Vol 37, Nos. 3 & 4, 2019

SPECIAL FEATURE: NEW WALL MAP OF ANTARCTICA ENCLOSED

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AURORA AUSTRALIS ON CAMERA

- capturing the beauty of the southern lights

Drilling through the Ross Ice Shelf

Micro-organisms in the volcanic vents of Erebus

What's causing sea level rise?

The mapping of Antarctica

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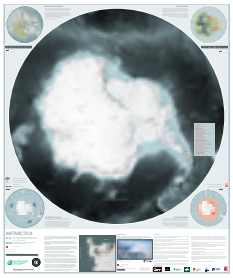
In Brief

Antarctic Treaty turns 60!

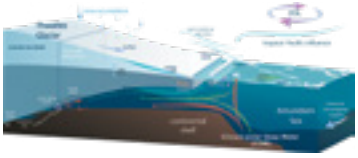
On 1 December 1959, the Antarctic Treaty was signed in Washington DC by twelve countries, including New Zealand, ensuring that Antarctica "shall continue forever to be used exclusively for peaceful purposes". The agreement specifically promoted the freedom of scientific research and laid the foundation for the extensive international science cooperation that exists today.



New wall map of Antarctica - enclosed with this edition

To commemorate the 60th anniversary of the Antarctic Treaty, the NZ Antarctic Society, in partnership with Land Information New Zealand, has published a new wall map of Antarctica reflecting the very latest data sets, which is enclosed in this edition of Antarctic magazine. The map and magazine will be sent to every school in the country. More information on the map making process can be found on page 30.

Sign your school up to NZAS membership for 2020



Credit: Ted Scambos, CIRES, University of Colorado

Schools can join the NZ Antarctic Society, and receive educational resources tailored for both primary and secondary school levels. In 2020, schools will receive educational posters on penguins and ice sheets, obtain access to the rich online resources of the Society's 50 years of publications, as well as receive two double issues of the magazine through the year, and the ability to attend events and hear from scientists in the main centres. More information on page 45.

Save the dates! - 2020 NZAS National Conference in Christchurch

Next year, on 23-25 Sept 2020, the NZ Antarctic Society is planning a national conference in Christchurch, with a range of keynote international and national speakers. Themes under consideration: Exploration of the Icy Continent, Film Making and Photography in Antarctica, the Legacy and Future of Scott Base, Science Research for the 21st Century, and Engaging the Next Generation. We welcome feedback on speakers, sponsorship and topics, please contact: conference@antarcticsociety.org.nz

Christchurch airport, *credit: David Paull*

Auroral curtains shimmer in the sky above Mt Erebus and Mt Terror, with Jupiter at centre; the view from Scott Base, Ross Island; *photo: Jonny Harrison, 2019 Winter Station Manager*

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Aurora australis on camera - capturing the beauty of the southern lights

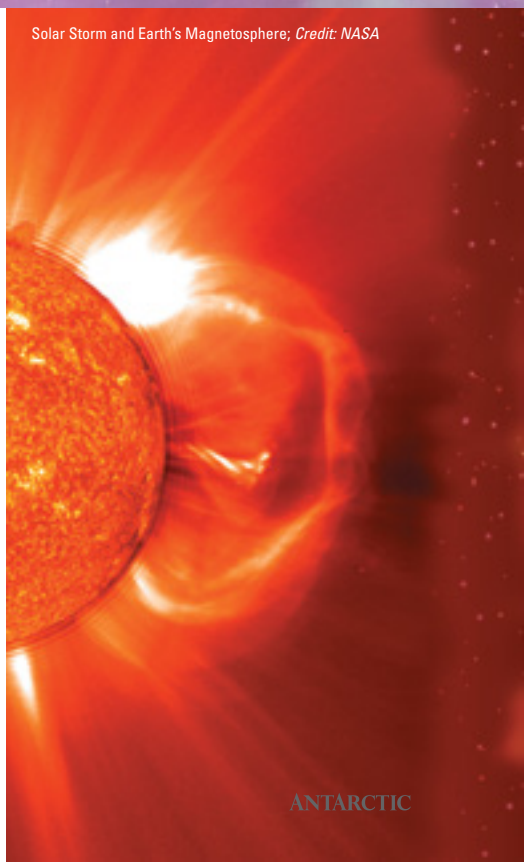
“solar particles interact with oxygen and nitrogen molecules, making them glow”

Corona of aurora australis, observed at the South Pole, 2019; *photo: Benjamin Eberhardt, IceCube Neutrino Observatory, NSF*

Beneath Earth’s crust, liquid iron flows within the outer core generating electric currents. As the planet rotates, this energy creates a dynamo effect, extending a huge magnetic field thousands of kilometres out into space. It’s called the magnetosphere – an energy shield that protects our atmosphere from harsh cosmic radiation, allowing life to flourish on Earth.

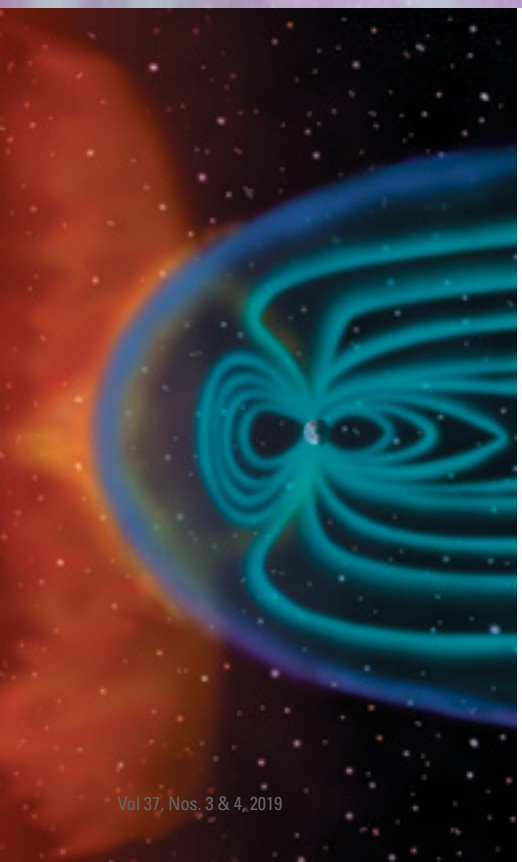
At the same time, 150 million kilometres away, charged particles stream out from the surface of the Sun in a relentless barrage of matter called the solar wind. Travelling at 400km per second, it slams into Earth’s magnetosphere, blowing it out into a teardrop shape. At the Poles, the near vertical magnetic lines bring these energised solar particles into the upper atmosphere.

Sometimes the solar wind can become more violent when plasma is ejected into space or when sunspots occur. These cause the magnetosphere to compress even further, allowing solar particles to penetrate closer to the surface of the Earth at polar latitudes. When that happens, the particles interact with oxygen and nitrogen



Solar Storm and Earth’s Magnetosphere; *Credit: NASA*

Herbert Ponting and telephoto apparatus, Antarctica 1911; *photo: Alexander Turnbull Library*



molecules in the atmosphere, making them glow. Around the Poles, an auroral oval forms. In the northern hemisphere, this phenomenon is known as aurora borealis, and when it appears in southern polar latitudes, it is called aurora australis.

"The potential harm to astronauts is one reason the International Space Station doesn't orbit over the Poles," says Professor Craig Rodger, Head of Otago University's Physics Department, and leader of their Space Physics research group. "While the ISS makes a complete circuit of the Earth every 90 minutes, it turns at around 50° latitude in both hemispheres 32 times per day, away from the polar regions and the solar wind which creates the aurora. Consequently, the astronauts avoid travelling through these higher radiation areas."

For human societies living in both hemispheres, the green shimmering curtains of aurora have been the subject of myths and legends for millennia. For Maori, who saw these glowing lights on the southern horizon, the 'Tahunui-a-rangi' were reflections in the sky of campfires of ancestors who had sailed to the land of ice.

