antarctic Division, Kingston, Australia, [2]University of New South Wales, Sydney, Australia, [3]Macquarie University, Sydney, Australia, [4]University of Melbourne, Melbourne, Australia, [5]Queen's University, Kingston, Canada

As human activities in Antarctica continually increase, so too does the usage and storage of large quantities of fuel, which subsequently increases the potential for spill events. At Australia's Casey station there have been multiple legacy and contemporary fuel spill events that have posed significant human health and ecological risks. To address this, research has focused on developing and applying bioremediation techniques using native microbiology in the soil to aid fuel degradation. Such techniques include biopiling to optimise microbial degradation of fuel coupled with geosynthetic barrier research to contain fuel contaminated soil and leachate, preventing further environment impacts. This was the first time biopiles were used in Antarctica and over 10 years of research have led to a reduction in the treatment time from 5 to 2 years, to remediate soils to a point that they can be reused in managed applications on station. This program of research is a multidisciplinary and collaborative effort, involving Antarctic microbiologists to understand how native microbes can aid soil remediation; ecotoxicologists to establish safe remediation targets for safe soil and water reuse; engineers to develop and optimised techniques for fuel-contaminated water treatment including passive permeable reactive barriers and active ion exchange treatment; and water treatment including passive permeable reactive barriers and active ion exchange treatment; and environmental chemists to develop new analytical methods to better understand how fuel is degrading under Antarctic conditions. This presentation provides an overview of research and outcomes of the fuel-spill research at Casey station and discusses how research and learnings of this program can lead to improved environmental clean-up practices in cold-climate regions.

Stakeholder perspectives on science-policy knowledge exchange practices in the Antarctic context

Natasha Gardiner[1,2,] Neil Gilbert[1,2,3], Daniela Liggett[1]

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The states that actively participate in Antarctic governance are primarily responsible for ensuring that Antarctic research informs relevant policy and decision-making forums. Delivering this mandate requires research and policy actors to engage in multi-directional knowledge exchange (KE) practices that mobilize the use of scientific evidence and other types of knowledge in decision-making processes. To date, minimal scholarship has investigated the efficacy of Antarctic science-policy interactions, particularly in domestic settings. Consequently, opportunities to share empirical lessons across contexts remain limited. We contribute to this knowledge gap by undertaking a critical qualitative analysis that explores Antarctic stakeholder perspectives regarding the success of science-policy KE practices in New Zealand and in the context of the Antarctic Treaty System. Our central research question is: 'How does the Antarctic science-policy interface(s) function at national and international levels and what are the drivers and barriers for success?' We report on the findings from two workshops (convened in New Zealand) and 30 semi-structured interviews (convened online), involving the participation of over 100 Antarctic policymakers, environmental managers, researchers and other stakeholders. Our analysis identifies opportunities to improve Antarctic KE practices, such as increasing the diversity of KE, shifting from a linear KE arrangement towards co-production alternatives and strengthening strategic leadership. We highlight several epistemological, institutional and systemic barriers that currently hinder KE and demonstrate that 'success' conjures diverse imaginaries. By providing further clarity on complex KE practices, this study equips the Antarctic community with new knowledge that may help to enrich Antarctic KE practices in the future.

Where does the science go? Tracing and understanding the uptake of scientific publications into policy-related forums

Indi Hodgson-Johnston[1]

[1]Australian Centre For Excellence In Antarctic Science, Hobart, Australia, [2] Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Australia

This ongoing research seeks to understand how scientific research is taken up and used by Antarctic, ocean and climate-related policy forums such as the Antarctic Treaty Consultative Meetings, the Commission for the Conservation of Antarctic Marine Living Resources, the Intergovernmental Panel for Climate Change, the International Whaling Commission, and the International Union for Conservation of Nature. Hopefully, this research will assist in better streamlining and understanding the critical “science to policy” pathway. The research has begun with an analysis of 9000+ publications lodged with the Australian Antarctic Division’s publication database. These were traced through a newly created database of documents from international and (Australian) domestic forums to identify references to the publications in policy-relevant settings. This analysis resulted in over 10,000 ‘hits’. Following this initial data analysis, work is underway to truly understand how these scientific publications have been used in a policy and legal setting. This work will present the initial results of the research, including: preliminary observations about areas of successful thematic impact; areas where institutions might benefit from this method compared to traditional academic metrics (including beyond alt-metrics); and how the community might implement small changes to their publications and procedures to make identification of pathways to impact easier.

Constructing Antarctic Security: An analysis of Antarctic security discourses

Thomas Lord[1]

[1]Gateway Antarctica, University of Canterbury, New Zealand

The concept of ‘security’ has never been far from Antarctic geopolitics. While concerns about the national security of states active in the region were, arguably, at the heart of negotiations leading up to the signing of the Antarctic Treaty in 1959, our understanding of the meaning of security – and the means through which security can be achieved – has since expanded significantly. This presentation will consider how the concept of security has been used in relation to the Antarctic in English-language academic literature from 2008 to 2022. Five key security discourses will be outlined: national security, regime security, maritime security, environmental security and human security. Ultimately, this presentation will discuss the way in which the concept of security has been constructed in relation to the Antarctic, key themes, and tensions within the literature, and propose further research directions to help ensure the Antarctic remains forever a region of peace.

Perceptions of Citizen Science in the Antarctic

Hanne Nielsen[1,2], Elizabeth Leane[1], Anne Hardy[1], Can Seng Ooi[1], Carolyn Philpott[1], Katie Marx[1]

[1]University of Tasmania, Hobart, Australia, [2]Institute for Marine and Antarctic Studies, Hobart, Australia

Tourism is the most common way that humans interact with Antarctica and the Southern Ocean. Almost all leisured visitors travel with an operator, and guest experiences are framed by a suite of on board lectures and activities, and guided excursions. Tourism also increasingly offers a platform for scientific observations and interactive activities to take place. At the same time, it raises questions around how to ensure that these tourist activities do not become a form of science-washing. This presentation examines how interactive citizen science activities impact visitors' attitudes towards Antarctica, and how these activities could be designed to maximize positive change. Following an overview of the history of citizen science in the Antarctic, we present findings from a 2022/23 field season in the Antarctic Peninsula aboard the Hurtigruten vessel *MS Fridtjof Nansen* and Intrepid *Travel's Ocean Endeavour*. Research methods included interviews with guests and auto-ethnography as researchers participated in the activities on offer. Questions related to perceptions of Antarctica, motivations for travel, participation in science activities, and what guests had learnt during the expedition. Here we examine guest perceptions of citizen science in Antarctica and whether the science programs played a role in motivating travel choices and mediating the Antarctic environment for our interviewees. Education is key to the expedition experience. Our research suggests that greater scientific understanding of the region gained from travelling there also led some guests to question their travel choices, as environmental concerns came to the fore. It appears that while citizen science can augment the Antarctic tourist experience, it also elicits questions about human impacts on the environment more broadly.

Public Awareness of Australia's Activities in Antarctica: Results from Recent National Surveys

Elizabeth Leane[1], Hanne Nielsen[1], Bruce Tranter[1], Claire Konkes[1], Ms Linda Hunt[1]

[1]University of Tasmania, Hobart, Australia

With the Antarctic region featuring more and more in discourse around anthropogenic climate change, understanding public awareness of the region and human activities there is increasingly important. However, despite increasing scholarly interest in public knowledge, opinions and attitudes in relation to Antarctica, robust empirical data is limited and piecemeal.
This presentation reports the findings of two recent nationally representative surveys of public attitudes towards, support for and knowledge of Australia's activities in the Antarctic. The first (2021-22) examined public support for government-funded Antarctic scientific research in the national context of Australia. Key results reinforce earlier findings in other national contexts – for example, that older people and men are more likely to support Antarctic research than younger people and women. They also reveal new information, including a correlation between particular sources of media coverage and support for Antarctic research. We followed this research with a longer set of survey questions (2022-23) aimed at determining Australians' broader attitudes towards Australia's Antarctic activities as well as obtaining a baseline of citizens' general knowledge of the region. Our presentation will also give a preliminary report on these data, which are still in the process of collection. Our results suggest that, if Australians are to have informed opinions about their nations' involvement in the region to its south, evidence-based and carefully considered public engagement is required.

Operation Deep Freeze I – how the USA used arts to create their narrative in the Antarctic

Ursula Rack[1]

[1] Gateway Antarctica, School of Earth and Environment, University of Canterbury, Christchurch, Aotearoa/New Zealand

The role of the United Navy's Operation Deep Freeze (OPDF I) (1955 – 1956) was to support the United States of America's International Geophysical Year activities in Antarctica. The US has chosen Aotearoa/New Zealand as their gateway to the Antarctic. However, the commander, Rear-Admiral George Dufek, was adamant that art would be an integral aspect of the expedition, as it had been on other Antarctic expeditions, such as those of Admiral Byrd USN and Captain Cook, RN. One selected artist was Commander Standish Backus U.S.N. Reserve. He was a war painter in World War Two and returned to duty for OPDF I. Robert Charles Haun volunteered to go south. Even when he was not chosen from the beginning, he painted murals at the nearby U.S. Navy Seabees Construction Battalion base and, having demonstrated his artistic ability and agreeable personality, was also taken to Antarctica. The paper will present an insight in how that art provided the US with rich visual resources for scientific and cultural diplomacy, and to share with the broader public, along with images in National Geographic and short documentaries by Disney. The art conveys an expedition narrative imbued with ideological, geopolitical, and technological themes through a range of artistic expressions. This presentation is already a preparation for the upcoming events in 2025 to celebrate seventy years collaboration between the USA and in Aotearoa/New Zealand.

Maramataka ki te Tiri o Te Moana: What could a Maramataka of Antarctica look like?

Ayla Hoeta[1], Holly Winton[2]

[1]Te Waka Tuuhara - Elam School of Fine Arts and Design, University of Auckland, New Zealand, [2]Te Puna Pātiotio - Antarctic Research Centre, Victoria University of Wellington, New Zealand

Maramataka is an ancestral lunar environmental knowledge system that through environmental tohu (signs, observations or environmental indicators), and after thousands of years, continues to impart Mātauranga (knowledge) to tangata whenua, people of the land. Maramataka is the mauri (energy) flow between whenua, moana and rangi (land, ocean and sky), experienced through tirotiro (conscious sight), connection and atunement to place and the natural environment. Connecting tohu internally and externally serve as guidance to practises of kaitiakinga (protection) which is one of the key values driving Aotearoa New Zealand led research in Antarctica. Recent developments recognise the importance of enabling indigenous korero (stories) and perspectives such as Mātauranga Māori which can offer insights into the conservation of Antarctica. Here we use Hautu Waka, an ancient kaupapa Māori framework of weaving, wayfinding, tirotiro and atunenment to navigate complexities. We investigate key tohu of Antarctic moana, whenua and rangi to envision what a Maramataka of Antarctica could look like. Drawing on past and present knowledge of environmental calendars contained in Mātauranga Maaori and paleoclimate knowledge bases, field observations, interviews and whakataukii (proverb), we present a conceptual Maramataka of the southwestern Ross Sea region. Of particular interest are the tohu related to hukapapa and hukaapunga (snow and ice) which are encompassed in all three wahanga: moana, rangi, whenua. We acknowledge that mana of maatauranga Maramataka in Aotearoa developed over millennia and this conceptual Maramataka serves as the starting point of a journey to share Antarctica korero using Maaori methods and frameworks.

“Step inside Sir Ed Hillary’s Hut in Antarctica”: bringing Antarctic cultural heritage to the public through Virtual Reality.

Gabriela Roldan[1]

[1]Antarctic Heritage Trust, Christchurch, New Zealand

Antarctic Heritage Trust (AHT) is a New Zealand-based charity with a vision of inspiring explorers. Through its mission to conserve, share and encourage the spirit of exploration, AHT cares for the expedition bases of early explorers in the Ross Sea region, including Hillary’s Hut ‘A’ (HSM 73). This hut is Scott Base’s first building (1957) and the birthplace of New Zealand’s Antarctic science programme. As part of AHT’s strategy to bring Antarctica to the world, in 2020 the Trust launched the Hillary’s Hut -Antarctica Virtual Reality Experience touring it nationwide to schools and community venues. To date, thousands of people have participated in the VR experience. This paper discusses the use of VR to connect people with Antarctica and its cultural legacy, and the challenges and opportunities that immersive technologies present for public engagement with the Ice. It examines the use of VR as a complementary teaching tool in the classroom and in community venues where it can share information and spark conversations about Antarctica with the public, give minority groups access to immersive technology, provide new experiences for people with learning and physical disabilities, and improve seniors’ technology literacy, among others. Although VR technology has long been employed for entertainment, business, and training, this presentation argues that the implementation of immersive VR in educational and public outreach settings has so far been limited and that VR presents an untapped resource for furthering the understanding of Antarctica in the wider community.

Note, the numbers beside each poster abstract refer to their placement at the icebreaker event.

HUMAN CONNECTIONS AND IMPACTS POSTER PRESENTATIONS

1. ‘Conspicuous Rock? They’re all conspicuous…’ – a call to share your knowledge and stories for Antarctic place names

Christopher Stephens[1]

[1]Ngā Pou Taunaha O Aotearoa New Zealand Geographic Board, Wellington, New Zealand

Over the past few years New Zealand (and other Treaty signatory nations) have answered a call from Scientific Committee on Antarctic Research (SCAR)’s Standing Committee on Antarctic Geographic Information (SCAGI) to improve existing Antarctic place naming data in the Composite Gazetteer of Antarctica. In reviewing past decisions of Ngā Pou Taunaha o Aotearoa New Zealand Geographic Board, there are still gaps as to the origin or precise location for some place names. We’d also like to make sure what we have and the improvements we’ve made are in fact, correct. This poster invites the Antarctic science community to have a look at the New Zealand Gazetteer, share knowledge, and help build up the stories of New Zealand’s place names in the Ross Sea region. Some names that still have us stumped are highlighted.

2. Taking Antarctica to the World: The New Zealand Antarctic Society

Natalie Robinson[1,2], Rex Hendry[1], **Gabriela Roldan**[1,3], Peter Barrett[1,4], Hubertien Wichers[1,3]

[1]New Zealand Antarctic Society, New Zealand, [2]National Institute for Water and Atmospheric Research, Wellington, New Zealand, [3]Gateway Antarctica, School of Earth and Environment, University of Canterbury, New Zealand, [4]Antarctic Research Centre, Te Herenga Waka, New Zealand

The New Zealand Antarctic Society has, since 1933, been bringing people interested in the Antarctic and Southern Ocean together to share their knowledge; foster interest in the region; and promote the protection of the Antarctic environment. The society positions itself as an independent voice, advocating for the Antarctic at all levels. We have recently developed a new strategic plan, designed to maintain relevancy in a changing world. An important pillar of our new vision is diversity and representation – within both the society’s membership and our wider audience – and we are embarking on innovative methods to realise this goal. We invite anyone with an interest in the Antarctic to contribute to our aspirations.

Besides a traditional subscription-based membership, we have developed a range of opportunities for people to share experiences; strengthen our networks; and contribute to a growing range of services for members and the wider public. We are looking to interact directly with classrooms and national curricula. We own a collection of physical and digital assets which preserve New Zealand's connection with Antarctica. We maintain a range of platforms for sharing science, heritage, news from national Antarctic programmes, book reviews, and tributes. Such items are the foundation for 'Antarctic' – our twice-yearly magazine – but are also delivered across our social media channels, YouTube channel, branch events and national speaker series. Pursuing these exciting and expanding opportunities relies on people like you who are passionate about, and committed to, Antarctica and the Southern Ocean. So, join us now to make a difference!

3. Scott Base redevelopment, Antarctica: A volcanic hazard and impact assessment

Adam Martin[1], Magill Christina[1], Marwan Katurji[2], Josh Hayes[1], Ceisha Poirot[3], Rebecca Fitzgerald[1], Craig Miller[1], Tom Wilson[2], Sarah Inglis[1], Dongqi Lin[2], Graham Leonard[1]

[1]Gns Science, , New Zealand, [2]University of Canterbury, , New Zealand, [3]Antarctica New Zealand, , New Zealand

Scott Base is Aotearoa New Zealand's Antarctic station on Ross Island. A multi-faceted project to understand potential volcanic hazards and impacts to the base incorporated a volcanic hazard likelihood assessment, ash-fall modelling for Mount Erebus volcano, impact assessment and monitoring possibilities. Results helped support a resilient final design of the new base and associated infrastructure. Scott Base is 36 km to the south of Mount Erebus which presents an ash-fall hazard, conditional on the eruption size, style and wind characteristics. Probabilistic modelling using Tephra2 found that ash thicknesses exceeding 0.5 mm occurred at Scott Base and nearby McMurdo Station (USA) on average less than every 1000 years; a light dusting of ash (~0.1 mm) is expected on average every 100 years. Deterministic modelling using Ash3D demonstrated that a large eruption (VEI 5) may result in 0–24 mm of ash deposition at Scott Base, controlled by wind conditions at the time. Ash concentrations over Scott Base may rapidly rise and remain very high for several hours. Disruption of services and damage to facilities could occur under future ash-fall events, but the severity and likelihood will largely be controlled by the amount of ash-fall accumulation. Many possible impacts can be mitigated by ash-fall management plans that consider how operations will be managed under future ash-fall events.

The impact and hazard analyses provided insights into the utility of a monitoring system for Mount Erebus. Monitoring would consist of analysis and interpretation of one or more data streams to support risk management in the redevelopment of Scott Base, for field work on Mount Erebus and for air transport within, and to and from, Antarctica.

4. Articulating the Antarctic: Turning Science into Policy

Clare I. M. Adams

Ministry for Primary Industries and the Antarctic Science Platform

While there is much enthusiasm for evidence-based policy informed by science, the mechanism to share scientific outputs and tangible policy impacts can sometimes be unclear. There is often scope for scientific policy needs to be linked more effectively into scientific research proposals, where appropriate, and science outputs from less policy-targeted research are often highly relevant as science evidence needed to develop policy. The science-policy interface needs conversations that lead to tangible infrastructure linking key Antarctic stakeholders and science providers. The development and evaluation of Antarctica's marine protected areas (MPAs) and their research and monitoring plans (RMPs) are examples of where enhanced connectivity between policy makers and science programmes can amplify the impact of both. In this project between the Ministry of Primary Industries (MPI) and the Antarctic Science Platform (ASP) we use collaborative conversations with Antarctic scientists to identify where Antarctic research relevant to the Ross Sea region Marine Protected area is headed, where the critical gaps are in that research, and how science outcomes fit with and inform international policy. These conversations will help highlight research priorities for the Antarctic Science Platform, as well as potentially informing the New Zealand government how cutting-edge Antarctic science fits within current policy frameworks. From bridging this science-policy gap, we hope to strengthen New Zealand's position in Antarctic governance through science and support current Antarctic protections.

5.

The use of weather, water, ice and climate (WWIC) information in the Polar Regions: What is known after the decade-long Polar Prediction Project?

Victoria Heinrich[1], Emma Stewart[2], Daniela Liggett[3]

[1] School of Psychological Sciences, University of Tasmania, Hobart, Tasmania, Australia,
[2] Department of Tourism, Sport & Society, Lincoln University, Christchurch, New Zealand,
[3] Gateway Antarctica, University of Canterbury, Christchurch, New Zealand

In the face of climate change, increasing human activity, compounding risks and limited infrastructure and rescue capabilities, improving weather, water, ice and climate services in Antarctica is vital to people's safety, operational success, adaptation and environmental protection. As a part of the World Meteorological Organisation's Polar Prediction Project (PPP) Social and Economics Research Application (SERA) task-team we aim to facilitate communication and understanding of people's informational needs, barriers, decision contexts and provider user-connections to inform the development of relevant services, policy, and programmes. To understand the progress and gaps in research on polar weather information users during the PPP (2013 - 2023) a systematic search and synthesis of the peer-reviewed literature was conducted. A bibliometric analysis examined author networks, key words, geographic and regional differences. We observed an imbalance in disciplinary backgrounds, research topics and focus. Thematic analysis identified themes around activity context, human factors, personal observations, situational awareness, information needs, information sharing, and the provision of environmental predictions. Across weather parameters, spatial and temporal resolutions, accessibility, and utility there is a mismatch between user needs and the services provided. Findings may help improve weather services and training, guide research agendas, and inform our understanding of the evolution of research networks. However, less research was achieved in the Antarctic compared to the Arctic which may lead to greater vulnerability and risk in southern Polar Regions. There is a continuing need for salient weather services in Antarctica and lessons to be learnt from Arctic innovations, user engagement and best practice participatory approaches.

6. Creative Antarctica: Australian Artists and Writers in the Far South

Elizabeth Leane[1], **Adele Jackson**[1,2], Hanne Nielsen[1], Carolyn Philpott[1], Philip Samartzis[3], Sean Williams[4], Martin Walch[1], William Fox[5], Miranda Nieboer[1], Sachie Yasuda[6]

[1]University of Tasmania, Hobart, Australia, [2]University of Canterbury, Christchurch, New Zealand [3]RMIT, Melbourne, Australia. [4]Flinders University, Adelaide, Australia, [5]Centre for Art + Environment, Nevada Museum of Art, Reno, United States, [6]Australian Antarctic Division, Kingston, Australia

Works of art and literature can question our presumptions, engage our emotions, and inspire us to think innovatively about our relationship with the Antarctic region. Australia, a nation with close historical, geographical, and political connections to Antarctica, has a comparatively long history of supporting creative arts practitioners to experience the continent. However, to date there has been no large-scale critical or curatorial response to this history and no in-depth analysis of the best models for future efforts. The Australian Research Council funded project “Creative Antarctica” aims to use a combination of cultural analysis, curatorial response and qualitative interview-based research to produce the first comprehensive history and analysis of Australians’ creative responses to Antarctica across all forms of art. Here, we report on the project’s first stage, in which we have constructed a database of around ninety Australian creative artists and writers who have visited Antarctica for professional purposes, on over 150 separate residencies. We have also commenced conducting questionnaires and semi-structured interviews with as many of these artists and writers as possible to determine what factors contribute to a successful Antarctic residency. In this presentation, we will report on what we have learned from our database, analysing the group of Australian artists who have held Antarctic residencies in terms of art form, means of travel, location, and other factors. We will also outline some preliminary findings from our interviews-in-progress. We anticipate that our findings will have implications for the way in which future Antarctic arts residencies are selected, structured and promoted.