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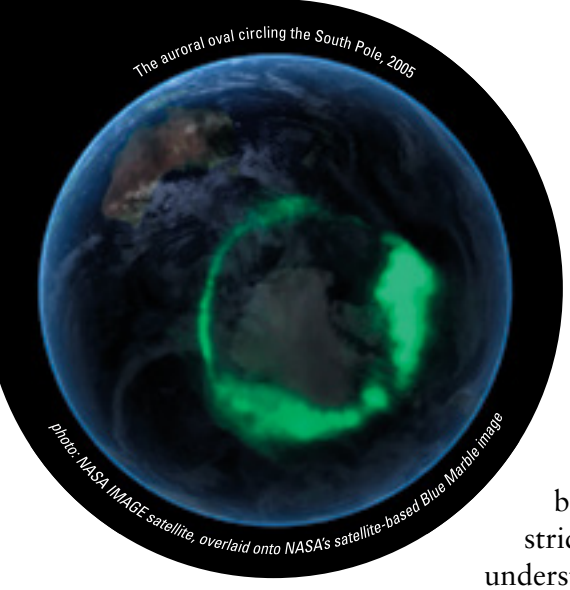


The auroral oval circling the South Pole, 2005

photo: NASA IMAGE satellite, overlaid onto NASA's satellite-based Blue Marble image

In the 20th Century, aurora continued to attract wonder and curiosity, while scientists began to make strides in our understanding of the phenomenon. In 1910, astrophysicist Carl Stormer travelled to northern Norway to photograph aurora from various locations. By using triangulation, he became one of the first to accurately measure the altitude and latitude of the aurora observed in the sky.

Robert Falcon Scott also included auroral research among the raft of scientific activities in his ill-fated Terra Nova expedition to Antarctica in 1910-12. However, expedition photographer Herbert Ponting was ill prepared to capture aurora on camera. In fact, his glass plates struggled to produce images of aurora at all, even with five minute exposures. Consequently, written observations and sketches had to suffice.

Camera technology has made huge advances since then, and today personnel wintering over in Antarctica capture glorious images and videos of the southern lights overhead.

Station leader at Scott Base this winter, Jonny Harrison, has been an avid photographer of aurora australis. With two consecutive Antarctic winters under his belt, Jonny has produced a stunning collection of memorable images.

"Photographing the aurora has been one of the pleasures of the long cold polar night, though being outside for too long in the frigid temperatures can be dangerous, so care is needed," he says. The coldest temperature he's endured while photographing aurora was -60°C with wind chill.

Dr Ian Griffin, Director of the Otago Museum, has been photographing the aurora from Dunedin for some years. He's also seen aurora from onboard NASA's SOFIA aircraft (Stratospheric Observatory for Infrared Astronomy) which flies south from New Zealand each year. That inspired him to organise two commercial flights over the Southern Ocean to view the aurora from the air. "It's not just pretty pictures, there is some really interesting science in this as well," Ian says. "It's like taking a CAT scan, you can see structure and we geotag the imagery."

"Aurora's ethereal lights remind us that Earth is part of nature on a cosmic scale," he says.

By **Delwyn Dickey**

Curtains of aurora observed at Scott Base, 2019; *photo: Jonny Harrison, Antarctica NZ*

"Tahunui-a-rangi - reflections in the sky of campfires of ancestors who had sailed south to the land of ice"

The Ross Ice Shelf Programme camp at 80.65 S and 174.5 E in December of 2017. The bright orange tent in the background housed the hot water drilling system through most of the operation. Setting up inside the tent allowed the drillers and scientists to work around-the-clock and in any weather; *photo: Christina Hulbe*

Drilling through the Ross Ice Shelf to the dark ocean cavity beneath

Climate change is one of the greatest scientific and social challenges facing the world today and University of Otago researchers are at the forefront of the global scientific response.

Polar regions have long been likened to the canary in the coalmine, giving early warning of problems to come. But they do more than respond, they are major actors in how climate change plays out.

Professor Christina Hulbe, Dean of University of Otago's School of Surveying, leads a team who have been investigating one of the regions thought likely to change first, trying to work out how vulnerable West Antarctica's Ross Ice Shelf is to a warming climate. A floating extension of the ice sheet, the ice shelf is where water that has been locked away as snow and ice returns to the sea. When the ice shelf changes, everything else does too.

"Geologic records of past climate conditions show us that when carbon dioxide levels were as high as they are today, there was less ice in the Ross Sea region, less polar ice overall, and sea level was higher. We should expect this to happen due to human-induced climate change as well.

"There are plenty of reasons to care about what happens next in West Antarctica—ice, ocean, atmosphere, marine ecosystems, they are all part of an interconnected system. Here in coastal Otago we think a lot about sea level rise as one of the major consequences of climate change. Antarctic ice is massive source of potential sea level rise and West Antarctica is a leading source of uncertainly in the sea level rise projection.

> *"We know that the Ross Ice Shelf will respond to climate change, but we're not sure how fast it will happen or if the largest impacts can still be avoided."*

Questions about the rate and timing of change are challenging because many of the processes are not well understood or well represented in computer models. This is partly because of the continent's remoteness and partly due to the short span of scientific exploration there.

"Everywhere we work, we find something new. It might be a new (usually shorter) time scale for change, a new facet to a process we thought we understood, or a new process we had not fully recognised before.

"For example, where we have been working in the central region of the ice shelf, when we actually drilled through the ice rather than just imaging it from the surface, we found ice in the deepest part of the shelf that was quite different from what we expected. When we cored the seabed sediments,

The muddy sea bed in the dark ocean cavity beneath the Ross Ice Shelf, depth: 741m. At Site 2, the ice shelf was 367m thick, and the water column beneath was another 428m; the drilling rig on top was situated 46m above sea level; *photo: Craig Stevens, NIWA*

The hot water drilling system, set up "outside" for the first of two boreholes drilled through the ice shelf in 2017. The borehole was used to install an ice-fixed oceanographic mooring for continuous measurement of water temperature and salinity. Here, the geophysics team is installing a cable with seismometers; *photo: Christina Hulbe*

we found a really subtle record that requires us to use some very sophisticated, new methods to get at the details of its story."

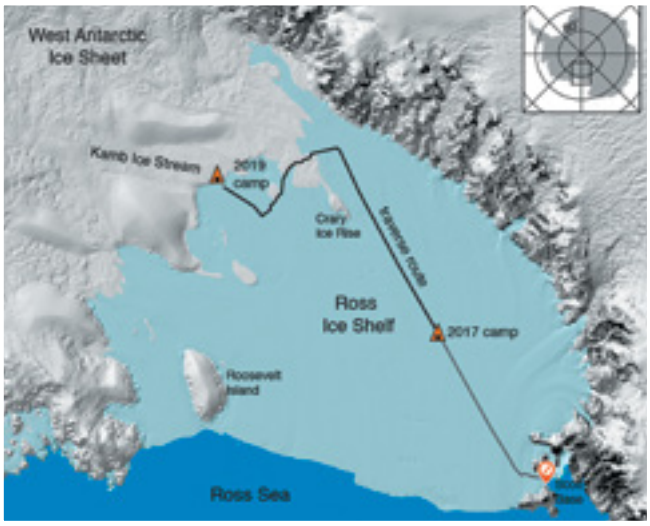
This explains some of Hulbe's enthusiasm for interdisciplinary research. No single scientific discipline, no one way of looking at such a complicated system, is going to find the answers that society needs. "I use mathematical models to test ideas about glaciological processes. To do that really well, I need to learn to look at the system in new ways. My own sense of what's important might limit the ways I use the data. Something I think is ordinary might actually be extraordinary from somebody else's point of view."

That approach characterises the NZARI-funded programme Hulbe leads, aimed at understanding of the Vulnerability of the Ross Ice Shelf in a Warming World. The team includes colleagues in Geology, Marine Science and Physics at Otago, and from Victoria, Canterbury and Auckland Universities, NIWA and GNS Science, as well as international partners. With the logistics support of Antarctica New Zealand, they are using a diverse range of technologies and methods to investigate processes and process interactions at two remote locations, hundreds of km away from Scott Base. The research is coordinated around boreholes drilled through the ice shelf, using a hot-water system built at Victoria. "What we want to do is assemble one holistic understanding of the interconnected system. We want to know what conditions are like today and what they were like in the past so that we can improve and test the models."

These two locations won't answer all of the questions but they are a large stride in the right direction. Says Hulbe, "We are on the right track. We know what we should be studying and we have, in New Zealand, the capability to do the work." And now, as the current Ross Ice Shelf programme heads into its final season of fieldwork, the new MBIE-funded Antarctic Science Platform will carry the effort forward.

"We want to ask and answer questions that challenge and excite us as scientists but we want to be of service to society as well. Climate change is global but it's local too. It matters right here at home that we keep making progress. The scientific community has to all work on this together."

By **Professor Christina Hulbe**
Dean of the School of Surveying, University of Otago



The 1100km traverse route from Scott Base across the Ross Ice shelf to the Kamb Ice Stream on Siple Coast. *Map made using Quantarctica data distribution, Norwegian Polar Research Institute.*

Map surface elevation data from: Bamber, J. L., Gomez-Dans, J. L., and Griggs, J. A.: A new 1 km digital elevation model of the Antarctic derived from combined satellite radar and laser data – Part 1: Data and methods, The Cryosphere, 3, 101–111, doi:10.5194/tc-3-101-2009, 2009.

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Busy summer ahead for NZ Defence Force on the ice

RNZAF C-130 Hercules at Phoenix Airfield, McMurdo, 2019; *photo: NZ Defence Force*

This summer will once again be a busy season for the New Zealand Defence Force in Antarctica. Between September and March, up to 220 personnel work at Scott Base, across at the nearby United States National Science Foundation's McMurdo Station, and the Pegasus Ice runway. In addition, military personnel manage the terminal operations for Antarctica at Christchurch airport.

Defence Force staff undertake a wide variety of roles while on deployment on 'Operation Antarctica', currently New Zealand's largest tri-service operational mission. These include unloading from a cargo ship a full year's worth of supplies for Scott Base, McMurdo Station and the Amundsen-Scott South Pole Station. Fifty New Zealand Army drivers and logistics experts unload more than 500 containers holding about 5000 tonnes of food and equipment.

At Scott Base, 10 Defence personnel are seconded to fill positions such as Communications Operators, Plant Operators and Cargo Handlers, while a team of 20 Army light engineers will undertake valuable building projects for the United States Antarctic Programme

This summer, pilots and crew from the Royal New Zealand Air Force's No. 40 Squadron are scheduled to make 12 flights to the frozen continent, in C-130 Hercules and Boeing B757 aircraft, carrying cargo and passengers. Primarily the flights support the US Antarctic Program and Antarctica New Zealand, but there are also flights into Terra Nova Bay in support of the Italian and Korean programmes. Air Force maintainers also help to support not only those aircraft at McMurdo, but also the LC-130 Hercules fleet belonging to the New York Air National Guard.

(above) NZ Army personnel unloading and transporting supplies from container ship, McMurdo, 2019; *photo: NZ Defence Force*

The biggest challenge working in the southern continent is the changeable and extreme weather, with some inventive solutions needed to avoid danger to personnel's health or damage to the Defence Force assets.

The NZDF has operated in Antarctica since 1956 when HMNZS Endeavour sailed from Wellington with the New Zealand-led Ross Dependency party of the Trans Antarctic Expedition and the International Geophysical Year team. In January 1957 with the support of the Army engineers, Scott Base was built. Every year since then, the NZDF has deployed personnel and assets to the remote region.

From 2022, the Royal New Zealand Navy's newest tanker, HMNZS Aotearoa, will be travelling to the frozen continent with fuel and cargo supplies for the region. The NZDF contribution to Antarctic research is expected to expand as new capabilities come on stream in the coming years.

By **Headquarters Joint Forces New Zealand**

Charismatic megafauna of Antarctica - the toothfish hunters of the Ross Sea

Antarctic seals, whales, and seabirds hold a particular fascination for human visitors to the Deep South. The 'charismatic megafauna' of Antarctica inspire a range of emotions from curiosity to awe. But, most importantly, these iconic species may hold the key to protecting the last great wilderness.

One thing all the charismatic megafauna of Antarctica have in common is that their true home is the ocean. The Antarctic continent itself is too cold and barren to support anything bigger than tiny invertebrates and slow-growing, miniscule plant life. The vast numbers of seabirds and seals that congregate each summer along the Antarctic coastline all make their living at sea. Some whale species such as humpback whales and blue whales travel thousands of kilometres to the Southern Ocean to take advantage of its extravagant productivity during the summer months. Others, such as killer whales and minke whales, follow the receding sea ice to access rich stocks of fish and other prey. Some, such as Weddell seals, live inside the ice year-round.

New Zealand's sector of the Antarctic is home to the world's largest Marine Protected Area (MPA), the Ross Sea region MPA. Established in 2017 by CCAMLR, the Commission for the Conservation of Antarctic Marine Living Resources, the MPA was designed to protect the Ross Sea region from the impacts of fishing for Antarctic toothfish. Toothfish are large and valuable fish prized by chefs and gourmets worldwide. Humans are of course not the only ones that appreciate the creamy, rich flesh of the toothfish: Toothfish is hunted by Weddell seals, sperm whales, and a particular kind of killer whale known as 'Type C' that is especially common in the Ross Sea.

"As toothfish predators, Weddell seals and Type-C killer whales are among the species that might be most directly affected by the removal of toothfish from the ecosystem through fishing."

It was this concern that was one of the major drivers for the Ross Sea region MPA, and prompted the designation of Weddell seals and Type-C killer whales as focal species for the MPA. The scientific study of these toothfish hunters – their abundance, foraging habits, distribution, reproductive success, and migratory habits – allows us to assess whether the MPA is achieving its aims. By virtue of their position in the food web, top predators such as seals, whales, and penguins integrate the cumulative effects of everything that happens at lower levels. Changes in the ecosystem, such as annual variation in marine productivity or long-term changes in the availability of prey, are transmitted via the food web and appear as measurable parameters, such as the number of breeding penguins or how many seal pups and whale calves are born each year. We just need a way of decoding the signal.

While long-term data sets exist for selected areas and subpopulations (such as the Weddell seals of Erebus Bay or the Adélie penguins of the Southern Ross Sea), our understanding of charismatic megafauna at the scale of the Ross Sea region is still rudimentary. We do not know how many Type C killer whales live in the Ross Sea region, or where they go to have their calves. For that matter, we do not know with any

certainty how many Weddell seals there are, due to their inconvenient habit of spending part of each day beneath the surface of the ice.

To advance our understanding, we need to study species not where it is most convenient or apparent to us, but in a manner that reflects their life cycle priorities and on scales, in both time and space, that are truly representative. For seals, whales, and penguins, this means developing technological solutions for studying them in their true home, the Southern Ocean. Two promising solutions are the development of high-performance remotely operated vehicles (ROV), such as the Boxfish ROV we used on our 2018-19 expedition to McMurdo Sound; and utilisation of recent technological advances in remote sensing from stationary cameras, unpiloted aerial vehicles (UAVs), and satellites.

Another consideration is that killer whales, who are properly considered the largest member of the dolphin family and have the enormous brains to prove it, perceive the world primarily through sound, not vision, as we do. Just as a dog's reality is different from ours and shaped by its phenomenal sense of smell, toothed whales including dolphins, killer whales, and sperm whales use echolocation to 'see' the world around them. One theory for why toothed whales have such large brains is to provide the extra processing power required to analyse exceedingly complex acoustic signals. The Top Predator Antarctic Research Programme (TPA) has established passive acoustic monitoring of Type-C killer whales in the Ross Sea to gain a better understanding of their ecology and social structure.

The iconic inhabitants of the Great White South have fascinated multiple generations of scientists, explorers, and enthusiastic citizens, many of whom caught the 'Antarctic bug' from an inspiring teacher or public speaker. The value of flagship species such as whales, seals, and penguins is immense, not just for scientific research, but also for raising awareness for marine conservation and for promoting the responsible stewardship of one of the last wild places on Earth.

By **Regina Eisert**, *University of Canterbury/ @TPAonIce*

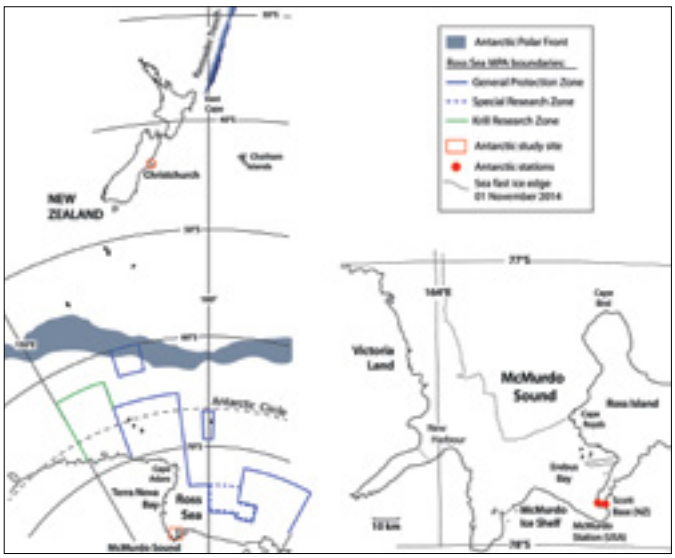
Acknowledgement: The author gratefully acknowledges funding from MPI, UNEP, and from the Pew Charitable Trusts, in-kind support from Boxfish Research Ltd., as well as excellent logistics support provided by Antarctica New Zealand. All images were taken in accordance with permits issued by the DOC and MFAT.