7. Where science meets policy: The Antarctic Clean-up Manual as a case study in protecting the Antarctic environment

Tim Spedding[1], Ewan McIvor[1], Catherine King[1]

[1] Australian Antarctic Division (AAD, Department of Agriculture, Water and Environment. Kingston, Tasmania, Australia

One of the key obligations of the 1991 Protocol on Environmental Protection to the Antarctic Treaty (Madrid Protocol) is the clean-up of “past and present waste disposal sites on land and abandoned work sites of Antarctic activities” unless clean-up would result in greater environmental impact. To assist Parties in addressing their clean-up obligations, in 2013 the Committee for Environmental Protection developed the Antarctic Clean-Up Manual. The Clean-Up manual provides scientifically proven guidance and practical resources that National Antarctic Programs can draw on to clean-up a range of contaminated sites in Antarctica. Recognizing the on-going nature of Antarctic contaminant risk assessment and remediation research, the manual is an evolving central resource, available online, and updated and added to as “new work, research and best practice emerges”. Input from the scientific community is therefore essential to the continuing development and improvement of the Clean-up manual. Here, we present jointly on the Clean-Up manual as a case study for the effective and ongoing integration of science into environmental policy for Antarctica, providing both a science and policy perspective. The current components of the manual are presented, along with a discussion on priority research needed to strengthen the manual into the future. Finally, we promote the Clean-up manual as a best practice tool for environmental managers and policy makers in order to support the effective and timely clean-up and remediation of sites across Antarctica, and the ongoing protection of the Antarctic environment.

8. International place naming in the Ross Sea region of Antarctica

Christopher Stephens[1]

[1]Ngā Pou Taunaha o Aotearoa New Zealand Geographic Board, Wellington, New Zealand

With the creation of the international Scientific Committee on Antarctic Research (SCAR) Composite Gazetteer of Antarctica in 1992, it was intended that guidelines for good place naming practice accompany it.

This was to help encourage some consistency between different nations and different languages who were naming places in Antarctica - and to ensure multiple names weren't being applied to the same features. While a guideline was drafted in 1994 by Germany, it was never ratified.
As a member of the Standing Committee on Antarctic Geographic Information (SCAGI) working group under SCAR, New Zealand has actively worked over the past several years as part of a renewed international effort to complete modern naming guidelines for use by Treaty signatory countries. The new guideline was submitted to SCAR and accepted as SCAR Report 41 International Principles and Procedures for Antarctic Place Names in October 2021. Christopher Stephens will provide an overview of how this new guideline encourages good naming practice in Antarctica in alignment with Antarctic Treaty objectives, and will touch on similar guidelines and practice for international naming of undersea features in the Southern Ocean.

9. Nitrogen cycle complications in diesel contaminated soil.

Kristopher Abdullah[1]

[1]UNSW, Sydney, Australia, [2]Environmental Stewardship Program, Australian Antarctic Division, Department of Climate Change, Energy, Environment and Water , Kingston, TAS, Australia

Petroleum hydrocarbons, particularly diesel, are significant anthropogenic pollutants within the Antarctic environment, causing a loss of microbial diversity due to ecotoxicity. While management practices around fuel use and disposal have improved, accidental spills still occur, and past so-called 'legacy spills' can persist in the terrestrial environment for decades. In 1999, 6000 L of diesel fuel from the main powerhouse of Casey station was spilled into the surrounding soils. Under the Antarctic treaty, Australia is legally and ethically motivated to remediate and restore this otherwise pristine site. Since 2005, bioremediation has been performed through the excavation of diesel-contaminated soil and the construction of biopiles, supplemented with urea to enrich native hydrocarbon- degrading bacteria. Despite the initial reduction in total available hydrocarbons, toxic nitrite has recently begun to accumulate. This has never been observed in bioremediation efforts and may result from observed disproportionate increases in bacteria that oxidise ammonium rather than nitrite. We need to determine which taxa and nitrogen cycling pathways are responsible for toxic nitrate accumulation so that Casey station can be remediated further, and future remediation projects can be better informed.

We paired RPKM and physicochemical analysis to investigate changes in nitrite and the relative abundance of functional markers between 2013 and 2018. When nitrite concentrations were greatest, nitrite oxidation markers (nirK and nirS) increased, whilst nitrification markers (e.g. AMO, HAO) remained relatively stable. We are resolving the discrepancy between the functional marker and taxonomic shifts. We will utilise metaproteomic analysis to reveal temporal changes in protein expression, yielding a deeper understanding of nitrogen cycling responses to nitrogen stimulation in the presence of hydrocarbon contamination. This will inform future remediation work and prevent future production of secondary contaminants during bioremediation.

10. Whole of Program Environmental Impact Minimisation - from impact assessments to monitoring at the Australian Antarctic Program

Andy Sharman, Melissa Wrohan, Kirsten Leggett, Tim Spedding
[1]*Australian Antarctic Division*

Australia is committed to the stewardship and protection of the Antarctic environment. Assessing the impacts of operational activities requires multiple lines of evidence, and decision maker's need synthesised, evidence- based information to do so. As such, through a commitment to continuous improvement, the Australian Antarctic Division is undertaking a rigorous environmental impact assessment process of existing, on-going operational activities (e.g. stations, field activities, transport, waste management) and has commenced design and implementation of a comprehensive environmental monitoring program that will improve our understanding of the potential and actual impacts associated with planned and future activities of the Australian Antarctic Program. This talk will provide a summary on the environmental assessment and monitoring plan process to date, and highlight specific examples related to increasing use of aerial vehicles, from large fixed wing cargo planes down to lightweight remotely piloted aircraft (drones), for program support and monitoring purposes. Preliminary results from noise monitoring trials of helicopters and remotely piloted aircraft will be discussed.

11. Remediation of fuel spill sites and development of site-specific environmental guidelines at sub- Antarctic Macquarie Island

Rebecca McWatters[1], **Bianca Sfiligoj[1],** Greg Hince[1], Catherine King[1], Jeremy Richardson[1], Jane Wasley[1],Daniel Wilkins[1], Tim Spedding[1]

[1]Australian Antarctic Division, Kingston, Tasmania, Australia

Various fuel spills have occurred at Macquarie Island's sub-Antarctic station and since 2003 the Australian Antarctic Division has undertaken a large program of site investigation and applied research to remediate fuel contaminated sites. A full scale in-situ air and nutrient sparging system operated at the station's fuel farm and main powerhouse contaminated sites for 9 years. Ecotoxicology research was contemporaneous and produced a large body of research around organism sensitivity to hydrocarbons. Comprehensive site-specific toxicity testing was developed to evaluate the ecological impacts of hydrocarbon contamination on a range of species, both in terrestrial and marine habitats. To ensure effective restoration and environmental protection of fuel spill sites on Macquarie Island that have undergone remediation, the Australian Antarctic Division has developed site-specific Environmental Quality Guidelines and Remediation Targets. Contemporary best practice ecotoxicological and statistical modelling methods, following Australia/New Zealand Water Quality Guidelines and the National Environmental Protection Measure were used. This body of work includes compilation of more than a decade of ecotoxicology research that has produced a comprehensive suite of toxicity tests for a representative range of native biota, including invertebrates, plants and soil microbes. These site-specific remediation targets for Macquarie Island directly inform site management and may be suitable for the broader sub-Antarctic region. This presentation will discuss the outcomes and challenges of conducting large scale remediation and ecotoxicological investigations in sub-Antarctic climates.

12. Contamination of the marine environment by Antarctic research stations: monitoring marine pollution at Casey station from 1997 to 2015

Jonathan S Stark, Glenn Johnstone, Cath King, Tania Raymond, Scott Stark

[1]Australian Antarctic Division

The majority of Antarctic research stations are situated in coastal areas, yet the extent and nature of contamination in adjacent marine environments has not been well documented. We examined pollution of marine sediments around Casey Station, a typically sized station on the coast in east Antarctica. Concentrations of metals, hydrocarbons, PBDEs, PCBs and nutrients were measured at disturbed locations including adjacent to

the wastewater outfall, former waste disposal sites, the Casey Wharf, and at multiple control locations. We examined spatial and temporal variation in sediment properties (grain size, organic matter) and contaminants. Monitoring between 1997 and 2015 shows that there is considerable pollution of the marine environment, and contaminant concentrations are increasing in some areas. There were very clear patterns of differences in contamination profiles among locations, with the disturbed locations having consistently higher concentrations of most contaminants and also nutrients in some cases, despite sometimes very large variation within locations. Some contaminants exceeded a range of internationally used sediment quality guideline values, including metals, hydrocarbons and PCBs. We demonstrate that Antarctic research stations such as Casey, are likely to pose a significant contamination risk to local marine ecosystems, although restricted to areas close to stations. Such contamination is likely to increase in extent and concentration over time.

ATMOSPHERE, WEATHER AND CLIMATE

Insights from observations of atmospheric, space weather and climate processes and highlights of their value in detecting, monitoring and understanding environmental change.

ATMOSPHERE, WEATHER AND CLIMATE

Chair: Liz Keller, GNS

ORAL PRESENTATIONS

Extreme temperature events for the past 19 years in the Ross Sea Region, Antarctica

Eva Bendix Nielsen[1], Marwan Katurji[1], Peyman Zawar-Reza[1]

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Mesoscale climate processes in Antarctica resulting in local variations and extreme air temperatures sustained for multiple days, impacting biodiversity by adverse influence on the glaciological and hydrological processes. Foehn induced warming events identified in the Ross Sea Region such as the Ross Ice Shelf near Simple Coast have in previous studies been associated with large melt events. A newly developed daily mean near surface air temperature dataset, AntAir ICE, with a spatial grid resolution of 1 km2, is capable of capturing mesoscale temperature variabilities. AntAir ICE is available for the period 2003-2021 over terrestrial Antarctica and the surrounding ice shelves. We use AntAir ICE to identify extreme temperature events with above freezing temperatures for more than 3 days during the austral summer seasons between 2003-2021 in the Ross Sea Region. The extent of melt identified from passive microware radiometer data during these extreme events is detected along with the synoptic pressure patterns. This study aims at capturing the mesoscale meteorological and climatological variability for multiple austral summer seasons within the Ross Sea Region and linking these extreme warming events to larger scale circulation patterns.

Statistically parameterizing and evaluating a positive degree-day model to estimate surface melt in Antarctica from 1979 to 2022

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Surface melting is one of the primary drivers of ice shelf collapse in Antarctica. Surface melting is expected to increase in the future as the global climate continues to warm, because there is a statistically significant positive relationship between air temperature and melting. Enhanced surface melt will impact the mass balance of the Antarctic Ice Sheet (AIS) and, through dynamic feedbacks, induce changes in global mean sea level (GMSL). However, current understanding of surface melt in Antarctica remains limited in terms of the uncertainties and driving processes, in past, present and future contexts. Here, we construct a novel grid cell-level positive degree-day (PDD) model, force it only with 2-m air temperature reanalysis data, and parameterize it spatially by minimizing the error with respect to satellite estimates and SEB model outputs on each computing cell over the period 1979 to 2022. We evaluate the PDD model by performing a goodness-of-fit test and cross-validation. We assess the accuracy of our parameterization method, based on the performance of the PDD model when considering all computing cells as a whole, independently of the time window chosen for parameterization. We conduct sensitivity experiments by adding +-10% to the training data (satellite estimates and SEB model outputs) used for PDD parameterization. We find that the PDD estimates change analogously to the variations in the training data with steady statistically significant correlations, suggesting the applicability of the PDD model to warmer and colder climate scenarios. Within the limitations discussed, we suggest that an appropriately parameterized PDD model can be a valuable tool for exploring Antarctic surface melt beyond the satellite era.

Simulating spatial variability in streamflow using a distributed hydrometeorological model in the McMurdo Dry Valleys

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The McMurdo Dry Valleys (MDV) is a polar desert. This region is characterized by ice-free valleys of bare ground, with a series of piedmont glaciers spilling in from the surrounding mountain ranges. Glacial melt results in a system of streams that terminate in perennially ice-covered lakes that lie in the basins of the valleys. The MDV is home to an ecosystem of cyanobacteria. This ecosystem is linked to freshwater availability, which is almost entirely from glacial melt. Previously, we adapted a hydro-meteorological model to successfully simulate the generation of melt at a single point on a glacier. Here, we extend this work by aiming to utilize a fully distributed hydrometeorological modelling system to simulate spatial variability in streamflow in Taylor and Wright valleys. This is done by applying the WRF-Hydro/Glacier model forced by atmospheric model data and assessing the ability of the model to simulate spatially distributed conditions for melt and the routing of meltwater using soil sensors, stream gauges and automatic weather station data. The spatially distributed validation of this model enables future work to answer questions around the impact of atmospheric forcing on meltwater routing and can inform futures changes in the spatial distribution of the ecosystem.

Latitudinal Distribution of Atmospheric Radiocarbon over the Southern Ocean

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The Southern Ocean is a key sink for anthropogenic carbon dioxide (CO_2), yet the processes that govern the rate of uptake remain only partly understood. We use observations of $\Delta^{14}C$ in CO2 from shipboard transects across the Southern Ocean to develop latitudinal gradients of $\Delta^{14}C$ in the surface atmosphere. We present five years of austral summer observations (2016-2020) from ships of opportunity travelling between New Zealand and the Ross Sea, Antarctica, along with long-term measurements from Baring Head, New Zealand and Arrival Heights, Antarctica. We observe lower $^{\Delta 14}C$ in the 50°S to 70°S region, with higher values to the north and south, consistent with upwelling of 14C-depleted deep waters in this region. We then combine model ocean simluations of CO_2 and ^{14}C with simulations from the NAME III atmospheric dispersion model to predict surface atmosphere $\Delta^{14}C$ and compare with the observations. Our model simulation does a reasonable job of matching the observations, capturing the spatial pattern and day-to-day variability quite well. However, the model underestimates the magnitude of the observed $\Delta^{14}C$ gradient, particularly between 50°S-60°S. The model-observation mismatch provides insights into our current understanding of Southern Ocean wind strength and deep water upwelling, and implications for the past the future strength of the Southern Ocean carbon sink.

Observing Antarctica from the Stratosphere - Identifying Future Opportunities

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The remoteness and size of Antarctica makes it a very difficult place to monitor. Satellites have played a critical role in transforming our knowledge of the frozen continent and adjacent seas, yet critical knowledge gaps remain. We present a tool that will assist in filling those data gaps across a range of scientific disciplines. The Kea Atmos is a high altitude platform system (HAPS) that operates in the stratosphere for long endurance earth observation campaigns. The fixed-wing aircraft is solar powered making its use over Antarctica in summer an attractive application. The aircraft will be capable of housing payloads in the order of 5 kg. We initially envisage RGB camera system deployment with an aspiration for optical multispectral (0.15 m) and synthetic aperture radar (0.25 m) capabilities. The flexibility of adjustable flight routes over fixed satellite orbits will allow unprecedented dwell times and revisit periods over areas of interest; this ability is of particular interest for investigating processes that happen quickly, or that require both high temporal and spatial resolution. Examples include polynya processes, pack ice deformation, iceberg calving and drift, grounding zone investigation, snow morphology, and penguin and marine mammal monitoring. We present expected aircraft capability and performance information to foster discussion about the scope of future Antarctic observation opportunities from the stratosphere. An inaugural Antarctic mission, launching from and returning to Christchurch is planned for summer 2025.

13.

Australian Antarctic Atmospheric Research: Current & Future Directions

Simon Alexander[1], Damian Murphy[1], John French[1], Petra Heil[1]
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The southern high latitudes play a key role in influencing, and in turn being influenced by, Southern Hemisphere climate. Recent years have seen a step-change in the quantity of surface-based atmospheric remote-sensing data collection in the Antarctic and Southern Ocean. For one, the identification of consistent short-wave radiation biases in climate models across the Southern Ocean has driven dedicated measurements from aircraft, ships, and land-based sites in order to increase our understanding of cloud, radiation, precipitation and aerosol properties. Studies of small-scale waves and their parameterization are an additional focus. Improved observations will contribute to reduce biases in climate model through model evaluation, validation and improvements of numerical parameterization. Here we will present highlights of the Australian contributions to this research. Looking forwards, the complex interactions between the atmosphere and other components of the Earth system require strengthened interdisciplinary research. For example, the biological gas production through aerosol and cloud production, will require the collection of key datasets on multi-disciplinary marine-science voyages, especially within the sea-ice zone, and in areas of high biological productivity, as well as extended observation systems at key land-based sites and opportunities for integration of palaeoatmospheric and palaeoclimate records. We will describe upcoming East Antarctic ship-based campaigns from an atmospheric goals perspective, and also detail our close links to sea-ice and land-based ice research through precipitation studies. We will describe our enduring international links with atmospheric scientists globally in order to advance understanding of the whole atmospheric column in areas of high strategic importance for Australia, and describe how we plan to strengthen and increase these collaborations in the future, including via multi-lateral initiatives or within international frameworks (i.e., WMO's Antarctic Regional Climate Centre).

14. Representation of mesocyclones in P-SKRIPS, the air-ocean-sea ice numerical model for the Ross Sea

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Mesocyclones, or Polar Lows, are under-studied features in the Ross Sea Regions (RSR), yet they can locally impact precipitation, flying conditions and the state of sea ice. Over the RSR, mesocyclones typically form from the conjunction of a cold continental flow off the coast of Adelie Land meeting a northern, warmer flow. It is also thought that the intensity and longevity of such mesocyclones is highly dependent on the surface conditions (and therefore sea ice cover), highlighting the impact of ocean, sea ice and atmosphere interactions in the sustenance of the mesocyclones. We present here P-SKRIPS, a new, coupled model setup that is physically consistent in the representation of ocean/atmosphere/sea ice interactions for polar climates (Malyarenko et al, 2022). Our coupled model is the first that includes a full conservation of heat and mass fluxes transferred between the climate (PWRF) and sea ice-ocean (MITgcm) models. It also allows us to examine in detail open water, sea ice cover, and ice sheet interfaces and the processes that span between models in the RSR. We have identified a mesocyclone event on the 6th to 8th of January 2014, visible in several regional climate models and reanalyses. The mesocyclone starts spinning off the coast of Victoria Land and moves eastwards over the open ocean, and loses intensity and disappears after two days, once it gets to the sea ice edge. We have run a series of sensitivity studies affecting the orography, the sea ice cover and the ocean-atmosphere interactions. The results indicate that the development and path of the mesocyclones, as well as the distribution of precipitation locally, depend on surface conditions and the sea ice cover.

15. Forty years of stratospheric trace gas measurements at Arrival Heights, Ross Island, Antarctica

Dan Smale[1]

[1] NIWA, Lauder, New Zealand

Over a 40-year period, NIWA's long term middle atmosphere trace gas research programme at Arrival Heights has made a substantial contribution to our present understanding of Antarctic ozone depletion. Starting in 1982 with the installation of a prototype UV/Vis spectrometer to measure stratospheric nitrogen dioxide, the work now involves a multitude of remote-sensing instruments located in a purpose-built atmospheric laboratory measuring a range of ozone depleting and greenhouse gases. For the first time, in 2022, balloon-based ozone, aerosol and water vapour sondes were launched from Scott Base. Cooperation with international colleagues has been a feature of the work and a highlight for the researchers involved.

Arrival Heights is a founding site of the Network for the Detection of Atmospheric Composition Change (NDACC) and a ground-truthing station for satellite validation activities. It is also a certified Global Atmosphere Watch (GAW) and GCOS Reference Upper atmosphere Network (GRUAN) station.

16. Opportunistic observations of Erebus volcanic plume composition by high resolution solar occultation mid infra-red spectroscopy

Dan Smale[1], Jim Hannigan[2], Sanil Lad[3], Mark Murphy[3], Jamie McGaw[3], John Robinson[1]

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Twice a year, in the first weeks of April and September, the sun skims the summit of Mount Erebus. Under clear conditions, using spectrometers at Arrival Heights, direct mid infra-red solar spectra absorption occultation measurements through the volcanic plume can be taken. Such opportunistic measurements allow us to quantify plume composition. We found that the incumbent spectral analysis procedure used to investigate stratospheric composition (the focus on ozone hole chemistry) could be adapted to explicitly measure plume concentrations. Applying this adapted technique, we calculated hydrogen chloride (HCl), hydrogen fluoride (HF) and sulphur dioxide (SO_2) plume concentrations. We found the calculated mass mixing ratios in accordance with prior campaign based in situ measurements. The mean mass ratios are consistent over time indicating long term stability of Erebus volcanic processes and composition. Other plume trace gases (such as CO_2, OCS, CO, H_2O and accompanying isotopes) will be analysed later.

17. Source mechanisms and transport patterns of tropospheric bromine monoxide: findings from longterm multi-axis differential optical absorption spectroscopy measurements at two Antarctic stations

Udo Frieß[1], Karin Kreher[2], Richard Querel[3], Holger Schmithüsen[4], **Dan Smale[1],** Rolf Weller[4], Ulrich Platt[1]

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The presence of reactive bromine in polar regions is a widespread phenomenon that plays an important role in the photochemistry of the Arctic and Antarctic lower troposphere. The chemical mechanisms leading to the heterogeneous release of gaseous bromine compounds from saline surfaces are in principle well understood. There are, however, substantial uncertainties about the contribution of different potential sources to the release of reactive bromine, as well as about its temporal variation and the vertical. Here we use continuous long-term measurements of the vertical distribution of bromine monoxide (BrO) and aerosols at the two Antarctic sites Neumayer (NM) and Arrival Heights (AH), covering the periods of 2003 - 2021 and 2012 - 2021, respectively, to investigate how chemical and physical parameters affect the abundance of BrO. A source-receptor analysis based on back trajectories together with sea ice maps shows that main source regions for BrO at NM is the Weddell Sea and the Filchner-Ronne Ice Shelf, as well as coastal polynyas where sea ice is newly formed. A strong morning peak in BrO frequently occurring during summer, and particular during autumn, suggests a night-time built up of Br_2 by heterogeneous reaction of ozone on the saline snowpack in the vicinity of the measurement sites. We furthermore show that BrO can be sustained for at least three days while travelling across the Antarctic continent in the absence of any saline surfaces that could serve as a source for reactive bromine.