Killer whale among the sea ice, McMurdo Sound;
photo: R. Eisert, University of Canterbury/@TPAonIce.

Weddell seals beneath a hole in the sea ice;
photo: B. King, Boxfish Research

Adelie penguins swimming;
photo: B. King, Boxfish Research

Killer whales underwater;
photo: R. Eisert, University of Canterbury/@TPAonIce



Map showing the Ross Sea region Marine Protected Area in relation to NZ and Antarctica;
credit: R. Eisert, University of Canterbury/@TPAonIce.

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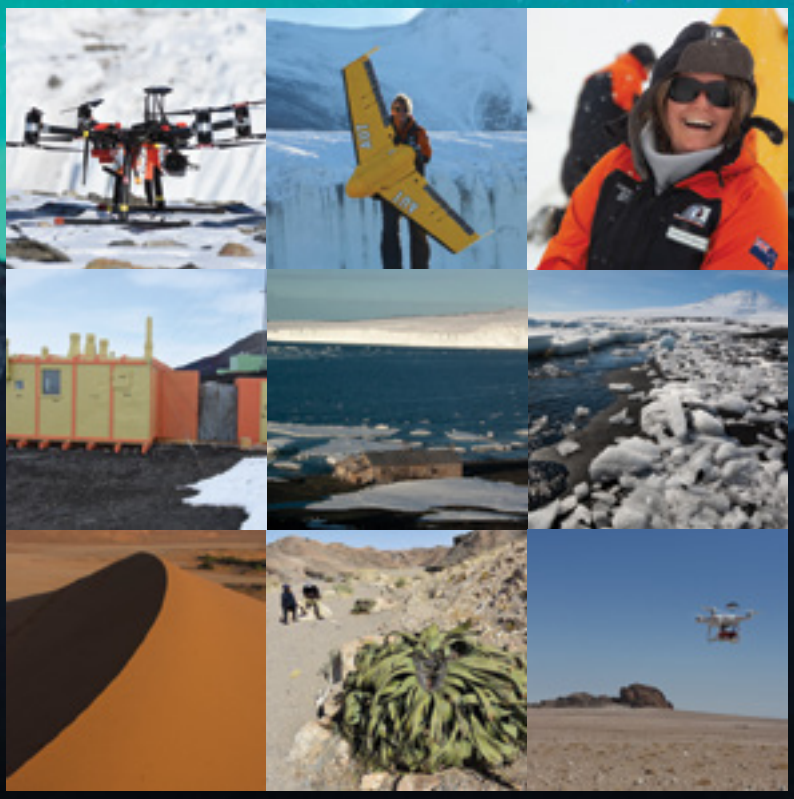

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Redeveloping Scott Base for the future

Since Scott Base's establishment in 1957, New Zealand has had a continuous presence in Antarctica. The base has had numerous upgrades and redevelopments, with the last major infrastructure investment occurring in the mid-1990s. The current facility is reaching the end of its functional life and safety risks are escalating. We have to mitigate increasing points of failure at Scott Base as the buildings, materials and systems are deteriorating with age.

As part of Budget 2019, Antarctica New Zealand received funding for the next phase of the Scott Base Redevelopment project. This allows us to complete a developed and detailed design, procure a main contractor, and finalise the project's Comprehensive Environmental Evaluation.

The seven-person project team has been working with architects, civil and structural engineers, and building services consultants to develop the optimal solution for the new base. The concept and preliminary design produced a preferred solution that replaces the current 12 separate buildings, with three large interconnected buildings and a separate helicopter hangar.

The building furthest up the hill contains dining and welfare spaces, in addition to accommodation to support up to 100 people. The middle building will house science support facilities and management offices, while the building closest to the Ross Sea will be for engineering, cargo, and storage. The hangar has capacity for two helicopters and other functions to support science.

The project has a number of unique design, logistical and construction challenges.

Extensive snow modelling showed that elevating the base on stilts allows wind to pass under the buildings, providing the most effective solution to reduce the impact of snow drifts.

Logistically, a singular resupply ship per year means that all cargo must be meticulously planned and optimised. The current Scott Base will be removed from Antarctica and brought back to New Zealand.

The environment also makes building in Antarctica difficult. The short summer construction window, and the relatively constrained site - due to the location of the existing base, and prevalence of the Ross Sea - add to the complexity. And all of this while minimising the disruption to science and general operations makes the project that much more challenging!

The developed and detailed design are due for completion in 2021, when we'll present the Government with a final proposal for funding. This exciting project will produce a new Scott Base that will provide a fit for purpose, environmentally sustainable, functional and efficient research base which will support our science programme in Antarctica for decades to come.

If you have any further questions, please contact Antarctica NZ at sbrproject@antarcticanz.govt.nz

(left) Three views of the proposed design for the future Scott Base; *images: Antarctica NZ / Jasmax / Hugh Broughton Architects*

Micro-organisms in the volcanic vents of Erebus – a key to life on other planets?

“We are looking for bacteria that are accessing new sources of energy, using methods only theoretically possible. This will not only provide us with an exciting new foundation for the limits of life on this planet, but for life on other planets”

Fumarole on Mt Erebus; *photo: Alasdair Turner*

Helicopter on Tramway Ridge below the summit of Mt Erebus, southernmost active volcano on Earth; *photo: Craig Cary, University of Waikato*

Field work at a geothermal vent on Mt Erebus; in the distance, the mountains of the Royal Society Range on the far side of McMurdo Sound; *photo: Craig Cary, University of Waikato*

A team from the University of Waikato and University of Canterbury, led by Professor Craig Cary, has received nearly $1million in a Marsden research grant to study unique micro-organisms that live in the geothermal fumaroles of Mt Erebus in Antarctica.

The research will break new ground as they will be drilling to access deep subsurfaces near the summit of the active volcano (3794m), which has never been attempted before.

This will make the fieldwork very challenging, as Professor Cary says, "no one knows how to drill into the geothermal surface of this volcano. We're developing technology so we can continually monitor and observe, using temperature sensors, but it is an unknown."

By drilling up to 10m into the sub-surface, the team hope to gain access to micro-organisms that survive in the unique geochemistry on the mountain.

"You only have to go 10cm deep to start discovering micro-organisms that aren't found anywhere else in the world," says Professor Cary.

This project will build on previous research undertaken by Professor Cary and his team of Professor Ian McDonald and Dr Charles Lee, initially funded by National Geographic then subsequently by a Marsden Fund grant. Their most recent papers indicated the need to go deeper into the sub-surface, resulting in this new study.

"As well as our previous research, the University of Waikato has a rich history in working on the top of Mt Erebus. Emeritus Professors Roy Daniel and Hugh Morgan, who built the Thermophile Research Unit at the University, went up the mountain first to cultivate the micro-organisms found there," says Professor Cary.

As well as going deeper, this new study will involve the team growing the bacteria on site and at Scott Base, a task not usually undertaken, as the conditions the micro-organisms exist in are extremely difficult to replicate.

One of the collaborators on the project, Slava Epstein from Northeastern University, has developed culture chambers that can be stuck down the bore holes drilled by the team, so they can incubate the bacteria in situ.

"Most bacteria in the world have never been cultured, so to culture bacteria from such a hard-to-reach place with such unusual chemistry is incredibly exciting," says Professor Cary.

"We are looking for bacteria that are accessing new sources of energy, using methods only theoretically possible. This will not only provide us with an exciting new foundation for the limits of life on this planet, but for life on other planets."

This research will take place over four seasons on Mt Erebus, beginning at the end of this year. The first phase will be an exploration or 'shake-down', in which researchers will test every tool, to see how it works exploring the sub-surface plumbing they will ultimately have to drill through.

The following seasons will be intense, with a larger team travelling to the site, including a telecommunications person who will create a network on the mountain so the data can be monitored from anywhere in the world.

The team hopes to put in place a significant outreach programme, so those in New Zealand can see what is happening in real-time.

"This project is formidable, and a testament to New Zealand's willingness to support high-risk science in very difficult to get to places, with a hopefully big payoff. We're aiming to find some unusual bacteria doing unusual things," says Professor Cary.

The team's possible findings could have ramifications for basic science, but also a myriad of possible applications commercially and in the search for life on other planets, due to the geochemistry involved.

"We're aiming to extend the boundaries of understanding on how life can exist on this planet, and thrive in these extreme environments," says Professor Cary.

By **Rosie Harris**

Antarctica New Zealand's new CEO

(Left) Sarah Williamson, CEO, Antarctica NZ
(Below) Scott Base; *photo: Anthony Powell, Antarctica NZ*

Sarah Williamson's affinity with Antarctica began the same way as it did for many of us, through the heroic tales of early explorers.

"My mum is a Cantabrian, she introduced me to Scott's journey and to some of the amazing early Antarctic explorers.

"The hardships they went through, their strength of character, what they sacrificed and the true grit they showed, that began the fascination with Antarctica for me," she says.

Sarah took the helm at Antarctica New Zealand at the end of June, after 19 years with Air New Zealand in a variety of roles, most recently as Group General Manager Business Performance leading a range of operational, logistical and corporate areas.

She lives in Ladbrooks with her husband and two teenage daughters.

Just six weeks into the role, she has attended the Antarctic Science Conference in Christchurch, announced the Scott Base Redevelopment project design with Minister Peters, attended the Antarctic Treaty Consultative Meeting and Committee for Environmental Protection meeting in Prague as well as COMNAP in Bulgaria.

"I have quickly learnt that the polar communities are an amazing resource within themselves, they actively and readily share information, best practice and ways of doing things," she says.

LOOKING AHEAD

"My vision is for Antarctica New Zealand to continue our gold standard logistics in an environment that's really difficult; to communicate what's happening on a continent that is a long way away; and to make sure we support the best science we can, because that is so important in a warming planet," she says

The Scott Base Redevelopment project is a vital part of this.

In Budget 2019, the Government committed $18.5 million for the next phase of the Scott Base Redevelopment project. This funding will be utilised over the next two years to complete a detailed design of the proposed new base. It also means the Redevelopment team can start working with the construction industry on how best to deliver the preferred design.

"This is a chance for us to take a set of buildings that have been built-up over time, and put in place a great new facility that helps our world-leading scientists continue their vital research.

"The place they live in needs to be set up in a safe and environmentally sustainable way, in what is a relatively hostile environment," she says.

CHRISTCHURCH'S ROLE IN ANTARCTICA

"You appreciate how invested Christchurch is as a gateway city, in making sure it is a great launching pad for folks going down to Antarctica, through Scott and Shackleton and expeditions past, it really is part of the fabric of the city," she says.

Her first trip to Antarctica is scheduled for November and she's hoping to spend some time in the field with science events.

"Everyone has said to me that you can't describe what it feels like to be in Antarctica, so I'm really looking forward to experiencing it first hand," she says.

Caring for an internationally significant Antarctic collection

Visit the Antarctic Gallery at Canterbury Museum

RealCool

Canterbury Museum

Rolleston Avenue, Christchurch
Free entry; donations appreciated
www.canterburymuseum.com

Unlocking clues from ancient fossils to predict future climate change

Victoria University of Wellington has a long and proud history of Antarctic research. Our scientists have been on the ice every year since 1957 and the University's Antarctic Research Centre was established in 1972 to further strengthen and extend our research in Antarctica.

"Understanding how the Antarctic ice sheets and Antarctic climate have responded to past periods of warmer temperatures and higher CO_2 levels is critical for figuring out how they may respond to present changes to the climate."

"Climate change is one of the most important issues facing humanity and there is a major role for environmental scientists to provide evidence and advice to decision makers. It is an urgent and challenging area, but one in which it is not too late to make a huge difference," says Professor Tim Naish, who is an earth scientist, the former director of the Antarctic Research Centre, and a lead author for the UN Intergovernmental Panel on Climate Change's fifth assessment report.

VICTORIA UNIVERSITY OF WELLINGTON - 62 YEARS ON THE ICE

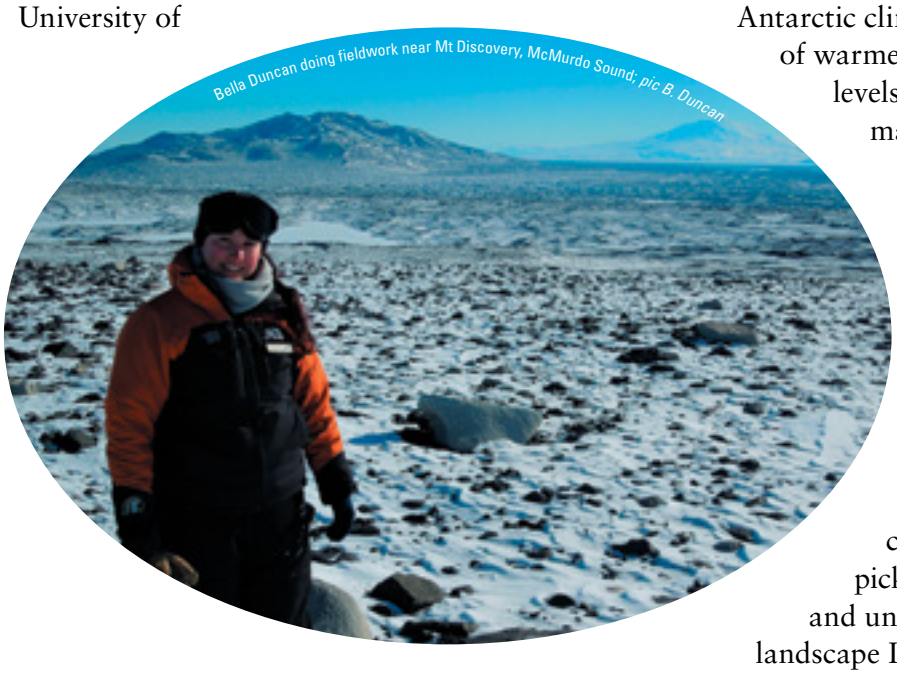
The University's reputation as a leading voice on climate change can be largely attributed to the Antarctic Research Centre's dedication to understanding the past, the present and the future impacts of the climate, and its research collaborations with other groups in this space, including GNS Science and the National Institute for Water and Atmospheric Research (NIWA), which are based in Wellington. A major area of interest to students and the public is improving predictions of how Antarctic ice melt will contribute to future sea level rise and how this will affect New Zealand.

Tim Naish (right) and colleagues investigate ancient glacial sediments in the Beardmore Glacier at the Cloudmaker; *photos: Andy Newman*

Tim Naish standing on top of Oliver Bluffs, just below Naish Peaks, looking across the upper Beardmore Glacier; *photo: Richard Levy*

Drilling through sea ice in McMurdo Sound; *photo: Dan Zwartz*

One of the recent graduates from the Antarctic Research Centre is Dr Bella Duncan who began her journey at Victoria University of Wellington studying for a Bachelor of Science in Geology and Geography in 2007. After her first year, she was hooked on earth science and went on to complete a Master of Science and PhD and was given the opportunity to visit Antarctica as part of those studies.



Bella Duncan doing fieldwork near Mt Discovery, McMurdo Sound; *pic B. Duncan*

She now works as a Postdoctoral Research Fellow within the Antarctic Research Centre where she uses molecular fossils - the chemical remnants of once living plants and other organisms - to look at the climate in Antarctica during periods of warmer temperatures and higher atmospheric CO_2 in the past.

"This is a pretty new area of research, and, in particular, hasn't been used much in Antarctica. It's so exciting to discover what our planet used to be like.

"Antarctica plays a key role in our global climate system, and what happens there under current climate change will have wide ranging implications for the planet. Therefore, understanding how the Antarctic ice sheets and Antarctic climate have responded to past periods of warmer temperatures and higher CO_2 levels is critical for figuring out how they may respond to present changes to the climate."

"It's a privilege to be able to work in an area contributing to our understanding of climate change."

ANTARCTIC FIELD WORK

Bella says visiting and conducting research in Antarctica has been a career highlight. "I vividly remember picking up rocks containing leaf fossils and understanding that the now icy, barren landscape I was standing on had once been covered in forests."

"Being an Antarctic scientist can lead you through a big range of emotions. There are days when researching the impacts of climate change can make you feel pretty frustrated and down, but conversely there are also times of optimism, hope, and the excitement of scientific discovery."

The University offers a variety of unique opportunities for students to study, and even visit Antarctica, whilst working alongside the leaders in Antarctic research in New Zealand. These opportunities include investigating Antarctica through the lens of geophysics, geology and climatology, to computer modelling and data science. Our science also has direct applications to decision making, policy, and law.

"I'd really encourage young people to take up the challenge of climate and environmental change research to help shape a more resilient and sustainable future," says Tim. *By* Lucy Dickie.

Left to right: Rebecca Jarvis, Len Gillman, Ashray Doshi, Barbara Bollard at Lake Fryxell, Taylor Valley; *photo: Len Gillman*

Mapping biodiversity in a changing Antarctica

Until comparatively recently, conservation scientists faced a dilemma - despite their commitment to preserving the environment, researching those environments left a detrimental footprint.