18. A new microwave instrument to measure stratospheric ClO from Scott Base

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Chlorine Monoxide (ClO) is the molecule most directly involved in the depletion of the Earth's ozone layer due to manmade Chlorofluorocarbons (CFCs) [Molina and Rowland, Nature, 1974]. The Antarctic spring is unusual in that the combination of very cold temperatures and sunlight result in a large amount of the total chlorine atoms being available in the reactive form of ClO, and this leads to the formation of the ozone hole. As part of the Network for the Detection of Atmospheric Composition Change (NDACC), the ChlOE1 (Chlorine Oxide Experiment) has been making ground-based microwave measurements of ClO from Scott Base since 1996. These measurements have been used to document the long-term decline of ClO in the ozone hole as a result of the Montreal Protocol [Nedoluha et al., JGR, 2016]. The new ChlOE4 microwave instrument was deployed in February 2023 into the first new building erected as part of the Antarctica New Zealand project to redevelop Scott Base. In order to ensure the accurate continuation of the long-term measurement timeseries both ChlOE1 and ChlOE4 will provide measurementsduring the 2023 Antarctic spring. In future years ChlOE4 will carry forward the long-term measurements of ClO in the ozone hole. In addition, early results from ChlOE4 show that we can simultaneously measure both O_3 and ClO throughout the year.
The deployment of ChlOE4, and the continuation of these measurements, is only possible because of support from Antarctica New Zealand, NIWA, NASA, and the US Naval Research Lab.

19. Greenhouse gas retrievals from portable, near-infrared Fourier transform spectrometer solar observations at Arrival Heights

David F. Pollard[1], Frank Hase[2], Darko Dubravica[2], Carlos Alberti[2,] **Dan Smale[1]**

[1]NIWA, Lauder, New Zealand, [2]Karlsruhe Institute of Technology, IMK-ASF, Karlsruhe, Germany

In this work, we provide details of the first seasonal time series of near-infrared retrievals of column-averaged dry-air mole fractions (DMFs, represented as Xgas) of CO_2, CH_4 and CO from measurements made in Antarctica during the deployment of a portable, near-infrared Fourier transform spectrometer (EM27/SUN)

to the Arrival Heights laboratory on Ross Island over the austral summer of 2019–2020 under the auspices of the Collaborative Carbon Column Observing Network (COCCON). The DMFs of all three species were lower in Antarctica than at mid-latitude, and for XCO2 and XCO, the retrieved values were less variable. For XCH4 however, the variability was significantly greater, and it was found that this was strongly correlated to the proximity of the polar vortex. In order to ensure the stability of the instrument and the traceability of the retrievals, side-by-side comparisons to the TCCON station at Lauder, New Zealand and retrievals of the instrument line shape (ILS) were made before and after the measurements in Antarctica. These indicate that, over the course of the deployment, the instrument stability was such that the change in retrieved XCO2 was well below 0.1 %.

20. Upper atmosphere in-situ ozone, water vapour & aerosol measurements above Scott Base from balloon-borne instruments.

Penny Smale[1], Richard Querel[1], Emrys Hall[2], Elizabeth Asher[2], **Dan Smale[1]**

[1]NIWA, Lauder, New Zealand, [2]National Oceanic and Atmospheric Administration, Boulder, CO, USA

Three balloon launches were conducted from Scott Base in November 2022 and February 2023 to investigate the logistical requirements of establishing a routine upper-air sounding programme. The payload included an electrochemical cell measuring ozone, a frost point hygrometer measuring water vapour, and a portable optical particle spectrometer that measures size and distribution of aerosols. This is the standard payload flown as part of NOAA's Earth's Radiation Budget project B^{2}SAP: Balloon Baseline Stratospheric Aerosol Profiles. Aims of B^{2}SAP include improving our scientific understanding of background aerosol levels ahead of any volcanic activity, or climate intervention activities (i.e., geoengineering). Vertical profiles of ozone and water vapour from the balloon measurements are in good agreement with coincident satellite measurements and co-located ground-based measurements from Arrival heights. Model simulations indicate that elevated levels of aerosol and water vapour from the Hunga Tonga–Hunga Ha'apai eruption in January 2022 will increase ozone depletion in the springtime of 2023 (i.e., a bigger than average 2023 ozone hole). A targeted campaign of balloon launches is planned in September 2023 to capture this effect.

21. Airborne microplastics in Antarctica and the Southern Ocean

Alexandra Aves[1], Laura Revell[1], Sally Gaw[1]

[1]School of Physical and Chemical Sciences, University Of Canterbury, Christchurch, New Zealand

Microplastics are an emerging contaminant of concern with a growing understanding of their threat to environmental processes. The presence of microplastics in the air uncovers new challenges to understand their movement throughout environmental matrices, the potential impacts on global climate processes and the increased risk to health via inhalation. Atmospheric transport of microplastics allows them to reach remote and sensitive environments which were previously thought to be untouched by plastic pollution. The limited accessibility of Antarctica and its historically uninhabitable environment has often left us assuming that anthropogenic changes experienced in other regions of the world may not be felt as strongly in this isolated continent. This presentation will highlight the work our research group is undertaking to further our understanding of airborne microplastics in the Antarctic and the Southern Ocean air, water and cryosphere. This talk will discuss the current state and challenges of airborne microplastic research, with focus on the observational studies which are underway and ongoing in the Antarctic and Southern Ocean.

22. Development of a rapid sidewall coring device for use in thermally drilled Ice bore holes

Levon Stone[1], **Drew Baldwin**[1], **Otto Burrows**[1], **Angus Stuart**[1], Professor Geoff Rodgers[1], Professor Dave Prior[2], Darcy Mandemo[3]

[1]University of Canterbury, Ilam , New Zealand, [2]University of Otago, Dunedin, New Zealand, [3]Victoria University of Wellington, Wellington, New Zealand

As the impact of global climate change becomes increasingly severe, the development of accurate models to predict these effects is imperative. There is a need to accurately model the flux of Antarctic ice sheets as this plays a major role in sea level rise. To do this, a better representation of the ice physical properties is needed. However, the extensive sampling at many locations and depths required to achieve this accurate representation is not feasible with conventional drilling practices. The goal of this project is to design, manufacture and test a prototype device that can collect ice core samples from the sidewall of a 125mm diameter borehole. This device will be used in boreholes that have been rapidly drilled with a hot water lance, increasing the rate at which samples can be taken. The aim is to make a device that will operate in Antarctic conditions collecting 10-20 ice samples per day.

The final deliverables will be an initial prototype device as well as a report and other associated documentation to enable effect use of the device.
The final product must be a portable and highly reliable unit which has suitable characteristics for use in harsh Antarctic conditions. These requirements include being operated by a small team wearing heavy clothing and gloves. The device must enable the rapid collection of samples suitable for subsequent scientific analysis including microstructural analysis.

DATA AND INSTRUMENTATION

Advances and investigations of data management and novel instrumentation.

DATA AND INSTRUMENTATION

Chair: Aleks Terauds, Australian Antarctic Division

ORAL PRESENTATIONS

A continent-wide detailed geological map dataset of Antarctica

Simon Cox[1], Belinda Smith Lyttle[1], GeoMAP Action Group[2]

[1]GNS Science, Dunedin, New Zealand, [2]Scientific Committee on Antarctic Research, Cambridge, United Kingdom

A dataset to describe exposed bedrock and surficial geology of Antarctica has been constructed by the GeoMAP Action Group of the Scientific Committee on Antarctic Research (SCAR) and GNS Science. Our group captured existing geological map data into a geographic information system (GIS), refined its spatial reliability, harmonised classification, and improved representation of glacial sequences and geomorphology, thereby creating a comprehensive and coherent representation of Antarctic geology. Description of rock and moraine polygons employs the international Geoscience Markup Language (GeoSciML) data protocols to provide attribute-rich and queryable information, including bibliographic links to 589 source maps and scientific literature. GeoMAP is the first detailed geological dataset covering all of Antarctica and is suitable for continent-wide perspectives and cross-discipline interrogation. It depicts 'known geology' of rock exposures rather than 'interpreted' sub-ice features. The definition of rock and substrate composition has potential to inform ecological, environmental, biological, heat flow, and meltwater modelling, as well as many other cross-discipline studies. GeoMAP v.2022-08 is now freely available to download (https://doi.org/10.1594/PANGAEA.951482) and described in detail in Nature Scientific Data (https://doi.org/10.1038/s41597-023-02152-9).

Development of an AIoT platform for long term and near real-time monitoring of remote environments in Antarctica

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Mosses, the dominant vegetation in Antarctica, are essential for the biogeochemical cycling of the environment and provides habitat and protection for microorganisms and invertebrates. However, changes in the health and composition of moss beds have been observed in the last two decades, and the reasons are difficult to determine due to the challenges of gathering empirical data in Antarctica. The mosses create their own microclimates that can be much warmer than the broader climate, making it difficult to rely on weather station data to monitor changes. Furthermore, developing continuous remote monitoring solutions for Antarctica is non-trivial due to the lack of power and network connectivity, and extreme cold conditions that can affect batteries. To address these challenges, an intelligent, autonomous, long-range and long-term monitoring platform for remote terrestrial environments in Antarctica is being developed. This Artificial Intelligence of Things (AIoT) platform captures environmental data and transmits it back to Australia in near real-time, allowing for global access. The AIoT platform is equipped with sensors measuring surface, soil, and boundary layer climates, along with a camera. AI and edge processing technologies from NVIDIA and Arduino, along with the LoRaWAN protocol enables low power, long-range wireless data transmission capabilities. This platform aims to increase the research capabilities in Antarctica, and the first prototype was successfully tested at the Australian Casey Research Station in Antarctica during the 2022-2023 summer season. Its development will enable continuous long-term monitoring of remote terrestrial environments, which will aid in the conservation and preservation of Antarctica's delicate ecosystem.

Tropical teleconnections through the Amundsen Sea Low impact Antarctic toothfish recruitment within the Ross Gyre

Erik Behrens[1], Arnaud Gruss[1], Matt Pinkerton1, Steve Parker[2], Graham Rickard[1], Craig Stevens[1]

[1]NIWA, Wellington, New Zealand, [2]CCAMLR, Hobart, Australia

Antarctic toothfish (Dissostichus mawsoni) spawn, among other regions, in the northern parts of the Ross Gyre during the winter season. This study shows that the fate of these buoyant eggs is strongly connected to sea-ice drift and can impact the overall yearly recruitment success to the Amundsen shelf break. A key driver for changes in the sea-ice drift is the state of the Amundsen Sea Low and its connection to tropical sea surface temperatures; during years when the Amundsen Sea Low is weaker, in sync with El Niño conditions, the northward sea-ice drift reduces, and more eggs stay within the Ross Gyre boundaries leading to a larger recruitment success; conversely, during stronger Amundsen Sea Low phases, in sync with La Niña conditions, more eggs leave the Ross Gyre for the open Southern Ocean, leading to a recruitment decline. The state of the Amundsen Sea Low and associated sea-ice drift is able to explain in total about 80% of the interannual recruitment variability over the period 1974-2015. About 60% are related to direct impacts on toothfish within their first year after spawning and about 20% to impacts on toothfish within their second year. This provides an opportunity to predict future interannual changes in the toothfish recruitment success. This study also suggests anthropogenic strengthening of the Amundsen Sea Low found in CMIP models will likely contribute to a long-term recruitment decline.

RSV Nuyina's Wet Well Sampling System

Rob King[1], Steve Whiteside[1], So Kawaguchi[1], Mike Murphy[2], Jia Wei Tan[3], Brian Winship[3],Christopher Chin[3], Michael Woodward[3]

[1]Australian Antarctic Division, Kingston, Australia, [2]Alto Consulting Engineers, Brisbane, Australia. [3]Australian Maritime College, Launceston, Australia

Australia's new Antarctic research and supply vessel, RSV Nuyina, has been equipped with a novel sampling system for krill, plankton and sea ice flora and fauna, the Wet Well. The system is an improvement over traditional trawling and net sampling in terms of the specimen quality achievable, delivering live research specimens from the surface ocean either in open water conditions or from under sea ice, without any ship time cost. This talk will identify the scientific drivers that led to the creation of this system and illustrate how the system can operate to deliver high quality specimens from the ocean in under five seconds. The results from the first Antarctic commissioning voyage will be presented along with details of the associated aquarium infrastructure and the intended direction for future development.

Seals mapping the East Antarctic continental shelf

Clive McMahon[1,2], Mark Hindell[2], Richard Coleman[2], Christophe Guinet[3], Ben Raymond[4], Michael Sumner[4], Jean-Benoit Charrassin[5], Sara Labrousse[5], Natalia Ribeiro Santos[6], Robert Harcourt[1,7]

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The poor coverage of bathymetric data for the Antarctic continental shelf is an impediment to understanding oceanographic processes affecting Antarctica's role in global climate. The shape of the bed on the continental shelf influences how warm water infiltrates onto the shelf, making it an important factor promoting ice shelf melting and influencing the flow of ice shelves into the ocean. These issues have global implications for sea-level rise and deep ocean circulation. Building on previous work using seal dives to redefine bathymetry, our decades-long study of ocean physics and animal behaviour provided new ocean depth information from over 500,000 individual dives from 265 seals on the East Antarctica continental shelf. The seal tags have a post-processed position uncertainty of 2-3 km, and provide transmitted depth data with a resolution of 10-25 m. About 25% of these seal dives were, on average, 220 m (sometimes over 1000 m) deeper than the interpolated seafloor in the International Bathymetric Chart of the Southern Ocean Version 2. Focusing on four well-sampled regions, we show that the bathymetry of between 22% and 60% of the sampled area was improved by incorporating seal dive data. This revealed new bathymetric features, including troughs off the Shackleton Ice Shelf and Underwood Glacier and a deep canyon near the Vanderford Glacier. Further acquisitions of seal data will improve our understanding and modelling of Antarctic coastal ocean processes and ice sheet dynamics.

Best practice guidelines for eDNA biomonitoring in Australia and New Zealand

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Environmental DNA (eDNA)-based methods are increasingly used in Antarctic research, for biodiversity monitoring and to detect threatened and non-native species. Rapid uptake in the application of eDNA approaches to management questions introduces a need to standardise methods for quality assurance and reproducibility. It is also important for end-users to be able to evaluate proposed methods and understand factors that influence interpretation of eDNA data. We introduce new best practice guidelines for environmental DNA biomonitoring. Developed collaboratively by eDNA experts, end-users, and stakeholders, these guidelines were designed for an Australian and New Zealand context and have direct relevance to Antarctic applications. They include two separate documents, each with a different focus but intended to be used in parallel. The eDNA protocol development guide for biomonitoring outlines general principles for using eDNA-based methods. The entire workflow is considered, from experimental design and ethics, to interpreting and communicating results. The guidelines inform project planning and development of Standard Operating Procedures, provide background information on eDNA workflows to end-users, and inform quality assurance and evaluation of methods. The eDNA test validation guidelines outline the use of eDNA and eRNA assays for detection of species. These provide technical details of the key steps to be used in assay development and the controls necessary for validation. Our aim is not to be prescriptive, but to set minimum standards to support consistent and best-practice approaches to eDNA testing. We hope that these guidelines will ensure environ mental managers are provided with robust scientific evidence to support decision-making.

Hauwai 20: An autonomous biosampler for year-round, under-sea ice biological collection and physical measurements in the Antarctic

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Sea ice is essential in supporting the primary production critical for the polar marine food web. The extent and duration of sea ice in the Antarctic are predicted to decline in a warming world. The primary production needed to support current populations is expected to decline in tandem. We know little about how the composition and structure of this critical sea ice community changes during most of the year due to our restricted access during the austral summer months. Year-round sampling below the sea ice would provide an essential data set to understand better how the community might respond to predicted change. An underice “Smart” biosampler, the Hauwai 20, has been designed and built for year-round under-ice sampling through a collaboration between the University of Waikato and Cellula Robotics, Vancouver, Canada. The sampler can take up to 150 discrete samples, each stored in a sealed puck. Each puck contains up to three filters, with user-selectable pore sizes from 0.22-1000 µm. A displacement pump pulls a sample through the filters for a user-defined volume. At the end of the sample, a preservative is injected into the puck, which is then sealed. Once the puck is stored, the flow path is sterilized. The sampler is moored on the seafloor, and an integrated winch raises a collection float-head containing the sample intake, CTD, altimeter, camera, and fluorometer and PAR sensors. The upwards-facing altimeter positions the float just under the sea ice for sampling. An ADCP mounted to the Hauwai on the sea floor provides continuous real-time current data to assure optimal float head deployment. The sampler can operate via a cable from shore or autonomously with a built-in battery pack. Samples can be triggered by programmed time intervals, remotely from off continent via the shore cable, or as a result of on board instrument data.

DATA AND INSTRUMENTATION POSTER PRESENTATIONS

23. Antarctic-Plots: a Python package to help conduct Antarctic research

Matt Tankersley[1]

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The Antarctic-Plots Python package aims to help automate common tasks associated with researching Antarctica. Some of these tasks include downloading and retrieving Antarctic datasets, including imagery, topography, geophysical measurements and many more. There are functions to easily and quickly creating publication quality figures. These include maps, cross-sections, profiles, and 3D perspective views. Additionally, there are geospatial tools provided for reprojecting, masking, and gridding data. This package is still early in it's development and many more datasets and functions will still be added.

24. A system for sampling ice from hot water holes.

Anna Sarjeant[1]**, Miss Jessica MacFarquhar**[1]**, Miss Hannah Harrison**[1]**,** Mr Angus Brown[1] , Geoff Rogers[1], David Prior[2], Darcy Mandeno[3]

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Antarctic ice core samples provide valuable data for modelling future sea level rise due to global climate change. There is an urgent need to improve the representation of the physical properties of ice sheet models; however, existing ice coring systems typically sample to extensive depths at a single location which does not provide the required level of variety. A rapid sampling approach is being developed through the MBIE Smart Ideas funded programme “Tere Tīpako Tio: Rapid Extensive Antarctic Ice Sampling” The idea is to use hot water drilling to create boreholes of various depths and to remove water from these holes leaving a dry borehole. We are designing a tool to collect ice samples once the water has been removed. The ice coring design proposed by this group involves the development of an easily portable device that fits within the pre-drilled boreholes that collect ice core samples from the bottom of these holes. The design will also incorporate a mechanism to divert the core axis away from the vertical to maximise the number of samples from a single borehole. This device is intended to allow for more extensive ice core sampling over many field sites, enabling more accurate widespread modelling of Antarctic ice sheets.

25. New Zealand's Antarctic research publications from 1966 to 2022 - value, trends and implications.

Peter Barrett[1]

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Trends in "Productivity" and "Impact" of research on Antarctica and the Southern Ocean (defined in oceanographic terms) by NZ-based authors over the last 26 years have been derived from a database of ~3200 peer-reviewed papers and ~100,000 citations extracted from Scopus. The database is over twice as large as that of Antarctica NZ, which reports on work it supports - this database captures more marine research and modelling. Definitions for the metrics come from the Antarctica NZ Statement of Intent (SOI) for 2013-16. "Productivity" is the number of papers published in each year (Publication Year) in peer-reviewed publications, which reflects activity in the previous one to three years. "Impact" is the number of cumulative citations for the Publication Year and the five years prior. For this Reporting Year is used as a more appropriate term than Publication Year, for this is a moving average that increases in numbers and years to cover six publication years. Inherent in this metric is that it reflects Impact around four years after the Reporting Year. All publications were assigned to one of nine subjects, but clustered for reporting on trends into three groups, Biological Sciences (44%), Physical Sciences (46%), and Humanities (~10%). The trend in publications (graph below) rises from 47 in 1996 to ~200 in 2015, then dropping to ~150 until rising to another peak in 2021. Biological Sciences leads slightly from 2000 to 2015, but Physical Sciences have taken a slight lead since. The trend based on the citations metric rises continuously from 2006 to 2018 and then declines, though more so in Biological Sciences. In the presentation I will suggest that past trends in peer-reviewed publications and citations data are objective indicators that make them useful for experts to consider when developing future strategy and its implementation. The science publication system has its flaws, but this product of it provides a logical starting point for addressing questions raised by these trends.

26. Performance evaluation of low-cost GNSS receivers for glacier monitoring in Terra Nova Bay, Antarctica

Holly Still[1], Hamish Bowman[1], Robert Odolinski[1], Christina Hulbe[1], David Prior[1]

[1]University of Otago, Dunedin, New Zealand

Field observations of glacier and ice-sheet velocity are often acquired with costly survey-grade Global Navigation Satellite System (GNSS) receivers, limiting the widespread deployment of GNSS systems and restricting access to users with well-funded research programs. This study examines the performance of lowcost, low-power GNSS positioning systems for glacier monitoring in high-latitude environments. We compared the performance of co-located low-cost u-blox-ZED-F9P GNSS receivers ($500 NZD) and survey-grade Trimble R10 receivers (>$15,000) under stationary (on land) and dynamic (on glacier) conditions in Terra Nova Bay, Antarctica. Our experiments show that low-cost u-blox systems can achieve millimetre to centimetre level precision in these challenging environments. The two systems yielded almost identical error magnitudes under short (3 m), medium (33 km) and long (390 km) baseline kinematic positioning scenar ios. We also examined the suitability of low-cost GNSS for glaciological applications by installing four u-blox and two Trimble receivers on Priestley Glacier, to observe tide-modulated ice flexure. The receivers successfully detected subtle tidal oscillations with amplitudes <3 cm, consistent with the predicted phasing from a tide model. These experiments demonstrate the potential of low-cost GNSS systems for both cost effective glacier monitoring and the expansion of GNSS networks in Antarctica.