Conservation researcher Dr Barbara Bollard, an Associate Professor at Auckland University of Technology (AUT), decided to explore the potential of emerging technology in unmanned aerial vehicles (UAVs) or drones. She had experienced years of frustration trying to find 'cloud free' days over New Zealand to map conservation areas from space, so drones which flew below the clouds seemed a perfect solution.

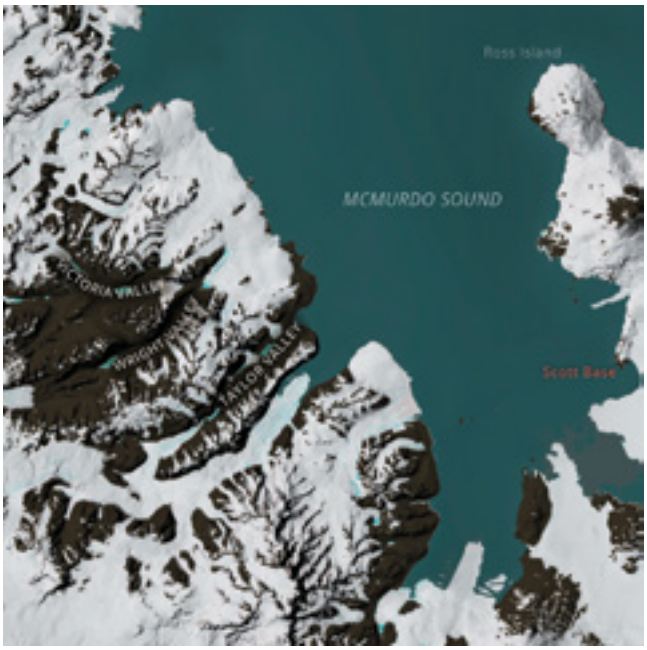
Fast forward seven years and Dr Bollard with AUT's UAV team are now using drones to map the most extreme environments on the planet, in Antarctica. The group includes PhD and MSc students, as well as AUT Head of Science Professor Len Gillman and engineer Ashray Doshi.

Trips to Antarctica have become a regular feature on the AUT science research calendar, starting in 2014 when the team flew UAVs in the McMurdo Dry Valleys (Spaulding Pond and Taylor Valley).

Dr Bollard and her team won a prestigious NZARI grant in 2015 to develop methods for operating UAVs for zero-impact research in rare and extreme environments. The team was so

UAV in Taylor Valley; photo: Len Gillman

successful that they were invited back for several seasons by Antarctica NZ to create 'baseline' maps of vegetation in Botany Bay, and other Antarctic Specially Protected Areas (ASPAs) in the McMurdo Dry Valleys. These three dimensional maps with sub-centimetre resolution are now being used for management planning.



Location of the three large McMurdo Dry Valleys in relation to Ross Island; *credit: Land Information New Zealand*

Camping out in freezing conditions, the team used a 2.5m-wide fixed-wing drone along with a custom built multirotor, engineered by Ashray Doshi, to withstand the extreme environmental conditions, such as the freezing temperatures and high winds. While there, they took thousands of images to make detailed maps of the environment, and in some locations were even able to map the human impact, right down to individual footprints left by previous scientists.

For mapping vegetation (mosses and lichens), the cameras had to be specially modified to capture different electro-magnetic signatures reflected from the unique plants and cyanobacterial mats.

The resulting map provides baseline data for follow-up surveys monitoring changes to vegetation. It is also being used in the conservation of Antarctic landforms at risk from climate change.

As Professor Gillman says, "Antarctica acts as a giant mirror reflecting UV light back into space. If it loses significant amounts of ice-cover, the planet will be screwed".

Operating in what is the driest, coldest and windiest place on Earth has its challenges. Dr Bollard says "due to the impact of the freezing air on the UAV batteries, I had to sew special thermal underwear for them in the field, which allowed them to keep flying for extended periods!"

Having hours of light that stretch around the clock mean extremely long days to meet tight deadlines, and often the scientists work through the night. Time on the ice is always limited and very little science can be done in the dark winter months.

Today, many of the projects the team have worked on have been turned into virtual reality (VR) experiences, giving insights into parameters that would not have been otherwise noticed. Dr Bollard says that by being able to view areas in 3D, they can look at the relationship between where things grow and how they grow.

More recently, the team have provided time and expertise to map 3D models of the interior and exterior of historical huts for VR experiences, so soon the public will be able to experience some of Antarctica's human history.

Camp at Canada Glacier, Taylor Valley; *photo: Len Gillman*

Virtual Reality Allows Immersive Access to Antarctica


TAE Hut; *photo: J Harrison*


Inside TAE Hut; photo: S Bassett

A new opportunity to step inside Sir Edmund Hillary's Antarctic hut will be launching soon. Antarctic Heritage Trust, in partnership with Auckland University of Technology have developed a unique virtual reality (VR) experience of Sir Ed's expedition base in Antarctica.

Donning a headset, people will be invited to step inside Hillary's (TAE/IGY) Hut and explore the first building at what is now New Zealand's Scott Base. A fully immersive experience, which includes a guided tour through the hut, it celebrates New Zealand's first presence in Antarctica as part of the Trans-Antarctic Expedition and International Geophysical Year.

The Trust finished conservation work on the hut in 2017, and is delighted to be giving people a glimpse into what life was like for Hillary and his team on the Ice.

Antarctic Heritage Trust Executive Director Nigel Watson says, "This fully immersive experience will be the closest thing possible to exploring the expedition's base without actually going to the hut itself.

It's exciting to see how cutting-edge technology, such as VR, can bring important heritage sites and their stories alive for the public."

The experience will be free and available nationwide through select public exhibitors, as well as available online.

The Trust would like to acknowledge project partner Auckland University of Technology, principal sponsor Ryman Healthcare, Antarctica New Zealand (logistics), and Staples VR (technical) for making this project possible.

For more information visit nzaht.org

Accessing Antarctic History Online

Canterbury Museum cares for more than 7,000 treasures telling stories from Antarctica's history.

However, only a fraction of this internationally significant collection can be displayed in our current Antarctic Gallery.

We display some of our more rarely-seen treasures in temporary exhibitions, but these can only run for a limited time and are not always accessible to out-of-town visitors.


Hauling stores up the beach at Cape Adare, 1899; *credit: Canterbury Museum*


Scientific staff of Southern Cross expedition, 1898; *credit: Canterbury Museum*

To address this, we began creating online versions of temporary exhibitions that have been developed from the collection. The content is the same, but it's accessible indefinitely and from anywhere in the world.


Osman the Great, a dog on Terra Nova expedition, 1911; *credit: Canterbury Museum*

Dogs in Antarctica: Tales from the Pack tells the stories of the often-unsung heroes of early Antarctic exploration: the dogs. The physical exhibition was packed down in April this year, but in the online version you can still read about the canine characters who helped explore Antarctica.

In October, we packed down Breaking the Ice, an exhibition created in partnership with Antarctic Heritage Trust. The exhibition tells the story of the first people to winter over in Antarctica, Carsten Borchgrevink's Southern Cross expedition (1899–1901). The online version is attracting digital visitors in the UK, USA, Norway and of course New Zealand.

By **Anthony Wright,** *Director, Canterbury Museum*

You can access these exhibitions through the Museum website:
www.canterburymuseum.com/discover/

Weddell seal surfaces through a drill hole in the sea ice; *photo: Natalie Robinson, NIWA*

" the global ocean has absorbed 93% of the additional heat in the climate system, resulting from human activity since the dawn of the industrial revolution... So, the oceans have bought us time, but have also committed us to change over the very long term, as they slowly release that heat back to the atmosphere "

Deciphering messages from supercooled water at the front of the ice shelf

For NIWA marine physicist Natalie Robinson, understanding the relationship between sea ice and the ice shelf is one of the reasons she returns year after year to Antarctica. The sea-ice expands to an area approximately equal to that of Antarctica in winter, then, in summer, contracts.

The sea-ice is an important element in the global climate system, but why it grows and recedes in the way it does is poorly understood.

Scientists like Natalie are helping to significantly advance our knowledge of this and other important research questions.

In this story, Natalie explores the whys and wherefores of Antarctic research and paints a vivid picture of what it's like on the front line of research on the white continent.

The Weddell Seal pops his head up through the hole in the floor of the shipping container – for the fourth time today. The shipping container is one of several making up our field camp on sea ice, 40km from Scott Base.

It feels as remote as anywhere. The frozen ocean surface stretches white for miles in every direction, and the distant chain of the TransAntarctic Mountains fills the westward horizon.

The container has been modified to have a lift-out section of floor. After melting through two metres of sea ice, we can access the ocean beneath our feet from the comfort of our warm shelter, whatever the weather.