27. Small hot water holes for access to Antarctic ice.

David Prior[1], Cliff Lochhead[2], Zoe MacClure[1], Brent Pooley[1] and the Tere Tīpako Tio team.

[1]University Of Otago, Dunedin, New Zealand, [2]Otago Polytechnic, Dunedin, New Zealand

Tere Tīpako Tio: Rapid Extensive Antarctic Ice Sampling Aotearoa is an MBIE funded smart idea with the objective of developing new tools and new field procedures to collect ice samples in the right places, rapidly and at a scale not previously possible. The basic idea is to drill holes with hot water, take the water out and then use take samples from the bottom and sides of the hole. In the preliminary field season in February-March 2023 we showed that we can drill holes with a small hot water drilling system and a 125mm diameter drilling lance at rates that will allow drilling to ~200m in a day.

We also showed that we can extract water from the hole with a simple bailing system. Teams of student engineers (see other posters at this conference) are designing tools to take ice samples from the holes. These systems will be tested in the 2023-2024 season and designs refined during 2024. Our ambitious goal is to sample ice from 30 drill sites across the McMurdo Ice Shelf in a one month field season in 2024-2025 and to use the physical property measurements of the ice to improve mechanical models for the ice shelf.

28. OPERATION TIO - a case study of collaboration using OCEANUM.IO

Ursula Crabtree, Sally Garrett, Dr David Johnson

[1]*Defence Technology Agency - New Zealand Defence Force, Devonport, New Zealand*

The New Zealand Defence Force routinely collects large observational datasets, and much of this data is unclassified. Consequently, there is considerable potential for this data to be used within other scientific endeavours. To assist this outcome, the Defence Technology Agency has collaborated with Oceanum to deploy the OCEANUM.IO Datamesh to enable external parties to efficiently discover and access datasets of interest. OCEANUM.IO is an enabling layer of technology that abstracts away data engineering challenges and aggregates a wealth of disparate data sources. The cloud-native service is a full data management system for seamless integration, storage, cataloguing, discovery, connection to tooling, and visualisation of environmental and geophysical datasets; specifically designed to facilitate data science workflows. An optional storage system leverages the latest cloud-native technology and open-source libraries to provide a highly-robust and performant system. The service can connect directly to third-party servers, perform format conversions, interpolation, subsetting, API access, performance caching and native support for Python and R libraries. The first NZDF dataset ingested into the OCEANUM.IO datamesh was collected during the 2022 resupply voyage to McMurdo Sound by Royal New Zealand Navy ship HMNZ AOTEAROA. Operation (OP) TIO (ice) provided an opportunity to conduct a range of science activities focussed on polar maritime safety issues. The OP TIO observations included data from 21 free floating wave buoys, 10 Global Drifters, 2 ARGO Floats, 85 expendable bathythermograph profiles, and ship-based measurements of meteorological, oceanographic, wave and sea ice characteristics. Simultaneous satellite-based synthetic aperture radar captures and highresolution wave modelling completes the data holding. Many of these datasets are of interest to researchers external to NZDF, and they are now available from OCEANUM.IO, where researchers can search, subset and download raw and post-processed data products. Examples of access methods for different types of data structures will be presented.

29. Leveraging Complementary Systems for Galaxy: Tool Management and Performance

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Over the course of Galaxy Project's 15+ years in the open source community numerous complementary systems have been spawned. While some of these systems may be partially duplicative, combining their strengths can result in a single, unified system that is be er suited for today's competitive software ecosystem. In addition to broadly outlining how the reproducible-science platform, Galaxy Project, is being used by researchers studying climate change and animal biology from an administrative perspective, this work will explore a successful highly-technical solution for merging two complementary systems - gxadmin and usagemetrics. From a people management perspective, the work will address how user interviews and evaluative analysis of similar applications were used to determine what new features could be developed to meet user needs. Additionally, the work will discuss the process of bringing together teams from different systems and improving communication among them. From a technical management perspective, the work will cover the consolidated solution, including the development of a solution that ensures continuity across deterministic and stochastic hardware resources. The work will also address how compatibility issues between Galaxy and complementary systems (such as databases and programming languages) were addressed, as well as the process of refactoring calculations to standardize metrics or allow for flexibility in metrics when standardization is impractical.

30. Mt Erebus volcanic hazard, potential for monitoring and support of operational risk management

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GNS Science is supporting Antarctica New Zealand to investigate volcanic hazard and mitigation options for Erebus volcano. This has so far included evaluating the eruption history (from 40 years of existing research) and hazards at a range of scales, a volcanic hazard and impact assessment for the Scott Base Rebuild (see Magill et al. this volume), investigation of options for monitoring Erebus, and approaches to field risk assessment and safety on the volcano and flying in its vicinity. This has also covered initial consideration of hazard from other volcanoes in the Ross Sea area.

Erebus is one of only a handful of volcanoes on Earth with a permanent lava lake. This presents a hazard from Volcanic Ballistic Projectiles (VBP) potentially within a few kilometres of the vent, and especially near the summit vents. Additionally, dozens of associated ash layers within ice cores point to occasional larger explosive events. We have in January 2023 completed high resolution stereo summit cone photography to allow change analysis in future seasons - to characterise the current activity expected to be primarily VBP. This will complement past studies of the active summit vents and eruptions. Scientific monitoring of Erebus was largely discontinued in 2016, however US colleagues have been developing options for renewed instrumentation. We are discussing the feasibility of volcano observatory near-real-time monitoring (in collaboration with GeoNet programme monitoring at GNS Science) with US counterparts and NZ stakeholders. This could potentially support wider operational risk management in three contexts: for field work in events on Erebus; at the redeveloped Scott Base; and in relation to air transport locally and inter-continental to and from Antarctica. This paper summarises the results of investigations to date and explores a range of options for scientific and monitoring support of operational risk mitigation.

31.

Checking the pulse of Antarctica – Can Digital Earth help?

Alix Post[1], Kimberley Baldry[1], Jonathan Mettes[1], Melissa Fedrigo[2], Norman Mueller[1]

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Earth Observations over Antarctica are critical for understanding changes in the cryosphere, ecosystems and oceans through time. Our ability to observe Antarctica systematically at a continental scale is constrained by difficulties accessing, storing and pre-processing satellite imagery prior to analysis. Some of these challenges are unique to the Antarctic environment, where factors such as cloud masking, reflectivity, prolonged periods of darkness and atmospheric differences in water vapour, aerosol and signal scattering mean that corrections applied to satellite data in other regions of the world aren't representative of Antarctic conditions. A new collaboration between Geoscience Australia and the Australian Antarctic Division, Digital Earth Antarctica, aims to improve access to corrected continental scale satellite data through use of Open Data Cube technology. This initiative builds on work in the international community in developing Open Data Cube platforms, which have been applied in the development of Digital Earth Australia and Digital Earth Africa. The Digital Earth Antarctica platform will provide open access to analysis ready time-series data that has been corrected and validated for Antarctic conditions. It will focus primarily on data from Landsat (optical), Sentinel-1 (synthetic aperture radar) and Sentinel-2 (optical), with other sensors to be added as the capability expands. Digital Earth Antarctica is an ambitious project that will work alongside other international efforts to enhance the accessibility of quality Antarctic Earth Observations.

ICE AND EARTH SYSTEM DYNAMICS

Investigations of ice and Earth system dynamics, and the impact of past, present and future changes.

ICE AND EARTH SYSTEM DYNAMICS

Chair: Nancy Bertler, Antarctic Science Platform Gary Wilson, GNS and Tim Naish, Victoria University of Wellington

ORAL PRESENTATIONS

The Uncertain Future of Antarctica's Melting Ice: A New Research Initiative

Tim Naish[1]

[1]*Victoria University Of Wellington, Wellington, New Zealand*

Among the most visible effects of anthropogenic global warming are rising seas around the world: Since 1880, the global mean sea level (GMSL) has increased by 20 centimetres. As a result, sea level globally will continue to rise well beyond the 21st century, even if warming of the planet is stabilized below the target set by the Paris climate agreement in 2015 of 2°C above the preindustrial average. The recent Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6) and the 2019 revision of the World Population Prospects both state that it is very likely that climate change–induced sea level rise will affect much of the world's coasts in the coming decades. An estimated 800 million people are likely to experience impacts of high-tide flooding by the end of the 21st century, even if the Paris climate agreement target is met. In many coastal settings, even a small increase in baseline sea level can substantially increase the frequency and magnitude of flooding during high tides, storm surges, and extreme weather. What's more, if policies aimed at curtailing greenhouse gas emissions and atmospheric warming this century fail, sea level rise will accelerate, dramatically reshaping our shorelines for centuries to come. Quantifying the pace of GMSL rise as well as the magnitude of the long-term rise (a few centuries onward), to which we are committed, is thus essential for effective adaptation planning and the evaluation of mitigation pathways and policies. Pinning down these quantities requires a focused effort from the scientific community to identify and understand the key rate-determining processes that affect melting of the Antarctic Ice Sheet (AIS)—the largest and most uncertain potential contributor to future sea level rise.

Many of these processes generate dynamical instabilities and involve nonlinear and potentially irreversible behaviours. Thus, establishing their relative roles in future ice sheet dynamics will not only improve sea level projections but may identify a threshold level of atmospheric carbon dioxide that once crossed, may cause unstoppable, multi generational mass loss from the AIS and commitment to global sea level rise. In February 2021, Instabilities and Thresholds in Antarctica (INSTANT), an international, interdisciplinary, and inter organizational program led by the Scientific Committee on Antarctic Research (SCAR), was launched with the specific goal of reducing these uncertainties and filling gaps in our knowledge of the AIS.

Sensitivity of climate and ocean circulation to West Antarctic Ice Sheet extent in past interglacials

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Earth system models often have difficulty reproducing the warmth of past interglacials, particularly at the polar regions. CO2 concentrations and orbital configurations do not by themselves reproduce regional climate for interglacial periods such as e.g. MIS 5e, MIS 11, and MIS 31. The West Antarctic ice sheet (WAIS) extent is a key source of uncertainty. Here we use an intermediate complexity model, UVic ESCM, to simulate three different orbital forcings (present-day, MIS 31 / 1.07 Ma, mid-Pliocene warm period / 3.2 Ma) with three different ice sheet configurations (present-day, WAIS absent, and an intermediate state) and compare to paleoclimate ice core and sediment proxy data to evaluate their consistency. These experiments offer insight into the sensitivity of climate to the interactions between CO2 concentrations, orbital forcing, and Antarctic ice sheet extent. Additionally, model outputs were used as boundary conditions for high-resolution regional ocean model simulations.

Implications of varied Pacific decadal variability over the last 2000 years to Australian and New Zealand climate risk.

Tessa Vance[1,2], Anthony Kiem[2], Andrew Lorrey[3]

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Phase changes of the Interdecadal Pacific Oscillation (IPO), an index defining Pacific decadal variability (PDV), alter the risk of climate extremes (e.g. droughts, floods, tropical cyclones) across New Zealand and eastern Australia. However, the low frequency nature of PDV means instrumental observations probably don't adequately capture long-term variability. A 2000 y Antarctic ice core reconstruction shows negative phases of the IPO are generally short (7±5 y), infrequent (10%) departures from a predominantly neutral positive state. Positive phases are longer (9±8 y) and more frequent (37%) within neutral-positive periods lasting decades (61±56 y). These statistics are supported by a 654 y pan-Pacific IPO reconstruction, which also finds negative phases are significantly less frequent than positive phases. This means hydroclimatic risk is currently poorly characterised across New Zealand and eastern Australia, because negative phases are over-represented in observations and in palaeoclimate reconstructions that only cover recent centuries. For example, rainfall is significantly lower during neutral-positive phases in eastern Australia. In New Zealand, the IPO influence on regional atmospheric circulation is seasonally-distinct and spatially heterogeneous. Positive phases are linked to increased extreme rainfall for western regions while negative phases are linked to extreme rainfall in northern/eastern regions. Long-term predominantly neutral-positive PDV therefore has climate risk implications for both nations which deserve re-evaluation. The initiation and future frequency of negative phases should be a research priority, given recent research suggests anthropogenic climate change may result in PDV that is different to what has occurred in the past.

What caused Late Holocene advance of the West Antarctic Ice Sheet at the Siple Coast?

Daniel Lowry[1], Holly Kyeore Han[2], Alena Malyarenko[3], Nick Golledge[4], Natalya Gomez[5], Katelyn Johnson[1]

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Since the Last Glacial Maximum, the West Antarctic Ice Sheet (WAIS) retreated more than 1000 km in the Ross Embayment. However, recent geologic evidence suggests that the ice sheet grounding line of the Siple Coast also experienced extensive readvance during the Late Holocene (3-0 ka). The timing and cause of this inferred readvance have been topics of debate, and have been attributed to both isostatic uplift (Kingslake et al., 2018), and regional climatic cooling (Neuhaus et al., 2021). We test these competing hypotheses using an ensemble of ice sheet model simulations with viscoelastic Earth deformation and a gravitationally self-consistent global sea level model. Our results highlight that the Siple Coast is especially sensitive to sea level feedback resulting from ice mass changes that occurred during the last deglaciation and throughout the Holocene. This feedback limits isostatic uplift at the Siple Coast as the ice sheet is advancing. The ice sheet model experiments indicate that relative oceanic cooling in the Late Holocene is a more likely driver of ice sheet readvance, implying that the Siple Coast grounding line is sensitive to changes in the Ross Sea polynya.

Climate variability as a major forcing of recent Antarctic ice-mass change

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Multiple datasets show the Antarctic Ice Sheet has lost mass over recent decades, and hence contributed to sea-level change. The forcing of this observed trend is not well understood; its shorter-period variability has been partly associated with El Niño Southern Oscillation (ENSO) both for the grounded ice sheet and its bounding ice shelves, but the connection with the dominant climate mode, the Southern Annular Mode (SAM), is not fully clear. Here we show that space gravimetric (GRACE) estimates of ice-mass variability over 2002-2021 may be largely explained by a simple linear relation with both SAM and lagged-ENSO. We decompose the detrended GRACE time series using empirical orthogonal functions and show that the principal components are dominated by decadal variability that correlate closely with detrended, timeintegrated SAM and ENSO indices. Multiple linear regression reveals that SAM and/or ENSO explain much of the decadal variability from the whole ice sheet down to individual drainage basins, while approximately 40% of the net whole-of-ice-sheet change (2002-2021) can be ascribed to persistent positive-SAM forcing. Analysing a gridded altimetry product over a similar period shows very similar spatial patterns of SAM and lagged-ENSO signal indicating the solution is robust. Understanding the forcings of SAM variability over the GRACE period, which is largely anthropogenic over multi-decadal timescales, may be a pathway to partially attributing ice-sheet change to human activity.

West Antarctic Ice Sheet history from International Ocean Discovery Program (IODP) Expedition 374 geological drilling in the Ross Sea

Robert Mckay[1], Laura De Santis, International Ocean Discovery Program Expedition 374 Science Team

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International Ocean Discovery Program (IODP) Expedition 374 collected a latitudinal and depth transect of five drill sites from the outer continental shelf and rise in the eastern Ross Sea in January to March 2018. The expedition aimed to resolve the relationship between climatic/oceanic change and West Antarctic Ice Sheet (WAIS) evolution over the past 20 million years. This location was selected because numerical ice sheet models indicate that it is highly sensitive to changes in ocean heat flux and sea level. It is also a region that is experiences large variances in ice volume through ice age cycles, and is influenced by ice sourced from both East and West Antarctica; and today it is a major source area of Antarctic Bottom Water formation and therefore a major control on the global overturning oceanic circulation The drilling was designed for optimal data-model integration, which will enable an improved understanding of the sensitivity of Antarctic Ice Sheet mass balance during warmer-than-present climates (e.g., the early Pliocene and middle Miocene). The objectives were to 1) Evaluate the contribution of West Antarctica to far-field ice volume and sea level estimates; 2) Reconstruct ice-proximal atmospheric and oceanic temperatures to identify past polar amplification and assess its forcings/feedbacks; 3) Assess the role of oceanic forcing (e.g., sea level and temperature) on Antarctic Ice Sheet stability/instability; 4) Identify the sensitivity of the AIS to Earth's orbital configuration under a variety of climate boundary conditions; 5) Reconstruct eastern Ross Sea bathymetry to examine relationships between seafloor geometry, ice sheet stability/instability, and global climate. We will present the scientific results that resulted from this expedition, with a focus on the paleoenvironmental reconstructions that were obtained from the sedimentolgical, geochemical and paleotonlogical datasets – as well as highlight future avenues of research from this expedition over coming years. This work is presented on behalf of the entire IODP Expedition 374 Science team.

Modelled ocean and atmosphere feedbacks associated with the West Antarctic ice sheet during the last interglacial period

Frank Mackenzie[1], Liz Keller, Nancy Bertler
[1]Te Herenga Waka - Victoria University Of Wellington, New Zealand

The marine-based West Antarctic Ice Sheet (WAIS) contains only around 10% of Antarctica's total ice volume, but has the potential to be a significant and early contributor to sea level rise (Dutton, et al., 2015). Looking to the past can tell us a great deal about how the Antarctic Ice Sheet responded to different climatic conditions, using both paleoproxies and Earth system models to simulate past climates (Otto-Bliesner, et al., 2021). The last interglacial (LIG, ~ 129-116 thousand years ago, ka) is an important case study for a warmer (~ 1.5 – 2 °C) global climate (Capron, et al., 2019). Preliminary analysis suggests that the Roosevelt Island ice core (RICE), taken from the Ross Ice Shelf (RIS), contains ice from the LIG (Lee , et al., 2020). If this is the case, it implies that the RIS, and therefore much of the WAIS, may have been intact during this warmer period, which runs contrary to previous estimations that WAIS would have been significantly reduced during the LIG (DeConto & Pollard, 2016). This project aims to use intermediate-complexity Earth system models to reconstruct the extent of the WAIS during the LIG. The aims of the project are twofold: to investigate whether an intact or partially intact WAIS is consistent with other paleorecords; and to investigate the feedbacks between the atmosphere, ocean and the extent of the WAIS during the LIG .

Oceanic ridges impact the strength and location of deep ocean warming and sea level change

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Teaser

A cold and dense water mass, that is only formed around Antarctic, is shrinking. Here, we investigate the significant role that this shrinking plays on warming the deep ocean, as well as raising sea level. Antarctic Bottom Water (AABW) fills over 30% of the abyssal ocean and drives the deepest part of the global overturning circulation. However, over recent decades AABW has been shrinking. This contraction is expected to impact the properties of the deepest parts of the ocean and may also contribute to sea level rise. Yet, these patterns of change are complex and have been investigated in a bulk sense, ignoring the potential role of topographic barriers in the ocean (i.e., ridges). Here, we show that contraction of AABW can explain deep warming of Antarctic-adjacent Ocean basins and creates warming hotspots along its northward path that are exacerbated by oceanic ridges. Ultimately, the contraction of AABW is driven by freshening of Antarctic coastal waters and is expected to accelerate in the coming decades.

Addressing bathymetry uncertainty beneath the Ross Ice Shelf

Matt Tankersley[1]

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The bathymetry underlying Antarctica's Ross Ice Shelf exterts a strong control on it's stability. The bathymetry guides the circulations of melt-inducing water masses and defines the geometry of pinning points. Collecting sub-ice shelf bathymetry data using typical polar surveying methods (e.g. seismic surveying or direct observations) can be inefficient, expensive or unfeasible. Gravity inversions provide a more practical
alternative, in which observed variations in Earth's gravitational field are used to predict the bathymetry. Here we present a gravity inversion algorithm designed specificy to model sub-ice shelf bathymetry. Features include several methods to separate the regional gravity field, various options to impose model regularization, and the ability to quantify spatially variable model uncertainties. Here, we use this inversion with airborne gravity data from the Ross Ice Shelf and model the underlying bathymetry. Our results build upon the Tinto et al. 2019 model by using the new algorithm as well as incorporating additional gravity data and bathymetric constraints, collected since 2019.

Interannual variability of fast-ice thickness in McMurdo Sound: drivers and trends.

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The fast-ice cover in McMurdo Sound has been remarkably stable since the earliest records more than 100 years ago. This is likely due to supercooled water flowing out from under the McMurdo Ice Shelf, which allows the sea ice to grow through heat loss to the ocean, as well as to the atmosphere. We will present a dataset of fast-ice thickness and extent covering the years 1986--2022. We will connect this to atmospheric and ocean drivers on time scales from events to seasons in order to provide a baseline of the interannual variability in fast-ice thickness and the formation/break-out history. This provides one of the longest studies of drivers of interannual fast-ice thickness variability from high-quality, in situ observations. Our work highlights the drivers most likely to influence fast-ice presence and thickness in McMurdo Sound. Thicker fast ice is related to lower temperatures, higher average off-shore winds and lower offshore storminess. Fast-ice formation and winter break-out is connected to the severity and timing of southerly storm events. Future extreme events and long-term trends can be assessed against the baseline presented here, helping us to better understand the balance between ice, ocean, and atmosphere. Further, we provided information on gaps in our understanding of regional fast-ice processes, which will hopefully contribute to future work towards a model with regional predictive capability of fast-ice in McMurdo Sound.

Magnitude and rate of ice loss from debuttressed glaciers on the Antarctic Peninsula since the presatellite era

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Tidewater glaciers on the Antarctic Peninsula are particularly vulnerable to global warming. Glaciers that are debuttressed by ice shelf collapse accelerate and thin in a strongly non-linear response to warming. This response is well documented for tributaries of the collapsed Larsen B Ice Shelf, but data prior to the debuttressing event in 2002 are sparse. We determine pre-collapse glacier surface elevations using photogrammetry of historic images and, for the first time, quantify the total magnitude and rate of volume loss of a glacier associated with ice shelf debuttressing. Comparison to modern configurations provided a volume change timeseries spanning 52 years and revealed a non-linear contribution to sea-level rise. The majority of ice loss occurred in the immediate decade post collapse at ~3.0 ± 0.1 Gt a-1, totaling at least 28.8 ± 1.1 Gt of ice loss since 1968 for the Crane Glacier. The volume and rate of ice flux to the ocean from this tipping-point type behaviour is important to quantify for models of climate-sensitive areas such as the Antarctic Peninsula.
Large glaciers further south, such as those adjoining the Scar Inlet Ice Shelf and the Larsen C Ice Shelf, will contribute significantly to sea-level rise if debuttressed.

Permafrost degassing in Taylor Valley, Antarctica

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Contemporary studies conducted in northern polar regions reveal that permafrost stability plays an important role in the modern carbon cycle as it potentially stores considerable quantities of greenhouse gases. Rapid and recent warming of the Arctic permafrost is resulting in significant greenhouse gas emission, both from physical and microbiological processes. The potential impact of greenhouse gas release from Antarctica is now also being investigated. In Antarctica, the McMurdo Dry Valleys comprise 10% of the ice-free soil surface areas in Antarctica and like the northern polar regions are also warming albeit from lower mean temperatures. The work presented herein examines a comprehensive sample suite of soil gases (e.g., CO2, CH4 and He) concentrations and CO2 flux measurements conducted in the Taylor Valley during the Austral summer 2019/2020. Analytical results reveal the presence of significant concentrations of CH4, CO2 and He (up to 18,447 ppmv, 34,400 ppmv and 6.49 ppmv, respectively) at the base of the active layer. When compared with the few previously obtained measurements, we observe increasing CO2 flux rates (estimated CO2 emission in the study area of 21.6 km2 ≈ 15 tons day-1). The distribution of the gas anomaly, when compared with geophysical investigations, implies an origin from deep brines migrating from inland (potentially from beneath the Antarctic Ice Sheet) towards the coast beneath the permafrost layer. These newly obtained data provide a baseline for future investigations aimed at monitoring the changing rate of greenhouse gas emission from Antarctic permafrost, and the potential origin of gases, as the southern polar region warms.

Early onset of the Antarctic Cold Reversal in the Ross Sea region – Potential Drivers and Implications

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The Roosevelt Island Climate Evolution (RICE) project recovered a 763.4 m deep ice core to bedrock from Roosevelt Island, at the northern edge of the Ross Ice Shelf. The ice at Roosevelt Island is grounded 210m below sea level and accumulates in situ, with the Ross Ice Shelf flowing around the rise. Comparison of the modern RICE isotope data with meteorological records suggest that the record is representative of the temperature variability in the Ross Sea Region, the Ross Ice Shelf and western West Antarctica. In addition, the analysis shows that the RICE record is particularly sensitive to changes in regional sea-ice extent and low and mid latitude climate drivers, in particular to the combined effects of the El Niño Southern Oscillation, the Pacific Decadal Oscillation and the Southern Annular Mode1. Here, we show gas, isotope, geochemical and physical properties data spanning the past 65 ka and discuss reconstructions of environmental conditions and ice dynamics. The age model is based on synchronization of CH_4 and $d^{18}O_{atm}$ records with the WAIS Divide Ice Core[2]. High resolution CH_4 and $d^{15}N$ records support analysis of the precise interhemispheric phasing of events. Our data suggest that the Ross Sea region entered conditions of the Antarctic Cold Reversal that preceded the onset Bólling Transition by ~125 years and preceded the WDC ARC onset by ~300 years. We interpret this early onset to reflect a change in atmospheric conditions that led to a reduction in snow accumulation and early, regional isotopic cooling.

Hydrological system controls on the Müller Ice Shelf, Antarctic Peninsula

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Over the last two decades, the Antarctic Ice Sheet has been losing mass, especially in the northern Antarctic Peninsula and the Amundsen Sea regions. Velocities of glaciers and ice streams in these areas have accelerated due to diminished “buttressing” from fringing ice shelves, which have either vanished completely or lost volume in response to atmospheric and oceanic forcing. Hydrofracturing and shelf flexure under the weight of liquid water have been identified as leading causes for ice shelf disintegration, yet many aspects of the hydrologic system on ice shelves have not been studied in detail in the field. This study aims to improve our understanding of the hydrological processes on ice shelves and how they affect ice shelf dynamics.
To achieve this objective, we address the following three goals: to quantify meltwater generation and refreezing on an ice shelf; to map movement of meltwater across and through an ice shelf; and to link the observed hydrological system structure with ice shelf dynamics. We tackled these goals by combining field based measurements on the Müller ice shelf with laboratory, remote sensing and modelling approaches. The main results include: the Müller ice shelf contains firn aquifers; refreezing and meltwater processes changed firn stratigraphy and impact ice shelf mechanical properties; and differential ice flow dynamics on the eastern and western sides of the ice shelf match hydrological structure. The work has produced a new model framework of ice shelf processes, and produced a useful validation dataset for modelling studies.

Kinematics and dynamics of the lateral shear margin of the Priestley Glacier: implications for understanding ice sheets.

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Shear zones at the margins of fast moving ice streams and outlet glaciers have a significant control on the rate of Antarctic ice flow. To predict the evolution of ice sheets in a warming world, we need to understand the processes that control ice deformation in shear zones and the mechanical behaviour of the shear zone ice. On-ice investigations are crucial to constrain better the inferences from remotely sensed data. There have been very few on-ice investigations of Antarctic shear margins, and only two (including this one) that have collected ice from a lateral shear margin. The Priestley Glacier feeds the Nansen Ice shelf in Terra Nova Bay. We have completed three field seasons of work on the true left shear margin of the Priestley Glacier, a few km downstream of the grounding line. Our field data allow us to constrain shear margin geometry and thermal structure, shear margin surface velocity and strain rate fields on the tidal to 3 year scale and the pattern of ice structure and elastic anisotropy on the m to 100m scale. A 60m ice borehole allows us to compare measurements of ice fabrics and layering with larger scale geophysical measures of anisotropy and provides samples for measurement of mechanical properties and anisotropy. Shear zone ice is highly anisotropic, is much weaker than any “ice” used in ice sheet models and mechanical properties are modulated by tidal rate variations. It is important to assess how these complexities will impact ice sheet models.

Speeding up seismic reflection surveying of the seafloor below the Ross Ice Shelf with a towed streamer and surface detonations

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Seismic reflection surveying has been proven to be useful at imaging the sedimentary units that make up the seafloor beneath ice shelves. Often, the preferred acquisition technique is similar to that which would be used on land, with buried explosive charges used as the source and surface geophones used to detect the signal returning from reflectors in the subsurface. However, this technique is labour intensive on an ice shelf as a hot-water drill is required to melt the hole (usually to a depth of 25 m) housing the source and geophones must be deployed manually. During the 2021-2022 season, a short (2.7 km long) seismic line was acquired in the Discovery Deep area of the western Ross Ice Shelf – coincident with a section of a “conventional” hot-water drill explosive survey – to evaluate the methods pioneered by Alfred Wegener Institute (AWI) researchers elsewhere in Antarctica and Greenland. This new technique involved 10 m lengths of detonator cord exploding on the surface and recorded into a 300 m long 96-channel gimballed geophone streamer towed behind a snowmobile. The AWI method was found to be up to four times as efficient, in terms of acquisition time, as the original method. Although the frequency content of the data is lower, the new method does not need to content the surface ghost (related to the 25 m deep shots in the original method) and all significant reflective units in the seafloor can be readily identified. We plan to make use of this efficiency to collect 80 km of new seismic reflection data in the coming season.

32. Major modes of climate variability dominate Antarctic ice-sheet and glacier elevation changes 2002-2020

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We investigate the relationship of large scale modes of climate variability with gridded Antarctic ice-elevation time series derived from satellite altimetry. We explore the presence and partial variance explained by the Southern Annular Mode (SAM), ENSO, and the location and strength of the Amundsen Sea Low. Multiple linear regression of time-integrated SAM and ENSO indices show strong and spatially coherent patterns across Antarctica. Smoothing these results shows very close agreement with the pattern derived from GRACE over the same period. We find that SAM and ENSO routinely explain more than 50% of the partial variance of the ice sheet elevation. Within the Amundsen Sea embayment we explore the addition of regression terms relating to the time-integrated location and strength of the Amundsen Sea Low although these are highly correlated (0.8) with time-integrated ENSO and SAM, respectively. Examining ice elevation time series near the fronts of Pine Island, Thwaites, and Totten glaciers, we find that approximately 80% of the variance of each of the detrended time series is explained by a combination of these climate modes. By contrast we find no obvious signal at the Denman Glacier front over this period. Applying a model of firn densification does not remove the signals, while ice discharge variability over relevant timescales is small, suggesting that errors in the surface mass balance model may be non-negligible over the timescales of relevance for one or more of these climate modes.

33. GPS rates of vertical bedrock motion suggest late Holocene ice-sheet readvance in a critical sector of East Antarctica

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We investigate present-day bedrock vertical motion using new GPS timeseries from the Totten-Denman Glacier region of East Antarctica (~77-120°E) where models of glacial isostatic adjustment (GIA) disagree, glaciers are likely losing mass, and few data constraints on GIA exist. We show that varying surface

mass balance loading (SMBL) is a dominant signal, contributing random-walk-like noise to GPS timeseries across Antarctica. In the study region, it induces site velocity biases of up to ~+1 mm/yr over 2010-2020. After correcting for SMBL displacement and GPS common mode error, subsidence is evident at all sites aside from the Totten Glacier region where uplift is ~1.5 mm/yr. Uplift near the Totten Glacier is consistent with late Holocene ice retreat while the widespread subsidence further west suggests possible late Holocene readvance of the region's ice sheet, in broad agreement with limited glacial geological data and highlighting the need for sampling beneath the current ice sheet.

34. Drivers of the sudden Antarctic sea-ice decline events

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Antarctic sea-ice extent showed an unprecedented decline during 2015/16 after showing a weak positive trend since the last four decades. Many studies have attempted to understand the reasons behind this sudden decline in the sea-ice and have shown important influences from the atmosphere as well as the upper ocean processes. In this study, we attempt to understand similar sudden Antarctic sea-ice decline episodes in the long pre-industrial control simulations from multiple CMIP6 models. We examine the change in sea-ice extent from August to December and classify the events as sudden decline events based on the magnitude of this change. Composite analyses are then carried out to understand the similar atmospheric as well as oceanic processes at play during such events. Preliminary analyses suggest an important role of the Zonal wave 3 amplification during September – October period followed by a negative SAM during November-December, similar to what was observed during 2016. More detailed analysis are currently being carried out and the results will be presented during the conference.

35. Dating Antarctica's largest known pre-Quaternary landslide and its implications on the topographic evolution of the Transantarctic Mountains

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In the 1960s, geologists discovered giant landslide deposits in the Transantarctic Mountains, which separate and influence the East and West Antarctic Ice Sheets. These landslides, likely some of the oldest landslides to exist on Earth, have fortuitously survived for millions of years in the Transantarctic Mountains due to Antarctica's arid polar climate. They hold important clues about the topographic evolution of the Transantarctic Mountains, as well as the tectonic and climatic conditions at the time of failure. Here, we present the current state of knowledge of the largest of the known pre-Quaternary landslides in the Transantarctic Mountains, the Mackellar Landslide, speculate about its age, and describe possible avenues for dating this ancient landslide. The Mackellar Landslide (Figure 1) is largely known from three cones of south-east dipping sandstone and shale debris capping the ridge running from Mt Mackellar (4,297 m asl) to Fairchild Peak (2,180 m asl) in the Queen Alexandra Range. A scar on the north-west face of Mt Mackellar is the presumed source of the debris, with the most distant cone being an impressive 16 km from its presumed source, and 1,000 m lower. We hypothesize that the growth of local topography leading to this massive landslide was a response to a peak in uplift and erosion rates some millions of years after the Transantarctic Mountains began rising ca. 55 million years ago. The debris on slicken-sided surfaces on a ridge ca. 400 m above today's glacier surface requires emplacement of the landslide prior to the establishment of the present, largely frozen, landscape at about 14 Ma. We therefore judge the likely age range to be between 55 Ma and 14 Ma. By that time, the Transantarctic Mountains were being actively eroded, and rising through a periodically over-riding East Antarctic Ice Sheet. Secondary mineral growth identified in thin-sections of a Mackellar-derived landslide breccia offers one potential avenue for measuring the age of the landslide. Other potential dating methods will be discussed. Dating of this degraded Cenozoic landslide, for which standard methods of landslide dating do not work, would be a significant achievement and pave the way for direct dating of other ancient landslides in Antarctica and elsewhere.

36. Structural and microstructural responses to shear localisation in the lateral margin of the Haupapa/ Tasman Glacier

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Valley glacier deformation kinematics inform ice sheet modelling. Ice microstructures, including c-axis alignment and grain size distributions, can be used to understand the kinematic and dynamic history within ice masses. Such data tells us about processes to include to improve the robustness of predictions of ice sheet response to climate change. There are limited microstructural measurements where deformation kinematics are constrained. Haupapa is an accessible location to study the structural and microstructural response to strain in a temperate valley glacier. We have identified a lateral shear margin on the true-left of the glacier, allowing examination of structures and microstructures within a shear zone. Large-scale observations and structural measurements allowed selection of large oriented samples for microstructural analysis. The samples were cut into parallel 5mm slabs of ~A4 size. The 3D ice microstructure (grain shapes/sizes) was built from polarized light images of each slice. Selected slices were analysed further using a fabric analyser (measures c-axis orientation) and cryo-electron backscattered diffraction (cryo-EBSD, measures full crystallographic orientation). The samples have coarse (~20mm) ice grains with lobate irregular boundaries and internal low angle boundaries and lattice distortion. Aggregates of finer (~1mm) sub-polygonal ice grains localise in ~10mm blobs and planar layers, which are folded. The coarse grains have c-axes aligned sub-perpendicular to the dominant layering and shear plane, matching laboratory experiments. The fine grains have an almost random c-axes alignment. This has never been observed in naturally deformed ice and may represent rapid localized shear, with implications for shear margin mechanics.

37. Understanding Ice Dynamics through Natural Ice Air Bubbles and Their Deformation

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The shape of air bubbles and air bubble behaviours in natural ice may provide a greater understanding of ice dynamics. Micro-computed tomography (Micro-CT) and optically imaged data collected from samples from the lateral shear margin of the Priestley Glacier show the variation of bubble shape. These bubbles are less stretched than we would expect for the amount of shear. This poses the question of what controls the kinetics of bubble shapes. How do deformation conditions (e.g., temperature, strain rate) affect the balance between bubble deformation (stretching the bubbles) and restoration to a sphere, driven by surface energy. We are investigating this using a deformation experiment that allows for the removal of the ice sample to take photos of the bubbles and the return of the sample for more deformation after this. The photos taken at regular time intervals dring deformation allow us to better understand the process es and changes occurring during deformation. In preliminary experiments the sample had been cut at 45 to the c-axis maximum, to mimic the deformation in the field, and removed for imaging every 23-26 hours. The sample was put under ~0.55MPa of stress at ~-11 C. The experiment run time was 172 hours, achieving a total axial strain of 0.18 at strain rates of 3x10-7s-1 (10a-1). The bulk strain and the strain calculated from bubble shape change are very similar, suggesting that at these fast rates bubble deformation is much faster than restoration. Experiments at slower rates are needed to scale back to natural conditions.

38. East Antarctic Ice Sheet variability during the middle Miocene Climate Transition captured in drill cores from the Friis Hills, Transantarctic Mountains.

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A recently recovered drill core record from a sedimentary sequence in the Friis Hills, East Antarctica, offers rare insight into terrestrial environmental change and East Antarctic ice sheet dynamics from the end of the Miocene Climate Optimum (MCO) through the Middle Miocene Climate Transition (MMCT; 15.1–13.8 Ma).

Sixteen cycles comprising diamictite and fossil-rich sandstone and mudstone were recovered. Paleoecologic and sedimentologic characteristics of organic-rich lithologies suggest the Friis Hills hinterland was likely ice free during interglacials. Major disconformities in the section suggest a transition to colder climates and thicker more extensive and erosive ice cover across the Friis Hills during glacial episodes, occurred after ~14.7 Ma. Thick diamictites in the upper three cycles are less well-dated but suggest that climate cooled and became drier after ca. 14.2 Ma. However, cyclical retreat of the ice and a return to warm climate conditions during interglacials continued through ca. 13.9 Ma. Glacial-interglacial cycles through much of the sequence are ~23 k.y. in duration, suggesting that the margin of the EAIS was most sensitive to climate change paced by astronomical precession. Sedimentary cycles comprising thin diamictites and relatively thick interglacial sandstone and mudstone units coincide with intervals of maximum eccentricity (high seasonality). Cycles comprising thick diamictites and relatively thin interglacial sedimentary deposits coincide with intervals of minimum eccentricity (low seasonality). New paleotemperature reconstructions based on biomarker proxies indicate average interglacial temperature was ~6 C. Proxy CO2 records suggest that average atmospheric concentrations decreased below ~400 ppm between 14.8 Ma and 14.6 Ma. Deep-sea δ18O records also suggest that increased ice volume during glacial episodes occurred after this fall in CO2. The FHDP data support results from other offshore drilling projects and modeling studies indicating that ~400 ppm represents a threshold above which Earth's average climate warms to the point that Antarctica cannot sustain marine-based ice sheets. Today, CO2 concentrations are ~416 ppm and climbing. We have potentially crossed a key climate threshold, thereby reversing a major cooling step in the Cenozoic evolution of Earth's climate system that has lasted for ~13 m.y

39. Experimental deformation of anisotropic ice from the shear margin of the Priestley Glacier.

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Both field studies and laboratory experiments have shown that deformation of polycrystalline ice results in the formation of fabrics, that produce significant mechanical anisotropy. Fabric plays an important role in producing accurate models for ice streams and glaciers, as shear margins with strong fabrics are understood to facilitate ice stream flow and stability.

Furthermore, many of the numerical models for ice streams tend to have the highest degrees of error within these shear zones. While many studies have used a variety of remote and ground surveying techniques, ice-core observations and numerical modelling methods to better understand the effect mechanical anisotropy has on ice flow, there are few experimental laboratory deformation data published on the issue. We provide data from laboratory experiments showing the significant effect that fabric orientation relative to compression direction has on strain symmetry, mechanical strength, fabric evolution and microstructural characteristics of polycrystalline ice deformed at 3 different strain rates. Our experiments use ice from the Priestley Glacier shear margin, which is characterized by very strong horizontal c-axis maxima subperpendicular to the shear plane. Cylinders cored parallel to the c-axis maximum are up to 5 times as strong in axial compression as those cored 45 degrees to the c-axis maximum. Cylinders cored 45 degrees and perpendicular to the c-axis maximum undergo approximate plane strain while cylinders cored parallel undergo pure shear flattening. Microstructural data shows kink banding is an important deformation mechanism within the 45 degree and perpendicular cylinders. These experiments provide important constraints for modelling parameters

40. The mechanical response of a shear margin to tidal forcing: Priestley Glacier, Antarctica

Holly Still[1], Christina Hulbe[1], Martin Forbes[1], David Prior[1], Hamish Bowman[1]
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Antarctic outlet glaciers are restrained by lateral drag within shear margins, localised zones of intense ice deformation. Shear margin properties (ice temperature, crystal fabrics, ice thickness) affect glacier sensitivity to ocean or climate perturbations. This study examines the tide-modulated mechanics of the glacier-left, floating shear margin of Priestley Glacier, Antarctica. We observed 3D ice motion over three weeks in January 2020 with a combination of high-precision GNSS and optical-electronic total station positioning. Precise total-station positioning allowed us to measure across-flow ice flexure and surface strain in response to the diurnal ocean tide. These datasets informed a tidally-forced 2D dynamic bending model, used to examine how vertical ice motion, horizontal strain and stress states are affected by different representations of shear margin ice stiffness and by lateral boundary conditions (extent of ice coupling at the margin).In November 2022, we returned to Priestley Glacier and installed a larger network of six GNSS receivers to track ice motion, and two continuously operating robotic total stations to observe ice surface strain. These observations will motivate further development of the ice flexure model and improve our understanding of shear margin mechanics.

41. Discovery Deep, Antarctica, characterised by seismic and gravity surveys

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Seismic reflection and gravity surveys were undertaken during the 2021-2022 summer in the Discovery Deep area of the western Ross Ice Shelf. A 30 km long seismic reflection survey imaged the details of the seafloor and underlying stratigraphy. A 2 km spaced gravity grid ties past regional gravity and bathymetry models. The surveys provide new controls for models of the bathymetry, sedimentary basin, and local crustal units.
The seismic data image an anticlinal package of sedimentary units that have been eroded near the seafloor, probably by successive glaciations. The absence of seafloor-draping strata in the data suggests that there is very little Holocene sediment on the ocean floor. The seismic image shows no break in the slope of the seafloor which plunges shoreward at ~ 0.4°, suggesting that the bottom of the basin lies further west. The interval velocity model indicates varying velocities within the seafloor sediments across the profile. A second seismic reflection survey was conducted along the central 2.7 km of the original survey using a towed snow streamer and surface shots. This method was found to be about four times as efficient in terms of acquisition time. The quality of the stacks is comparable (lower frequency).

42. Ice Deformation Mechanisms: Effect of grain size and sample size on ice rheology

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Laboratory deformation ice samples are miniscule – relative to nature – and concerns arise surrounding upscaling mechanical and rheological properties to large-scale structures. Comparisons of inter-laboratory minimum strain experiments against sample diameters identified a sample size effect. We propose this mechanical discrepancy is caused by a weak rim thickness, controlled by the grain size. To investigate this idea, we uniaxially deformed large diameter (70 mm) polycrystalline synthetic ice past minimum strain (1%) at high temperatures (-5 °C) and compared the results to previously deformed small (27 mm) and medium (40 mm) diameter samples following the same methodology and conditions.