This water is as cold as our ocean gets. So cold that, through a quirk of the pressure effect, it arrives at our site 'supercooled'. That means it's cold enough that it could have frozen, but so far it has remained liquid.

It's a clear indication that we're looking at melted ice shelf - glacial ice whose story began as fallen snow eons ago, somewhere in the middle of the Antarctic continent. Since then it's been slowly flowing northward.

When it reached the coast, it kept flowing out over the water, melding with other glaciers, to form the huge platform of floating ice known as the Ross Ice Shelf. It's a peaceful sleeping giant - twice the area of New Zealand, varying between 300 and 700m thick.

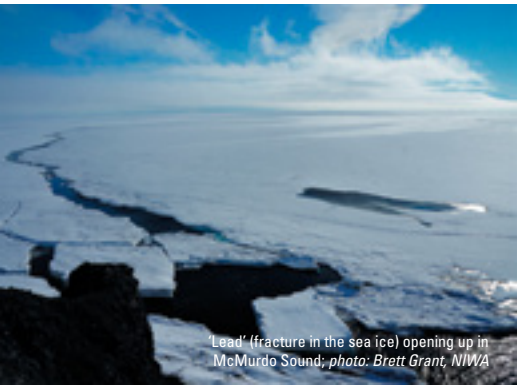
The Ross Ice Shelf stems the flow of ice streams that drain 20 per cent of the Antarctic continent. For now, it's thought to be stable. But it's highly sensitive to the water that circulates beneath it, and intrusions of warm water are generating a lot of melting.

This connects the fate of Antarctica to the global ocean and to our changing climate. That connection is complex, indirect and intricate. But the fundamental chemistry and physics of man-made climate change are simple and have been known about for over a century:

1) when organic fuels are burnt, Carbon (C) and Hydrogen (H) atoms are separated from each other and instead join with Oxygen (O) atoms present in the air we breathe, to create CO2 and H2O.

2) These two products are both what are known as 'greenhouse gases' because they have a similar effect in the atmosphere as the glass in a greenhouse: they allow all the visible light in but prevent some of the heat from getting out again.

Nansen Ice Shelf; *photo: Craig Stevens, NIWA*



'Lead' (fracture in the sea ice) opening up in McMurdo Sound; *photo: Brett Grant, NIWA*

That's it. That's all that is needed to understand why Earth's atmosphere is changing; why that change logically leads to higher temperatures; and why we know that these changes are a result of human activity since the dawn of the industrial revolution.

All of the rest of the research in the very broad field of climate change is aimed at quantifying this effect and understanding the incomprehensibly large array of interactions and feedbacks that this fundamental change has had, is having now, and will have in the future.

Although our everyday experience of 'climate' is with the atmosphere, an enormous part of the story is in the ocean. The ocean makes up 70 per cent of the surface of the Earth and provides habitat for most of its life.

And it's an extremely powerful agent for distributing heat around the globe. Just like the atmosphere, the ocean has major arterial highways that it moves heat along, with smaller circulation cells and storms (known as eddies) that move into every corner.

However, the ocean can hold as much heat in just its top 3m as the whole atmosphere stacked above it. And when you consider that the ocean averages 4km in depth, it becomes apparent what an enormous potential heat store those watery depths are.

As of 2015, the global ocean had absorbed 93 per cent of the additional heat in the climate system resulting from human activity since the dawn of the industrial revolution. This compares with just 1 per cent taken up by the atmosphere over the same period.

Without the oceans, the atmosphere would have retained almost all of this additional heat, and the air we breathe would already be 30-50 degrees warmer. Too hot for human habitation.

So, the oceans have bought us time, but have also committed us to change over the very long term as they slowly release that heat back to the atmosphere. Or it is used to melt ice.

So here we are – six people in a shipping container in the middle of nowhere, deciphering a message of recent ice melt, coded into temperature and salinity changes in the ocean water. We're trying to better understand exactly how the ocean affects the ice so we can better predict how the melt might speed up in the future.

The seal has been such a frequent visitor that we've nicknamed him 'Walter'. Before we arrived, Walter had never breathed air warmer than zero degrees.

It's clear he likes it. He's taken to sleeping jammed against the sides of the hole with his face under the flow of warm air, which we've been pumping downwards in order to keep the hole itself open.

It is a privilege to work in this pristine wilderness, and to witness this sentient voyager of the deep so comfortable in our presence. In this untouched wilderness, he has never seen humans as a direct threat to his survival. But I find myself pondering the silent threat humans pose to Walter's future generations, as well as my own.

By **Dr Natalie Robinson**, *marine physicist with NIWA.*

Resolving and predicting future sea level rise

Our planet is warming as greenhouse gas concentrations in Earth's atmosphere continue to increase. The warmer temperatures are causing sea level to rise as warming oceans expand and water from melting glaciers, ice caps and ice sheets flows into the sea.

ICE SHEETS

However, projecting just how much and how fast sea level will rise is difficult – mostly because we don't know enough about Antarctica's ice sheets. Understanding Antarctica's likely contribution to future global sea level rise, and predicting sea level change around Aotearoa, is a major focus of the NZ Sea Rise Programme – a multi-million-dollar research programme supported by the Ministry of Business, Innovation, and Employment.

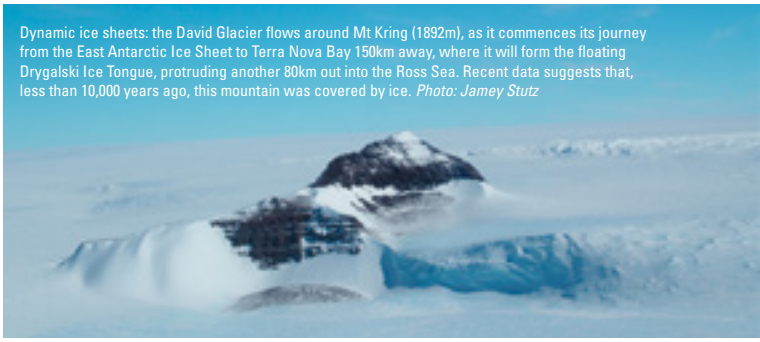
We used to think that sea level rise was like pouring water into a bathtub: if you added water to the ocean, it would rise uniformly around the world. But we now know that a range of complex processes mean that sea level rise will be greater than the global average in some parts of the world and less than average in others.

GRAVITY

Some of it comes down to simple physics: the massive ice sheets in Antarctica and Greenland exert a gravitational pull on the ocean around them, causing sea level to be higher next to the ice sheets. So when ice in Greenland melts, sea level drops next to the ice sheet and rises at locations far away from Greenland – including in Aotearoa. The opposite occurs when Antarctica's ice sheets melt.

OCEAN CURRENTS

Sea level can also vary across the globe as changing ocean currents redistribute heat: warming waters expand and cause local sea level to rise.

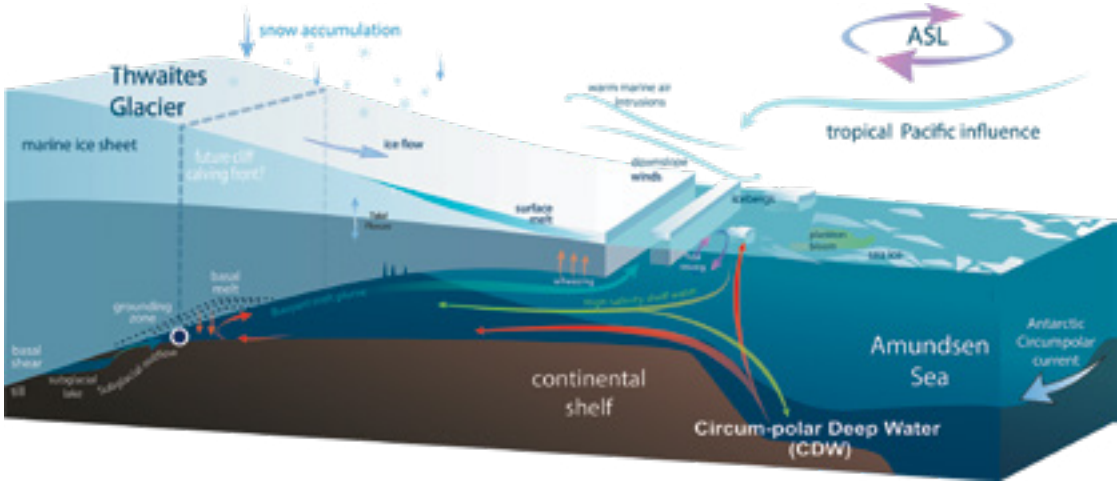


Dynamic ice sheets: the David Glacier flows around Mt Kring (1892m), as it commences its journey from the East Antarctic Ice Sheet to Terra Nova Bay 150km away, where it will form the floating Drygalski Ice Tongue, protruding another 80km out into the Ross Sea. Recent data suggests that, less than 10,000 years ago, this mountain was covered by ice. *Photo: Jamey Stutz*