Preliminary data suggests ice rheology is grain size dependent and supports the idea of a weak rim with thickness controlled by grain size. We further deformed two samples up to high strain aiming to eliminate the complex geometric response. We consecutively re-lathe the same sample – to restore a cylindrical shape – after small increments of strain (5%) and repeated this process with the aim of reaching a cumulative high strain of 20%. At the time of writing, we have achieved strains of up to 8% and obtained consistent results.

43. Visco-elastic deformation of natural ice from Priestley Glacier: implications for tidal deformation of ice shelves

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This poster presents the preliminary results of a laboratory-based data collection program to measure, for the first time, visco-elastic properties of natural ice at frequencies appropriate to tidal flexure in the ice shelf. Antarctica's ice shelves are linked to several significant Earth processes as they stabilise the mass balance of the East Antarctic Ice Sheet and drive thermohaline circulation. Buttressing refers to how ice shelves restrain the flow rate of grounded glaciers, protecting the ice sheet from increased melting and associated sea level rise. However, the microscale mechanisms of these shelves are poorly understood, especially viscoelastic properties. Ice collected from the lateral shear margin from Priestley Glacier in 2019/2020 will be deformed in June 2023.
We will use a cutting-edge piezoelectric device that will apply high stress at low frequencies to mimic the large strain amplitude of tidal cycles on the ice shelf. These methods will be conducted at Lamont-Doherty Earth Observatory. The high strain amplitude and low frequency required to model tidal energy is difficult to conduct on on ice. We hope to present data that reflects this visco-elastic deformation associated with tidal flexure.

SEA-ICE INTERACTIONS

Investigations of sea ice and ocean processes, interactions of the ocean with ice shelves and sea ice, as well as the influence of sea ice on a global climate system.

SEA-ICE INTERACTIONS

Chair: Tim Spedding, Australian Antartic Division

ORAL PRESENTATIONS

An unprecedented season for sea ice: a view from the ocean

Natalie Robinson[1], Brett Grant[1], Ollie Twigge[1], Craig Stewart[1], Greg Leonard[2], Ken Ryan[3]

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The 2022 Antarctic sea ice growth season was unprecedented in the satellite era, including the lowest pan-Antarctic September extent on record. In McMurdo Sound the fast ice cover formed and re-formed several times until the end of August, when a stable cover was finally established – four months later than usual. This local effect was driven by a series of southerly storms that drove extreme activity of the McMurdo Sound polynya. As a result, new sea ice growth occurred throughout the winter, driving deep and persistent brine rejection. This offset in timing also affected recruitment of, and into, the sub-ice platelet layer (SIPL). This resulted in two highly differentiated SIPL regimes which were exploited for surface-based sampling in October and November. Here we present new ocean data from southern McMurdo Sound, captured throughout this unusual season with a novel seafloor-mounted mooring. Instead of the expected homogenising of the water column through the autumn months, significant spatial and temporal variability persisted through to the end of the winter months, to depths as great as 250 m below sea level.

The Influence of Snow on Antarctic Sea Ice Evolution: Drone-based Mapping of the Snow Surface Temperature

Julia Martin[1], Ruzica Dadic[1,2], Roberta Pirazzini[3], Lauren Vargo[1], Oliver Wigmore[1], Martin Schneebeli[2], Brian Anderson[1], Henna-Reetta Hannula[3], Huw Horgan[1,2]

[1]Victoria University of Wellington, Antarctic Research Centre, Wellington, New Zealand, [2]WSL Institute for Snow and Avalanche Research SLF, Davos, Switzerland, [3]Finnish Meteorological Institute, Helsinki, Finland

Antarctic sea ice is a key parameter for Earth's energy balance. The snow cover dominates the variability of sea ice's thermal and optical properties and is essential to understanding sea ice growth and decay. It governs the energy and mass fluxes between the ocean and the atmosphere, sea ice thickness, bottom water formation, and ocean circulation. The current lack of data on the physical properties of the snow and its effect on sea ice leads to large uncertainties in the coupling of climate feedback and results in significant biases in model representations of the sea ice cover. To increase our understanding of the snow-sea ice - interactions, we quantitatively investigated the physical properties of snow on Antarctic sea ice (McMurdo Sound, October – December 2022) using a wide range of ground-based and airborne instrumentation. Here, we present a drone-based method and results for infrared mapping of the snow surface temperature combined with ground surveys of snow depth and sea ice thickness. We used a DJI Matrice 30T drone to simultaneously take RGB and infrared images of the surface and ice of 5 different 200x200 m measurement fields with different freezing histories. One of the measurement fields is located in a transition zone between sea ice of two different ages (March 2022 and August 2022, respectively) with different snow thickness distributions. We georeference the drone imagery using ground targets and a mobile DGPS system to account for the vertical tidal displacement. We correct the temporal temperature changes during the flight using hot ground targets and mobile infrared sensors positioned within the drone footprint. We then explore the link between surface temperatures and the spatial variability of snow depth and ice thickness. This multiparameter 2-D approach allows us to study the influence of the spatial distribution of snow on the surface energy balance of the snow-sea ice-ocean system and on sea ice evolution.

Sea ice thickness in the western Ross Sea and a vision for beyond

Daniel Price[1], Wolfgang Rack[1], Patricia Langhorne[2], Christian Haas[3], Greg Leonard[3], Gemma Brett[1], Nathan Kurtz[4], Steven Fons[4]

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Antarctic sea ice is a stabilizing factor for global climate. But, as sea-ice thickness is particularly difficult to measure, it has an unknown mass trend. Airborne electromagnetic induction (AEM) is the only remote method of sea ice thickness determination that does not rely on the uncertain deduction of ice thickness from freeboard. In November 2017, using AEM techniques from Basler JKB, we conducted the first survey of thickness distributions in the Ross Sea over 700 km of fast ice and 800 km of pack ice. Rough ice occupied 41% of the fast ice transect by length, 50% by volume. Driven by compaction against the coast, the thickest 10% of rough ice was almost 6 m thick on average. Interaction with ice shelf melt water caused level fast ice to be thicker because of a sub-ice platelet layer (SIPL) beneath the consolidated ice, implying vigorous heat loss to the ocean in some places. The surveyed pack ice was thinner than the first-year fast ice, but about twice as thick as in the central Ross Sea. Sea-ice thickness gradients were highest at polynya boundaries, where the thickest 10% of ice was ~8 m. Overall, 80% of the pack ice was heavily deformed, concentrated in ridges 3–12 m thick. Significantly, AEM data were near-coincident with CryoSat-2 radar altimeter overflights. These show that the satellite appears to consistently underestimate the coastal pack ice thickness distribution by ~50%, This highlights the urgent need for reliable sea ice and snow thickness estimates at regional scales.

The Terra Nova Bay Polynya activity in the new coupled model Polar-SKRIPSv1

Alena Malyarenko[1,2], Alexandra Gossart[2], Yoshihiro Nakayama[3]

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The polynyas are the ice factories found around the Antarctic coast, responsible for heat and mass exchange between the atmosphere and the ocean. The sea ice production of the Terra Nova Bay Polynya, which grows only to about 3000 km^2, is responsible for up to 10% of total Antarctic Bottom formation in the Southern Ocean. The dense water, formed in the Terra Nova Bay Polynya, flows northwards and has been observed to outflow from the Ross Sea with a tidal signal. We have developed the first fully coupled regional model Polar-SKRIPSv1 for the Ross Sea. We use the Polar-SKRIPSv1 as published in Malyarenko et al. (2022). This coupled model uses the MITgcm model of the ocean, and the Polar version of the Weather and the Weather Research and Forecasting Model (PWRF). Our model is unique in conserving energy and can operate at the regional scale, making it the best tool to study mesoscale processes in the Ross Sea and make predictions on how variability of local wind jets above the continental shelf can impact the salinity and temperature of the ocean, and thus global thermohaline circulation. In this presentation we show a case study for 2017. We focus on the sea ice production, heat and mass fluxes in the Terra Nova Bay Polynya, and show how the polynya activity depends on the poorly constrained parameters, such as drag coefficient between air and ice, and ice and water.

Does the floe size distribution in the marginal ice zone follow a power law?

Fabien Montiel[1], Nico Mokus[1]

[1] *University of Otago, New Zealand*

In this talk, we question the long-standing hypothesis that sea ice fragment (or floe) size in ice-covered oceans follows a power law statistical distribution. Since the early 1980s, aerial images of fragmented ice covered were analysed under this paradigm. From a process-oriented perspective, the emergence of the power law floe size distribution (FSD) as a result of the repeated fragmentation of an ice sheet is hard (though not impossible) to justify. We developed an idealised model simulating the floe-resolving repeated fragmentation of an initially infinite viscoelastic ice cover under the forcing of ocean waves. Under a broad range of sea ice and wave conditions, we find that the resulting FSD follows a log-normal distribution, not a power law. Re-analysing several legacy datasets under this new paradigm further supports our finding. Finally, we propose a simple repeated fragmentation process for which the log-normal distribution of fragment sizes naturally emerges. Based on our analyses, we suggest that future measurements of floe sizes be statistically qualified via a log-normal distribution as opposed to a power law.

Heat and water mass distributions in the Ross Sea from observations and model simulations

Denise Fernandez[1], Craig Stevens[1,2,] Melissa Bowen[3], Craig Stewart[1]

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The regional oceanography of the Ross Sea Antarctic embayment is, in relation with other circumpolar regions, one of the best-sampled in terms of high-quality hydrography. However, the observations are sparse on the continental shelf, particularly over the water mass formation regions that are likely to have the most significant trends in temperature and salinity. Therefore, the understanding of the ocean circulation on the continental shelf is still evolving. In addition, the in situ shipboard observations have a seasonal bias because accessibility to the region is challenging during the Austral Winter. Autonomous profiling floats provide an extension of all year-round upper ocean measurements. With increasing float availability and high-resolution model simulations and improving state estimates in the Ross Sea there is now an opportunity to investigate the heat pathways and trends in fundamental physical parameters. In this talk I will describe these advances and comparisons and discuss future planning for a Ross Sea Observatory based on coordinated efforts with other national programs.

The stability of the Denman Ice Shelf System

Sarah Thompson[1], Sue Cook[1], Bernd Kulessa[2,3], Ben Galton-Fenzi[4], Duanne White[5,6]

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The Denman Glacier in East Antarctica drains a large area of the East Antarctic Ice Sheet (EAIS), containing enough ice to raise global sea levels by 1.5 m. The glacier system is currently stabilised by a large floating ice shelf system, slowing the flow of ice from the interior of the EAIS to the ocean. However, if these ice shelves were to retreat the Denman Glacier could accelerate significantly and thus move more ice from the ice sheet interior into the ocean. Designed as part of the Australian Antarctic Program's Denman Terrestrial Campaign, we present collaborative field plans for the 2023-24 season which examine key processes likely to affect the future stability of the Denman system (i) ice shelf thinning and flow, (ii) surface hydrology, and (iii) ice fracture. Through a combination of remote-sensing, geophysical and borehole techniques, we aim to undertake some of the first coincident measurements of ocean heat supply, basal melting, and ice shelf response for a marine subglacial basin region. Results will not only provide a better understanding of the evolution and stability of the Denman system and future contribution to sea level rise but will also provide valuable insight into key parameters that control the dynamics of East Antarctic ice shelves. Datasets will be used to both validate and complement satellite remote sensing missions, contribute to international airborne geophysical campaigns, and improve our understanding of the ice shelf systems system to allow better incorporation into the models used to predict future sea level rise.

44.

The Influence of Snow on Antarctic Sea Ice

Julia Martin[1], Ruzica Dadic[1,2], Roberta Pirazzini[3], Martin Schneebeli[2], Brian Anderson[1], Bin Cheng[3], Petra Heil[4], Henna-Reetta Hannula[3], Mario Hoppmann[5], Polona Itkin[6], Matthias Jaggi[2], Michael Lehning[2], Greg Leonard[7], Bonnie Light[8], Henning Löwe[2], Amy Macfarlane[2], Wolfgang Rack[9], Natalie Robinson[10], IngaSmith[7], Lauren Vargo[1], Benjamin Walter[1], Melinda Webster[8], Oliver Wigmore[1], Fabian Wolfsperger[2]

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Snow cover affects the variability of the physical properties of sea ice. The snow's unique thermal and optical properties govern the mass and energy fluxes in the sea ice system. They are important for sea ice evolution, the energy exchanges between the ocean and the atmosphere, and light availability for ecosystems below the sea ice. Furthermore, snow significantly impacts remote sensing retrievals, especially for sea ice thickness. Yet, data on the physical properties of snow and its effects on sea ice are extremely limited, especially in Antarctica. This leads to large uncertainties in the coupling of climate feedback and results in significant biases in model representations of the sea ice cover. During our field campaign from October to December 2022 in McMurdo Sound, we quantitatively investigated the physical properties of snow on Antarctic sea ice, following the same protocols used during the MOSAiC expedition. The season's unique sea ice conditions provided the ideal laboratory to study a range of snow conditions and to differentiate between sea ice and snow drivers for the atmosphere-sea ice-ocean system. Our set of snow measurements on sea ice, unprecedented in Antarctica, includes ground snow/ice measurements, automatic weather and radiation stations, and drone-based measurements. These extensive measurements made it possible to capture the physical properties of snow and their spatial variability and simultaneously measure the different components of the energy balance at varying spatial scales. We will use this dataset to improve our understanding of the role that snow plays in the Antarctic sea ice system.

45. Illuminating the Dark: Unravelling the Mystery of Light Harvesting Bacteria in Sea Ice

Ian Blixt[1], Andrew Martin[1], Mark McGuiness[2], Ken Ryan[1]

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In response to global anthropogenic climate change, sea ice extent across the Southern Ocean is becoming highly variable on an annual basis, with 2022 being the lowest sea ice extent on record. Within sea ice of the Southern Ocean there is a highly productive microbial ecosystem that produces nearly 40 million tonnes of biogenic carbon annually, representing an important food source for a range of marine keystone species such as krill and silverfish. As sea ice extent changes in response to climate change, so does the availability of the Sea Ice Microbial Community (SIMCO) as a food source. Thus, there is an urgent need to predict the ecological outcomes associated with changing climate and sea ice conditions. However, the recent discovery of rhodopsin-based phototrophy in sea ice bacteria has fundamentally questioned our understanding of the sea ice microbial loop, and thus our understanding of SIMCO overall. In this presentation, I will discuss the Photoheterotrophic eXtremophiLes (PXL) model, a logistic growth model based on dynamic energy budget theory that I am currently developing. When complete, PXL will describe how this novel phototrophy affects bacterial abundance throughout the ice column. I will present preliminary results of this model, discuss how I will use it to create more accurate estimates of total annual SIMCO biomass, and discuss how that can be used to link climate processes and ecosystem dynamics in the Ross Sea.

46. Incorporating Dynamic Ice Sheets into the New Zealand Earth System Model

Alanna Alevropoulos-Borrill[1], Jonny Williams[2], Robin Smith[3], Stephen Cornford[4], Dan Martin[5], Nicholas Golledge[1], Dan Lowry[6], Stefan Jendersie[1], Tony Payne[4], Claire Donnelly[7]

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Earth System Models (ESMs) are essential tools for projecting the climate response to changing anthropogenic emissions. Within ESMs, component models representing the atmosphere, ocean, land and sea ice are fully coupled, meaning that they frequently interact. While the existing suite of ESMs are

the most complex models used for future climate projection, they lack representation of dynamic ice sheets. As such, simulations of ice sheets are often stand-alone, meaning only the one-directional influence of the climate on the ice sheets is considered. In reality, the evolution of the ice sheets impacts the ocean and atmosphere on local to global scales. The incorporation of ice sheet evolution in ESMs is therefore a critical issue to address in order to represent important ice-climate feedbacks. Here, we present the method for coupling of the BISICLES ice sheet model to the New Zealand Earth System Model (NZESM) based on the implementation of the coupling for the UK Earth System Model (UKESM1.0-ice). This presentation describes the coupling process, while highlighting the challenges and limitations of the method. We additionally propose an updated method of coupling to incorporate an improved representation of sub-ice shelf melt rates for the Antarctic Ice Sheet. This coupling protocol will improve the representation of present-day rates of ice sheet change and provide greater confidence in future projections of both the climate and global sea level.

47. The Salinity Budget of the Ross Sea Continental Shelf, Antarctica

Liangjun Yan[1], Prof. Zhaomin Wang[2], Chengyan Liu[2], Craig Stevens[3], Alena Malyarenko[3], Denise Fernandez[3]

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Toward understanding the trend and variability in the bottom water salinity in the Ross Sea, this study focuses on the seasonality of the salinity budget over the Ross Sea continental shelf, using a new coupled regional ocean-sea ice-ice shelf model. Owing to the sea ice production, the upstream advection, and the glacial melting, the Ross Sea continental shelf is characterized by the relatively saltier water on the western shelf than on the eastern shelf, with the saltiest water in the Terra Nova Bay Polynya. During the early freezing season (March–April), there is remarkable sea ice production over the broad continental shelf, which makes a significant contribution to the production of High Salinity Shelf Water (HSSW). The brine rejection in the polynyas leads to the salinification and deepening of the mixed layer, yet the upstream advection acts to decrease the salinity below the mixed layer until the deep convection is fully developed throughout the water column. The seasonal cycle of the salinity budget in the Ross Sea continental shelf is largely determined by the formation/melting of sea ice, the intrusion of modified Circumpolar Deep Water, and the outflow of HSSW, while the contribution of the Ross Ice Shelf melting is relatively small.

48. Effects of frazil ice in CTDs on measurements of supercooling.

Maren Elisabeth Richter[1], Inga J. Smith[1], Jonathan R. Everts[1], Peter Russell[1], Pat J. Langhorne[1], and Greg H. Leonard[2]

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Salinity effects of particles entrained into conductivity cells have previously mainly been studied in the context of suspended sediment. Particles influencing conductivity cells can also be small ice crystals (frazil) that may form in supercooled water. The detection of supercooled water depends on accurate, high precision temperature, salinity and pressure measurements. As it is currently not possible to measure salinity in situ, the standard procedure is to measure conductance over a known volume and calculate salinity. Frazil ice entrained into a conductivity cell changes the volume of conductive fluid in the conductivity cell, thus changing the conductivity, salinity and supercooling measurements. We present results on the effect of entraining microplastic into a Sea-Bird Electronics (SBE) conductivity cell to simulate the effect of frazil. We show that particle volumes comparable to frazil volumes observed in the ocean change the measured conductivity and led to changes in calculated supercooling between 0.3 mK and 10 mK, possibly up to the same order of magnitude as naturally observed supercooling in the ocean. Further, we demonstrate that where supercooling is present, natural frazil ice concentrations can have an appreciable effect on parameters calculated with both the EOS-80 and TEOS-10 equations of state of seawater. Thus, to ensure accurate measurements in locations of very high frazil concentration, the entrainment of frazil needs to be prevented, which is not possible with methods currently available, or corrected for. An example for such a correction is given in the accompanying paper and could be modified to be applicable to other particles, e.g., sediment.

49. Simulating Antarctic sea-ice using a new brittle rheology

Rafael Costa Santana[1], Guillaume Boutin[2], Chris Horvat[1], Einar Olason[2,] Pierre Rampal[3]

[1]University of Auckland, [2]Nansen Environmental and Remote Sensing Center, [3]Université Grenobles Alpes,

Sea ice plays an important role in determining the exchange of heat, salt, and momentum between the atmospheres and oceans - thus understanding its variability is highly important for projections of future climate. After decades of limited change, Antarctic sea ice has recently undergone a rapid decrease in its extent. It is therefore important to understand the drivers of this poorly- predicted variability to improve climate projections. The Next Generation Sea Ice Model (neXtSIM) is a state-of-the-art Lagrangian model aimed to study the dynamic behaviour of sea ice in response to various environmental factors. We developed an implementation of neXtSIM for the Southern Ocean for the first time, using both a novel brittle Bingham-Maxwell rheology (BBM) and a typical modified Elastic-Viscous-Plastic (mEVP) rheology. We forced the model with ERA5 atmospheric data and the Biogeochemical Southern Ocean State Estimation (BSOSE) ocean fields. We validated the two neXtSIM simulations as well as BSOSE (mEVP Eulerian sea ice model) results using satellite observations of sea ice extent (SIE), thickness (SIT), and drift. The two neXtSIM runs improved upon BSOSE in regard to all variables compared which highlights the importance of using a Lagrangian model to simulate sea ice. The two neXtSIM simulations (BBM and mEVP runs) tended to overestimate SIE by about 2.5 x 106 km2 (14%) in winter and underestimated SIE in 0.1 x 106 km2 (<1%). The BBM had larger average drift in comparison to the mEVP run and better correlated with sea-ice drift observations, with an average complex correlation between modelled and observed velocity vector of 0.73, whereas the mEVP run had a correlation of 0.54. This result can be attributed to the different ways sea ice deforms in the two different simulations. In the BBM run, sea ice fractures more easily and is more effectively transported by the wind and currents. In contrast, sea ice tends to deform as a viscous fluid in the mEVP. The formation of fractures/leads in the BBM run, however, leads to the formation of thicker ice in the Weddell Sea and near the coast, increasing the root mean square error sea ice thickness with observations by up to 15 cm (23%) compared to mEVP run, though smaller than typical observation uncertainty levels (22-45 cm) in thickness. These results demonstrate the promise of neXtSIM, and the BBM rheology, for understanding Antarctic sea ice change. They illustrate that im- proved measurements of sea ice thickness and observations of Linear Kinematic Features (LKFs) are needed to better understand Antarctic sea ice thermo- and dynamics (Kowk, 2017). Such new observations may provide better baselines to calibrate and evaluate thickness and LKFs from the BBM and mEVP runs and in comparison with Eulerian models.

50. Bridging the gap for ice-ocean-ecosystem processes: Case Studies Integrated Observatory for the far East Antarctica-Ross Sea Region RSfEAR

Petra Heil[2,3,] Craig Stevens[1,4], Won Sang Lee[5], Clare Eayrs[5], Hyoung Chul Shin[5], Simon Alexander[2,3,] **Wolfgang Rack[6]**

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Our understanding of cross-disciplinary connections for the Antarctic Earth system remains incomplete, especially around its coastal margins. The focus here is on sea-ice, oceanic and atmospheric drivers in the Ross Sea-far East Antarctic Region (RSfEAR) - one which spans a large longitudinal range and connects a number of ice shelves and polynyas promoting sea-ice growth and underpinning a diverse and rich ecosystem. Here we synthesize recent case study work to inform the design for a regional integrated observing system. The design is built around themes: (i) regional setting, (ii) recent studies in the region, (iii) gap analysis, (iv) future observing system design and (v) wider implications for stakeholders.

51. Holding ice tongues in place– the stabilising force of land-fast sea ice.

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This satellite study looks into the interaction of the ocean with ice tongues by quantifying the current-induced horizontal bending with and without the presence of land-fast sea ice. This study was motivated by the calving of the entire length of the Parker Ice Tongue (18 km or 41 km^2) in March 2020, coincident with repeated summer break-outs of the surrounding land-fast sea ice. A complete ice tongue collapse for these otherwise stable glaciological landmarks along the Victoria Land Coast is previously unrecorded. Ice tongues are unconfined by land on their lateral margins and are sensitive to external forcing from the ocean. They are found sporadically around the Antarctic coast but are common in the western Ross Sea. Lateral flexure creates bending stresses within these ice tongues which is likely to contribute to their fragility and may restrict their wider occurrence.

52. Circumpolar Deep Water vs Ross Sea Polynya: The Present Picture

Nikhil Hale[1], Alexandra Gossart[1], Alena Malyarenko[1,2]

[1]Antarctic Research Centre, Victoria University Of Wellington, Wellington, New Zealand, [2]National Institute of Water and Atmospheric Research, Wellington, New Zealand

The Ross Sea Polynya (RSP) is a critical driver of Antarctic sea ice production and High Salinity Shelf Water (HSSW) formation. The presence of HSSW within the Ross Ice Shelf (RIS) cavity prevents the intrusion of warmer Circumpolar Deep Water (CDW) and reduces basal melting of the RIS. However, Antarctic polynyas remain poorly understood because of limited observation and modelling studies. Therefore, the influence of a future, warmer climate on polynya processes is uncertain. To address this knowledge gap, we aim to investigate the present-day activity of the RSP during 2013-2017 using a high-resolution (10km) regional coupled model, P-SKRIPS. It simulates ocean-atmosphere fluxes and sea ice production well, making it an ideal tool for studying polynya processes. We will analyse the relationship between HSSW production by the RSP, CDW circulation, and basal melting of the RIS. Further, we will explore RSP activity during climatic periods in the Last Millennium, which serve as analogues for future climates. These findings will deepen our knowledge of polynya dynamics and their potential response to future climate change, thereby shedding light on the role of the RSP in the Antarctic ecosystem and having broader implications for climate science.

53. What are the impacts on sea ice and climate from Antarctic ice-mass loss? An introduction to a multimodel experiment

Andrew Pauling[1], Max Thomas[1], Inga Smith[1], Jeff Ridley[2], Torge Martin[3]

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Antarctic ice-mass loss from ice sheets and ice shelves is increasing and is projected to increase further as the climate warms. The fresh water entering the Southern Ocean due to this ice-mass loss has been proposed as a mechanism responsible for the lack of decline in Antarctic sea ice area, in contrast to the loss seen in the Arctic. Though increased Antarctic ice-mass loss is expected to impact climate it is absent from almost all models in the current Coupled Model Intercomparison Project (CMIP6). Previous studies that include changing Antarctic ice-mass loss suggest that the climate response depends on the model used for reasons that are not clear. We use the HadGEM3-GC3.1 model to contribute model experiments to the Southern Ocean Freshwater release model experiments Initiative (SOFIA), an international model intercomparison, in

in which freshwater is added to the Southern Ocean to simulate the otherwise missing ice-sheet mass loss. This intercomparison will allow us to evaluate HadGEM3-GC3.1 against other models and identify reasons for model discrepancies. We will give an overview of the SOFIA protocol and present preliminary results from the “antwater” experiment in which 0.1 Sv of freshwater is distributed evenly around Antarctica at the ocean surface under pre-industrial forcing.

54. Evaluation of sea-ice parameterisations in WAVEWATCH III

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[1]University Of Otago, Dunedin, New Zealand, [2]MetOcean Solutions, Raglan, New Zealand

Sea-ice is a key component of the global climate system. At its outer edge, the marginal ice zone (MIZ) describes the region where ice breaks up into floes under the flexural stresses caused by the passage of ocean waves. The MIZ is typically 10s to 100s of km wide and its retreat or expansion is correlated with mean wave height. Wave induced break-up of the sea-ice is therefore assumed to be an important driver in the outward delineation of Antarctic sea-ice extent. This has led to a flurry of recent studies on understanding ocean-wave sea-ice interactions, followed by a suite of sea-ice dependent attenuation models in ocean wave forecast models. In this work we do the first ever comprehensive evaluation of all of the sea-ice models implemented in the widely used ocean wave forecast model, WAVEWATCH III (WW3). Using default parameter values for each available parametrisation, the ocean waves are hindcast for the Ross Sea for a period that coincides with buoy-in-ice deployments as part of the 2017 PIPERS campaign in the Ross Sea. Buoy data from the PIPERS campaign is then used to evaluate the performance of the different sea-ice implementations in WW3.

55. Coastal sea ice mass balance: a New Zealand - Australian led research effort

Wolfgang Rack[1], Petra Heil[2], Dan Price[1,3], Adrian Tan[4], Christian Haas[5], Nathan Kurtz[6], Irena Hajnsek[7], Pat Langhorne[8]

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Sea ice has the highest mass turnover of all cryosphere components, modifying global climate via albedo, ocean-atmosphere heat flux, and ocean overturning circulation. As sea ice is affected through changes in atmosphere, ocean, and ice sheet processes, explanations of trends in ice extent remain uncertain. The lack of thickness observations is a limiting factor in our understanding of both the gradual increase over most of the satellite era and the recent decrease. Here, we describe a new international research effort to close a gap in sea ice mass balance in an under explored stretch of coastline between Ross Island and Law Dome. It is the region driving the trend in southern hemisphere sea ice cover. Linking sea ice deformation with ice thickness distribution, we target a long-standing problem by quantifying the role of coastal ice in the overall Antarctic sea ice mass balance. Basler DC-3 ice thickness measurements are planned in 2024 between Scott Base and Casey in conjunction with satellite strategies supported by NASA and DLR. Our proposed EM-bird survey flights will gather coincident measurements of ice thickness, freeboard, and snow, accompanied by a multi-sensor satellite data approach. It will enable the determination of representative ice thickness statistics. By analysing key cryospheric variables, we open a window for cross-disciplinary research for sea ice related processes at the basin and hemispheric scales between the Ross Sea and East Antarctic coast. Presenting the overall aims and objectives, we invite discussions about collaborations to explore the wider use of the new data products.

ECOSYSTEMS IN A CHANGING WORLD

Marine, aquatic and terrestrial ecosystems and the impacts of environmental change on diversity, function, and resilience.

ECOSYSTEMS IN A CHANGING WORLD

Chair: Craig Cary, University of Waikato
Michelle LaRue, University of Canterbury

ORAL PRESENTATIONS

Securing Antarctica's Environmental Future – Outcomes and Opportunities

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Securing Antarctica's Environmental Future (SAEF) is an Australia-based, international research program delivering interdisciplinary science to forecast environmental change across Antarctica, the Southern Ocean, and the sub-Antarctic islands, and to underpin effective environmental stewardship strategies in the face of this change. SAEF's research is structured around three main themes – Climate Processes and Change; Biodiversity Status and Trends; Supporting Environmental Stewardship – supported by an integrated focus on uncertainty quantification, new technologies, and rapid deployment of new information. Key new research findings have enhanced understanding of cryosphere dynamics, improved knowledge of biodiversity patterns across the continent, Southern Ocean and sub-Antarctic, and informed new environmental management tools and data. A major contribution to evidence-based policy has been the co-development, through SCAR and with collaborators from New Zealand and elsewhere, of the SCAR Antarctic Climate Change and the Environment Decadal Synopsis. Substantial opportunities exist for collaboration with the New Zealand Antarctic Science Platform, both through joint research and joint impact-related work, as already demonstrated by the SCAR ACCE Decadal Synopsis.

ANTOS Biodiversity Monitoring: the need for standardised protocols for long-term monitoring across Antarctica, a case study from the moss beds of East Antarctica

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It was previously thought that East Antarctica was shielded from the impacts of climate change, thus biological changes were predicted to be relatively slow. However, extreme events are becoming more apparent and since 2020 East Antarctica has experienced heatwaves in summer and autumn. The consequences for terrestrial biota are likely to be profound. Detecting biological effects of climate change in Antarctica has been hindered by the paucity of long-term data. We have monitored vegetation communities in the Windmill Islands, East Antarctica, since 2000 and observed significant changes in species composition and plant health. These variations are likely due to changes in water availability and linked to the positive phase of the Southern Annular Mode. These environmental factors are driven by both global heating and ozone depletion, with the latter playing a stronger role in Austral summer. The Antarctic Near-Shore and Terrestrial Observing System (ANTOS) aims to improve guidance for Antarctic managers and researchers, so baseline biological data and long-term environmental variability can be tracked, coordinated and integrated across national programs. The vegetation chapter of the terrestrial biodiversity monitoring manual, created by the ANTOS expert group, will be discussed here to provide insights into its use and elicit feedback from stakeholders.

Illuminating Ross Ice Shelf ecosystem connectivity through the lens of the benthic microbial communities

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The Ross Ice Shelf (RIS) covers an area of coastal Antarctica roughly the size of France in ice several hundreds of meters thick. In combination with long water residence times (2-6 years), the under-shelf ecosystem is hypothesised to live independently of light-driven processes (e.g. photosynthesis). On behalf of a large New Zealand collaborative effort, we present the first biological reconstruction of the RIS benthic ecosystem through the lens of the microbial community. Sediment cores (~0-20cm) and water column samples were collected between 2017 and 2021 from the middle RIS at Hot Water Drill Site 2 (HWD-2) and the groundling line at Kamb Ice Stream (KIS) Site 1 and KIS-2, and are anchored by two external shelf sites that reflect the inflow of organic carbon-rich water to the shelf at Cape Evans and the outflow of oligotrophic shelf water at New Harbour. We have reconstructed 303 putative metagenome assembled genomes and sediment depth-resolved microbial taxonomy (16S rRNA) reflecting the unique gradient of oligotrophy and increasing isolation under the RIS. In this difficult to study ecosystem the types and abundance of microbial functional genes are enriching our understanding of cavity circulation patterns and external inputs into the RIS ecosystem.

Biogeography and Genetic Diversity of Terrestrial Mites in theRoss Sea Region, Antarctica

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Free-living terrestrial mites (Acari) have persisted through numerous glacial cycles in Antarctica. Very little is known, however, of their genetic diversity and distribution, particularly within the Ross Sea region. To redress this gap, we sampled mites throughout the Ross Sea region, East Antarctica, including Victoria Land and the Queen Maud Mountains (QMM), covering a latitudinal range of 72–85 ◦S, as well as Lauft Island near Mt. Siple (73 ◦S) in West Antarctica and Macquarie Island (54 ◦S) in the sub-Antarctic. We assessed genetic diversity using mitochondrial cytochrome c oxidase subunit I gene sequences (COI-5P DNA barcode region), and also morphologically identified voucher specimens. We obtained 130 sequences representing four genera: Nanorchestes (n = 30 sequences), Stereotydeus (n = 46), Coccorhagidia (n = 18) and Eupodes (n = 36). Tree-based analyses (maximum likelihood) revealed 13 genetic clusters, representing as many as 23 putative species indicated by barcode index numbers (BINs) from the Barcode of Life Datasystems (BOLD) database. We found evidence for geographically-isolated cryptic species, e.g., within Stereotydeus belli and S. punctatus, as well as unique genetic groups occurring in sympatry (e.g., Nanorchestes spp. in QMM). Collectively, these data confirm high genetic divergence as a consequence of geographic isolation over evolutionary timescales. From a conservation perspective, additional targeted sampling of understudied areas in the Ross Sea region

Reviving the Past: A Temporal Analysis of Moss Distribution in Antarctic Specially Protected Areas (ASPAs) through Historical Photographs and Modern Drone Imagery

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In this study, our multidisciplinary team combined the power of historical photographs and cutting-edge drone technology to analyze changes in moss distribution within Antarctic Specially Protected Areas (ASPAs) over the past four decades. By using a comprehensive dataset of archival images from the 1980s and recent high resolution drone-captured images from ASPA 135 near Casey Station, collected in January 2023, we provide a comprehensive assessment of changes in vegetation cover. Leveraging advanced AI and 3D modelling algorithms, our research offers valuable insights into the dynamics of Antarctica's unique and fragile ecosystems. Furthermore, this study underscores the significance of preserving historical photographs as invaluable resources for understanding and protecting the delicate balance of Antarctic biodiversity.

A glimpse into the future: Changing sea ice environments and microalgal communities in McMurdo Sound, Antarctica.

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Marine microalgal communities make up the base of the marine food web and are changing in many ecosystems due to climate related stressors. Sea ice coverage in Antarctica hit a record low in 2022, with a series of southerly storms causing most sea ice in McMurdo Sound to form six months later than in a typical year. This provided a unique opportunity to observe variation in Antarctic microalgal communities in sea ice and the sub-ice platelet layer in typical 2 m thick annual ice, and in new thinner 1 m thick environments. Sea ice and platelet ice cores were collected using a coring drill and a novel platelet layer sampling system that preserves the structure of the ice/platelet interface respectively. Microalgal communities were characterised using chlorophyll-a, cell counts, and high-throughput sequencing metabarcoding. Analysis showed higher biomass at the sea/platelet ice interface in typical ice environments but deeper in newer ice, with overall biomass in the new ice being higher than in the typical. There was a shift in the most prevalent microalgal species observed in new and typical ice environments, and significant differences between sea and platelet ice microalgal communities. With ongoing climate change, it is anticipated that the timing of sea ice formation will continue to change. This will have an impact on ice associated microalgal biomass, community composition and diversity. As the base of the food-web these changes will influence all organisms that are reliant on these essential primary producers.

Foraging in a Changing Climate: Assessing the Energetic Viability of Adélie Penguin Prey Switching

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Increasing pressures placed on the Southern Ocean ecosystem, including the influence of anthropogenic climate change and fisheries, are predicted to affect change in the amount and diversity of prey available to high-order predators. One adaption predators may use to mitigate prey-field disruption is changing their prey source or 'prey switching'. The energetic viability of this strategy rests on the quality of alternate prey, and the ability of predators to efficiently collect it. We used a bioenergetics model to compare current and hypothetical future diet scenarios for the Adélie penguins (*Pygoscelis adeliae*) breeding in Mac. Robertson Land, East Antarctica to explore the energetic implications of foraging for alternative prey. Results indicate that under a scenario of increased prevalence of gelatinous organisms (e.g., salps), Adélie penguins will need to forage for ~25% more mass of food daily to successfully fledge chicks. Results also highlight the particular importance of prey availability during the guard and pre-moult hyperphagia phases. Under future scenarios of escalating pressures, the management of Antarctic krill (*Euphausia superba*) fisheries taking account of the needs of krill-dependent species such as the Adélie penguin, will be increasingly important given the high calorific content of krill.

Effects of temperature on life history of several Antarctic terrestrial bdelloid rotifers and drivers of species distribution

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Ice-free areas in Antarctica constitute less than 1% of the area of the continent and represent some of the most isolated habitats on Earth, limiting dispersal opportunities for species and driving high levels of endemism. Relatively low biodiversity has been described in the continental Antarctic, with microinvertebrates (including rotifers, tardigrades, nematodes, and mites) representing the dominant taxa. Environmental drivers of the distribution of Antarctic terrestrial micro-invertebrates and how communities respond to environmental change are poorly understood. An understanding of these drivers for individual species, including the role of environmental stressors associated with human induced pressures (e.g. climate change, localised contamination) are required to enable informed protection of Antarctic biodiversity and broader scale area protection. In this study, standardised culturing procedures for several species of endemic Antarctic bdelloid rotifers were developed and the effect of temperature on life history observed. Habrotrocha sp., an undescribed Antarctic endemic, exhibited a shorter lifecycle and increased reproductive output at higher temperatures. Experiments for other species have shown similar positive relationships between reproduction and temperature, but with mixed results for fecundity. These results will be discussed in light of expected ecosystem change, focusing on species distributions in the Vestfold Hills region of East Antarctica. This understanding of biological response, coupled with existing information on the distribution of species, will contribute to forecasting future terrestrial biodiversity patterns under a range of stress scenarios.

Using environmental DNA (eDNA) for monitoring in the Southern Ocean: understanding limitations and opportunities

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Environmental DNA (eDNA) based methods detect DNA shed into the environment by organisms living there. This can be used to characterise biodiversity, or to detect the presence of individual species of interest. We aim to incorporate eDNA-based methods into Southern Ocean biodiversity monitoring. As a relatively new monitoring approach, we need to understand the variables that influence eDNA data interpretation in Southern Ocean ecosystems. For example, it may be difficult to use eDNA methods to understand spatial and temporal boundaries of species distributions, if eDNA remains detectable for weeks or can be moved around by ocean currents. It is also important to understand how eDNA methods can augment existing monitoring approaches. To assess the usefulness of eDNA-based methods for biodiversity detection, we conducted eDNA surveys alongside established continuous plankton recorder surveys (a long-term marine monitoring program). We compare results and discuss the strengths and challenges of each survey method. To demonstrate the potential of eDNA-based methods for targeted species monitoring, we developed a species-specific assay to detect Antarctic krill, a keystone species of the Southern Ocean, from water samples. In an aquarium experiment, we investigated how long krill eDNA remained detectable in water samples and how that eDNA degraded over time. We developed a method to determine the time since krill eDNA was shed based on the fragmentation of the DNA and applied this method to field surveys. In this presentation we summarise our findings and make recommendation for robust eDNA-based monitoring in the Southern Ocean.

Moss cores as indicators of past Antarctic terrestrial microclimates

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Monitoring Antarctic terrestrial ecosystems within and outside of specially protected areas is increasingly important as they face an uncertain future due to changes in climates at various scales. Linking changes in health and biodiversity to climate is difficult as weather records are sparsely distributed, limited to a few decades or less, or simply do not exist. Additionally, many coastal ice-free areas rich in biodiversity are too far away from the locations of ice-core records and have unique microclimates. Hence, there is substantial need for climate proxies for areas where this biodiversity lives. Mosses are the dominant plant form of the ice-free landscapes of Antarctica. As resilient plants with simple structures, mosses can capture and preserve long-term records of their immediate microclimate as chemical signatures in their tissues. Here, we discuss the considerable potential mosses have as climate proxies of their local water source and availability. Living moss cores already collected provide high-resolution archives, at annual to decadal scales, of up to 500 years. Our results reveal that various moss populations in specially protected areas in the Windmill Islands, Dry Valleys and South Shetland Islands have experienced rapid drying since the 1960s. Applying these measures in other coastal sites may allow us to determine how widespread changes in water availability and temperature are across the continent. It will also indicate which terrestrial sites are at risk of the negative impacts of climate change in order to inform critical conservation efforts in a rapidly changing environment.

56. Machine-Learning-Assisted Identification, Extraction, and Synthesis of Antarctic Biogeographical Knowledge

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To understand what Antarctic ecosystems may look like following environmental changes driven by a warming climate, it is necessary to have a systematic and comprehensive understanding of the extant biodiversity and biogeography. Despite the enormous body of information that exists across journal articles, book chapters, and gray literature such as student theses and institutional reports, there are no taxonomically and spatially comprehensive sources of Antarctic biogeographical knowledge. As part of the New Zealand Antarctic Science Platform, we designed and implemented an informatic pipeline that retrieved more than 250,000 potentially relevant articles using expert-approved broad search terms from full-text search engines. Natural language processing, data structuring, and machine learning were then applied to the retrieved articles to identify those containing relevant information (i.e., spatially explicit occurrence of taxonomically resolved biological species). We then used a combination of machine learning and rule-based algorithms to extract biogeographical knowledge for the Ross Sea region from almost 5,000 PDFs of relevant articles as well as manually identified knowledge of biological and ecological processes to aid the construction of ecological models. With annotations by experienced researchers and a consensus-based annotation process, we achieved greater fidelity than conventional workflows for collating biogeographical information, and the incorporation of machine learning enabled us to identify and extract information that would have otherwise taken many person-years. The compiled information is likely the most comprehensive body of knowledge on Antarctic biodiversity and biogeography in existence, and it will form the basis of our projection for ecosystem change using process-based ecological modeling and predictions of environmental attributes downscaled from regional climate models. Importantly, our informatic pipeline, which will be fully documented and publicly available, enables recent publications to be captured and incorporated with relative ease and can be applied to other regions of Antarctica with a fraction of our initial efforts.

57. Shelf-based mooring reveals seasonally variable benthic behaviour of Antarctic krill

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Antarctic krill are key to Southern Ocean ecosystems and represent a valuable fishery. While most krill research has focussed on surface waters (0 – 250m), krill have also been observed near the seafloor at depths between 400 – 4,000m. Perturbations to krill populations may influence food webs and biogeochemical cycles, therefore sustainable management of the krill fishery depends on accurate biomass estimates. Estimates are typically achieved through ship-based acoustic surveys, which may struggle to obtain reliable acoustic data from depths > 250m. To facilitate observations of krill at the seafloor, a mooring was deployed in Prydz Bay, East Antarctica (at 387m depth), equipped with an upward looking echosounder, current velocity profiler and camera. Greatest internal densities were observed from swarms near the surface, however the echosounder also revealed significant krill biomass below 250 m depth. Krill diel vertical migration varied with season indicating this behaviour may be influenced by environmental drivers such as sea ice cover, sunlight, and food availability. Combined with ship-based surveys, these moorings will become an important tool in improving the accuracy of krill biomass estimates and strengthening our understanding of krill-seafloor interactions and their influence on the broader Antarctic ecosystem.

58. Development of DNA markers to resolve uncertainties of seabird bycatch using feathers collected from dead seabirds

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Incidental mortality in fisheries is a major driver of population changes for albatrosses and petrels globally. However, inaccurate identification of species caught as bycatch can hinder monitoring efforts due to visual similarities between closely related species and/or degradation of specimens.

Genetic methods can be powerful diagnostic tools, but require appropriate genetic markers and reference databases to identify the target species. A range of simple and short genetic markers were assessed for the identification of the albatross and petrel species listed in Annex 1 to the Agreement on the Conservation of Albatrosses and Petrels and in Australia's Threat Abatement Plan for the incidental catch (or bycatch) of seabirds during oceanic longline fishing operations. DNA sequences were also generated to improve the coverage of reference databases. Analysis found that the combination of two genetic markers identified 35 of the 36 target seabird species either to species or sister species. Thirty-two specimens were identified to species and three to sister species level. No reference sequences were available for one petrel species. Genetic methods provide a streamlined framework for the molecular identification of seabird bycatch, and are recommended for use in fisheries within and outside Australian waters to improve the resolution of bycatch reporting and to corroborate logbook entries, observer reports and audits of imagery captured by electronic monitoring systems.

59. Using point process models to understand and forecast the distributions of bryophytes in a changing Antarctica

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Bryophytes' metabolism is dependent on water availability and temperature, making the expected alterations in meltwater flow in Antarctica a significant threat to these critical ecosystems. To understand their future distributions under changing climatic conditions, it is imperative to use predictors that are relevant to their physiological tolerances. Thus, our goal is to understand and forecast how climate change will impact the distribution of Antarctic bryophytes. We developed a flexible Bayesian hierarchical approach capable of dealing with presence-only data while incorporating sampling bias, an issue particularly relevant to Antarctica. We used newly generated variables related to bryophytes' physiology: presence of meltwater, number of days above 0 C, and temperature thresholds of photosynthesis optima of Antarctic bryophytes. We developed inhomogeneous point process models for 30 species of Antarctic bryophytes. Preliminary results show that availability of meltwater, and number of days with temperatures that allow photosynthesis and growth are highly important to explain the distribution of Antarctic bryophytes. We observed that overall, potential suitable habitats reflect the physiological dependence of bryophytes on warmer and wetter environmental conditions.

Endemic species (e.g., Schistidium antarctici) were more sensitive to changes in water availability in our model, while more cosmopolitan species (such as Bryum pseudotriquetrum) were more tolerant.

60. What does protection sound like? Fiordland National Park

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Global marine ecosystems have experienced degradation and loss of biodiversity as a result of human impacts and climate change. Monitoring of ecologically significant areas is vital in understanding these effects and their subsequent management. Soundscapes offer a unique opportunity for examining organisms and habitats in a way that eliminate many potential weaknesses of traditional monitoring techniques. Underwater, sounds are a ubiquitous and dynamic property of all ecosystems – from the biological sounds of animals communicating to the sounds of water and wind movement, and more recently anthropogenic sounds. This fundamental property of every environment is being increasingly influenced by the presence of human activities, but is not yet recognised for the breadth of information it holds, and as a key indicator of change in an ecosystem. A nation-wide program, focusing on several high priority protection sites, utilise passive acoustic monitoring (PAM) creating baseline datasets. With the emphasis on characterising the ambient soundscapes and acoustic signatures of significant species, identifying key acoustic parameters that reflect ecosystem health and biodiversity, and in locations where human use will likely contribute to negative acoustic exposures. Here, spatiotemporal trends in the underwater soundscapes at sites within Fiordland National Park are reported, illustrating diel, lunar and seasonal patterns in sound pressure levels. Identifying biotic, abiotic and anthropogenetic sound sources which make-up the marine soundscape. This study creates baseline data sets for a culturally, ecologically, and economically valuable areas, such as the Ross Sea Region MPA. PAM is an increasingly useful tool in understanding anthropogenic presence, ecosystems health and biological condition, and offers an effective, minimally invasive, and less labourintensive way of monitoring marine ecosystems.

61. Modelling connectivity among Antarctica's ice-free areas

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The biota of Antarctica's ice-free areas face many threats in the coming century. Of particular concern is how climate-induced expansion of ice-free areas will alter patterns of connectivity across the continent. A key step in anticipating the magnitude of future biotic change is to first establish a broadscale understand the extent of current connections among ice-free areas. This research aims to combine best-available knowledge on mechanisms of dispersal across a diverse subset of terrestrial taxa to predict current patterns of connectivity among the ice-free areas of the continent. We will do so by modelling ice-free habitat as nodes of a network, representing the suitability of habitat for taxonomic groups and features that act as landscape barriers among regions. In particular, we aim to (1) Identify regions of high or low connectivity among taxonomic groups, (2) examine how connectivity differs spatially among organisms with varying dispersal mechanisms.

62. Uncovering the Diversity of Planococcus sp. in Antarctic Wildlife

Vendula Koublová[1], Pavel Švec[1]

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The Antarctic ecosystem offers a unique opportunity to study the diversity of microbial life in a challenging environment. In our long-term study of cultivable bacteria inhabiting the Antarctic Peninsula region and the local fauna, we discovered a large group of bacteria belonging to the genus Planococcus. These grampositive bacteria can tolerate high salinity and thus are often associated with marine environments. Although Planococcus spp. have been isolated in Antarctica before, it was mainly from non-animal sources such as soil or cyanobacterial mats, whereas our strains originate from several species of seals, penguins, gulls, and seaside soils where these animals reside. Using a combination of rep-PCR fingerprinting and MALDI-TOF, the studied bacterial strains were grouped based on their relatedness. 16S rRNA gene was sequenced in selected representatives from these groups, and more than 200 strains of Planococcus spp. were identified. The preliminary data suggest that some of these groups may represent novel bacterial species.

Many Planococcus species evolved remarkable adaptations allowing them to survive in hostile environments. Some are able to withstand extremely low temperatures, while others can metabolize various xenobiotics. Several species can produce diverse secondary metabolites, including antibiotics that help them compete with other bacteria. Thorough characterization of the yet unknown species can reveal new adaptations to the environment.

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SOUTHERN OCEAN AND THE MARINE PROTECTED AREA

Insights from observations, and understanding, of the Southern Ocean voyages and assessment of the effectiveness of the marine protected area.

SOUTHERN OCEAN AND THE MARINE PROTECTED AREA

Chair: Barb Hayden, NIWA

ORAL PRESENTATIONS

The Antarctic blues, marine mammals on MARs, and the rise of AI: lessons learned and future directions from nearly two decades of listening to the Southern Ocean

Brian Miller[1], Nat Kelly

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In 2023 annual recovery and deployment of moored acoustic recorders (MARs) were successfully completed along resupply routes to Australia's Antarctic stations. This marked the AAD's 10th consecutive year of longterm autonomous underwater acoustic monitoring off East Antarctica, and the 15th year of data collection since 2004. The hundreds of thousands of hours of underwater sounds recorded by these moorings, and those of our international collaborators, are a primary data source on critically endangered Antarctic blue whales (ABWs), and also provide valuable information on a dozen other Antarctic animals. The data also provide a means of monitoring trends in sounds of ice, storms, and human activities including shipping, geophysical surveys, and potential marine construction. Additionally, from 2006 to 2021 in-situ acoustic recordings were made from sonobuoys during a series of seven Antarctic marine science voyages. The combined spatial extent of these synoptic sonobuoy recordings spanned ~330° of longitude throughout the Antarctic and sub Antarctic, and enabled locating ABWs in real-time for further in-depth study. We discuss how these passive acoustic data and new developments in machine learning, alongside other in-situ ecological and remotely sensed data, continue to provide new insights into the distribution, behaviour, and trends in Southern Ocean marine mammals.

Conservation challenges for the Commission for the Conservation of Antarctic Marine Living Resources

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The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) committed to a convention-wide network of Marine Protected Areas in 2005. It then developed a comprehensive scientific process to underpin the identification of candidate areas, adopted a Measure to guide designation and implementation, and designated two MPAs around the South Orkneys Islands and in the Ross Sea. However, it has struggled to progress other proposals or to fully implement the existing MPAs. Two Members have proposed that the original commitment to the network be reviewed, and more fundamentally, have challenged the intent and purpose of the Convention. This research tracks the various arguments raised to counter progress in both designating and implementing Marine Protected Areas and considers responses to those arguments. It analyses the impact of the impasse on the overall capacity of CCAMLR to deliver its objective and discusses possible ways forward.

High-resolution physical-biogeochemical modelling in the Ross Sea

Helen Macdonald[1], Graham Rickard[1], Stefan Jendersie[2], Alexander Hayward[1,3], Matt Pinkerton[1]

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The Ross Sea is one of the most productive regions in the Southern Ocean, supporting a wide range of mammals, birds, fish, invertebrates and benthic species. The Ross Sea region is still in a relatively pristine condition (compared to other shelf-sea regions) and contains the world's largest marine protected area. We are developing a high-resolution, coupled physical-biogeochemical model to investigate primary productivity in this region. The physical model includes interactions between ice-shelf cavity and the open ocean as well as a parameterization of the effect of ice coverage on surface fluxes. The biogeochemical model includes two phytoplankton groups (Diatoms and Phaeocystis antarctica) which are the dominant phytoplankton groups in the region. We compare the model output to remote sensed data and in situ observations to understand the model's performance and show that the model adequately represents the seasonal cycle of primary productivity. The seasonal cycle of phytoplankton growth is closely linked to light availability and nutrient dynamics, and these are intimately linked to ice cover. We use the model to better understand the sensitivity of primary productivity to future changes in environmental conditions, including sea-ice, to project how the seasonal cycle of primary productivity might change in the future.

Science data collection by the New Zealand Defence Force during the 2022 Antarctic Resupply Mission.

Sally Garrett[1], Peter McComb, John Harris, Ursula Crabtree

[1]*Defence Technology Agency*

The maiden resupply voyage of HMNZS AOTEAROA to Winter Quarters Bay, McMurdo Sound, provided a vessel with an opportunity to complete experimentation in the Ross Sea and the Southern Ocean. Completed in February 2022, the resupply voyage was named OP (operation) TIO (ice). The science programs on the voyage focused on improving the safety of maritime operations by increasing the accuracy of forecasts for ocean conditions, understanding the probability of sea ice detection from ship and satellite based systems and finally, understanding the reliability and accuracy of Global Navigation Satellite Systems to improve the safety of navigation. The OP TIO observations included data from 21 free floating wave buoys, 10 Global Drifters, 2 ARGO Floats, 85 expendable bathythermo graph profiles, and ship-based measurements of meteorological, oceanographic, wave and sea ice characteristics. Simultaneous satellite-based synthetic aperture radar captures, and high resolution wave modelling completes the environmental data holding. In addition, high-frequency positional information from four different navigation systems was recorded. The complete set of voyage data and instructions for their access and future research plans will be presented with lessons learned on completing science activities from HMNZS AOTEAROA.

Protecting the Ross Sea MPA: Science and Filmmaking Working Together

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Science communication distills complex ideas into accessible and understandable formats. It plays a vital role in bridging the gap between the scientific community and the public, encouraging greater appreciation for the role of science in society. Decades of campaigning, policy and science came together in 2017 when the largest marine protected area in the world was established: the Ross Sea Marine Protected Area (MPA). New Zealand is a kaitiaki of the Ross Sea MPA and need to actively support and participate in science, which delivers informed research to CCAMLR that will determine the MPA's future. NIWA is a key player in the scientific monitoring of the function and health of the MPA, including NIWA's RV Tangaroa sailing to the Ross Sea every other year since 2001, and annual ice-based fieldwork. We also have a responsibility to communicate about our work and the extraordinary, precious part of the world that is the Ross Sea. Facilitating an emotional connection to the importance of the ongoing research supporting the Ross Sea MPA is vital to fostering informed understanding about our role in the MPA's future. Following NIWA's 2023 Antarctic voyage, NIWA's videography team sought to capture our work in the Ross Sea. This 12-minute film premiere explores the historical context and importance of the MPA, covers existing research in the region and showcases how different science disciplines are working alongside each other.

63. First observations of Weddell seals foraging in sponges in Erebus Bay, Antarctica

Rose Foster-Dyer[1], Kimberly Goetz[2], Matt Pinkerton[3],Takashi Iwata[4], Rachel Holser[5], Sarah Michael[6], Craig Pritchard[7], Simon Childerhouse[8], Jay Rotella[9], Luisa Federwisch[10], Daniel Costa[5], Michelle LaRue[1]

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Attaching cameras to marine mammals allows for first-hand observation of underwater behaviours that may otherwise go unseen. While studying the foraging behaviour of 26 lactating Weddell seals (*Leptonychotes weddellii*) in Erebus Bay during the austral spring of 2018 and 2019, we witnessed three adults and one pup investigating the cavities of Rossellidae glass sponges, with one seal visibly chewing when she removed her head from the sponge. To our knowledge, this is the first report of such behaviour. While the prey item was not identifiable, some Trematomus fish (a known Weddell seal prey) use glass sponges for shelter and in which to lay their eggs. Three of the four sponge foraging observations occurred around 13:00 (NZDT). Two of the three sponge-foraging adults had higher-than-average reproductive rates, and the greatest number of previous pups of any seal in our study population, each having ten pups in 12 years – far higher than the study population average of three previous pups (± 2.6 SD). This novel foraging strategy may have evolved in response to changes in prey availability, and could offer an evolutionary advantage to some individuals that exploit prey resources that others may not. Our observations offer new insight into the foraging behaviours of one of the world's most studied marine mammals. Further research on the social aspects of Weddell seal behaviour may increase our understanding of the extent and mechanisms of behavioural transfer between conspecifics. Research into the specific foraging behaviour of especially successful or experienced breeders is also warranted.

64. New Zealand's vessel-based Antarctic research achievements and opportunities

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RV Tangaroa has been carrying out ocean-based fieldwork in the Ross Sea region of Antarctica since 2001. The 2023 Ross Sea voyage was the 15th voyage to Antarctica with a multidisciplinary focus across ocean and atmospheric physics, pelagic food webs, and seafloor ecosystem. This voyage was highly successful and has delivered an exceptional body of data to the international scientific community. This legacy of RV Tangaroa Antarctic voyages has built a breadth of knowledge that is at the core of identifying signals of climate change in the marine environment and contributing to the management of the Ross Sea MPA. This presentation will provide a summary of the main scientific findings that have come out of the previous 15 voyages, provide a synopsis of the strategy and capability for future voyages. NIWA manages a process of inviting Expressions of Interest for participation in the biannual RV Tangaroa Antarctic voyages and we welcome discussion about how Antarctic scientists can get involved with the programme for the 2025 and 2027 voyages and into the future.

65. Monitoring Adélie penguin populations: Indicators of change in the Ross Sea region

Esme Robinson[1], Kerry Barton[2], Jordy Hendrikx[1], Rebecca Macneil, Fiona Shanhun[3] and Dean Anderson[4]

[1]Antarctica New Zealand [2]BartonK Solutions [3]Environment Canterbury [4]Manaaki Whenua Landcare Research

Adélie penguins (*Pygoscelis adeliae*) are a bio-indicator species, used by the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) to monitor the health and function of marine ecosystem processes. New Zealand has undertaken monitoring of Adélie penguin populations in the Ross Sea region since the early 1980s. Aerial reconnaissance and photography are used to determine the breeding locations of the birds, and to count the number of breeding pairs (nests occupied during the early incubation period). Colonies on Ross Island are surveyed annually (Capes Crozier, Bird and Royds). Locations along the Northern Victoria Land Coast are surveyed at five yearly intervals. The census provides data against which future population levels can be compared, in order to monitor environmental change of the Ross Sea ecosystem, both natural and anthropogenic. The accumulated (and ongoing) survey information collected by this significant long-term research programme now provides a valuable resource, that contributes to management of the Southern Ocean Antarctic Toothfish fishery, and monitoring of the Ross

Sea region Marine Protected Area, as well as contributing to the research goals of the Committee for Environmental Protection. This poster presents the latest Ross Island Adélie penguin population data, as well as data from selected Northern Victoria Land sites. Results highlight the value of long-term records of top predator abundance and distribution.

66. Advancing paleoclimate reconstructions of primary production: A multi-archive approach

Emma de Jong[1,2], Holly Winton[1], Sebastian Naeher[3], Bella Duncan[1], Rob McKay[1], Cliff Atkins[2], Jae Il Lee[4], Stacy Deppeler[5], Johan Etourneau[6,7]

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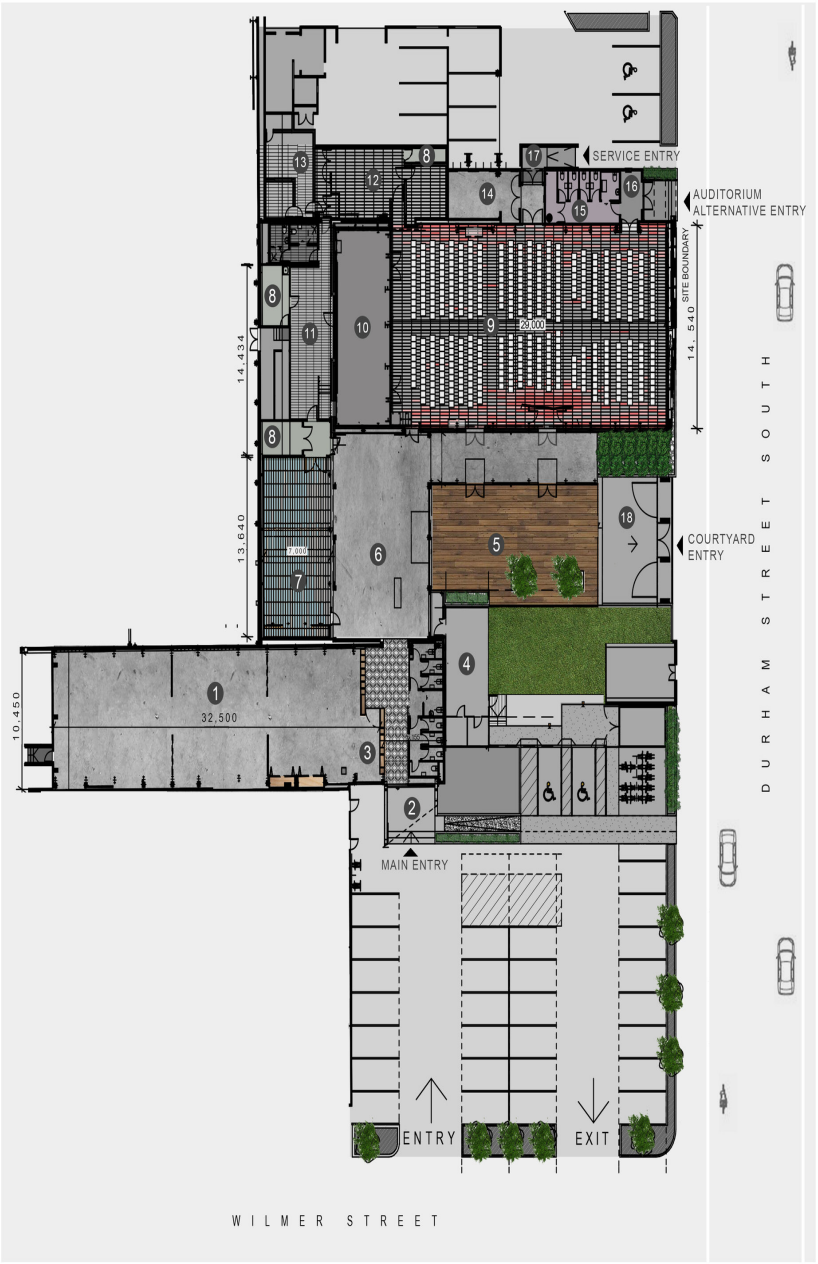
Antarctic phytoplankton play an essential role in climate. The Ross Sea, Antarctica has high primary production rates promoting atmospheric carbon dioxide draw down into the ocean. However, our understanding of how phytoplankton in the Ross Sea may respond to future climate change is limited by short observational records. Molecular fossils (lipid biomarkers) found in snow and marine sediment samples can extend observational records of primary production, while also providing a unique opportunity to compare across archives. Here we present new results on the spatial variability of phytoplankton biomarker concentration and composition in Ross Sea paleoclimate archives: a spatial array of snow samples and marine core tops from McMurdo Sound to Terra Nova Bay, as well as filtered Ross Sea oceanwater. Most importantly, we demonstrate the ability of fatty acids to be compared across archives to help recreate past phytoplankton changes. The highly branched isoprenoid (HBI), IPSO25 (Ice Proxy Southern Ocean), has also been identified in the sediment samples for the first time in the southwestern Ross Sea. Overall, these results will help validate biomarkers as a proxy to interpret longer palaeobiology records in Antarctica and help inform the impact climate change might have on biodiversity, sea-ice extent, and the global climate system.



1. YOUTH SPACE/ COURTS
2. VISITOR ENTRY
3. YOUTH ENTRY
4. KITCHEN
5. TIMBER DECK
6. FOYER
7. STUDIOS
8. STORAGE
9. AUDITORIUM
10. STAGE
11. BACKSTAGE/ GREENROOM
12. MONITOR WORLD
13. RECORDING STUDIO
14. EQUIPMENT STORE
15. W/CS
16. LOBBY
17. LOADING ACCESS
18. ENTRY/ COURTYARD