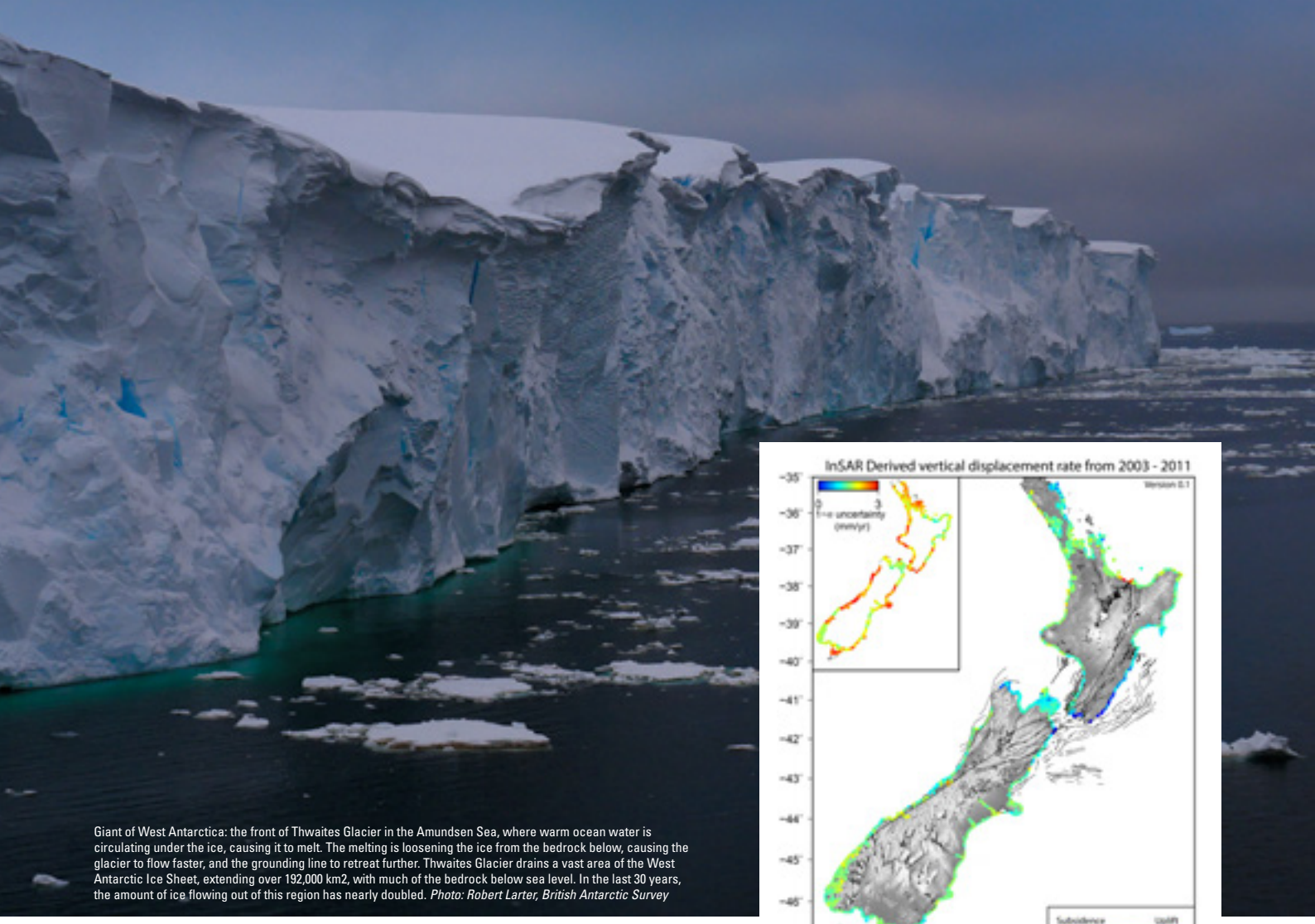
GLACIAL REBOUND

Another thing that influences sea level is glacial rebound (or isostatic rebound): the shape of Earth's surface is very slowly changing in response to the retreat and final disappearance of massive ice sheets that covered large areas of our planet during the last ice age.

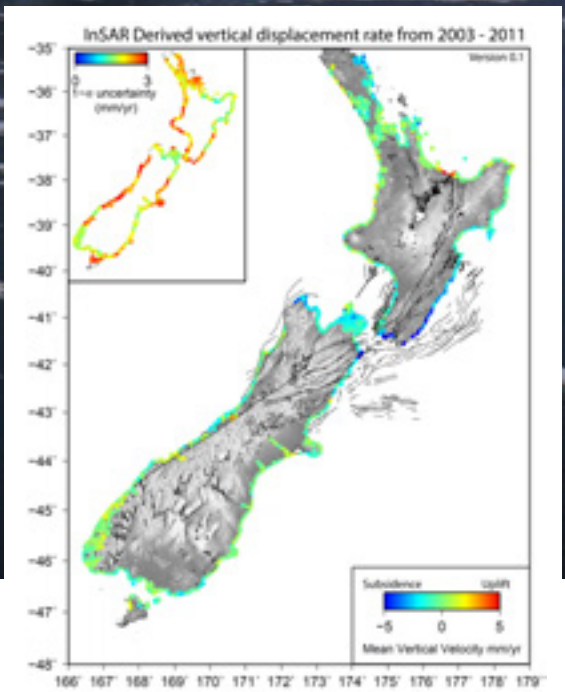
In parts of the world that carried the weight of huge ice sheets – much of the Northern Hemisphere, Antarctica's continental shelves, and New Zealand's South Island – the land is now slowly rising. Other areas of land are subsiding as the Earth's mantle flows towards these areas



A multi-national effort is underway to better identify and measure the drivers behind the observed changes on the accelerating Thwaites Glacier. A complete retreat of the glacier would destabilise the West Antarctic Ice Sheet, raising global sea level by more than 3 metres - a scenario which could occur over the next few centuries. *Credit: Ted Scambos, CIRES, University of Colorado*



Giant of West Antarctica: the front of Thwaites Glacier in the Amundsen Sea, where warm ocean water is circulating under the ice, causing it to melt. The melting is loosening the ice from the bedrock below, causing the glacier to flow faster, and the grounding line to retreat further. Thwaites Glacier drains a vast area of the West Antarctic Ice Sheet, extending over 192,000 km2, with much of the bedrock below sea level. In the last 30 years, the amount of ice flowing out of this region has nearly doubled. *Photo: Robert Larter, British Antarctic Survey*



Map showing vertical displacement rate around the NZ coastline; the land movement estimated from Synthetic Aperture Radar Satellite (InSAR) data. *Credit: Ian Hamling, GNS Science*

of glacial rebound. These changes in the shape of Earth's crust cause sea level to fall in some regions and rise in others.

PLATE TECTONICS

New Zealanders understand plate tectonics better than most people in the world. We live on a plate boundary and our coastline is always changing. Local land movement due to tectonic activity also has a direct impact on sea level along our coastline. Scientists can measure the amount of vertical land movement using global positioning satellite technology and radar systems mounted on Earth orbiting satellites like Envisat and Sentinel. These instruments show us that parts of our coast are going up at a rate of 10 mm every year and others are sinking by as much as 5 mm per year. Areas of land that are going up reduce the effect of global sea level rise and can even cause a local drop in sea level – at least in the short-term.

SUBSIDENCE

But sea level rise will be higher than the global average in areas that are subsiding. Subsidence often happens in low lying areas, or basins, that are usually filled with soft sediment. These sediments compact over time causing the land to sink. This sinking can be accelerated when we pump water out of the basin to use the land for farming and industry or to build houses and airports. These low-lying subsiding regions are the most susceptible to sea level rise.

As well as predicting the amount of sea level change around Aotearoa, our team will study the effect this change will have on our coastline. Will sea level rise change the size and number of coastal floods, will the ground get wetter, will our river mouths and estuaries become saltier? Our new discoveries will be used to prepare for, and adapt to, inevitable change so that our communities remain resilient and strong.

By **Richard Levy, Tim Naish, Rebecca Priestley, Nick Golledge,** *and* **Rob Bell**
Te tai pari o Aotearoa - NZ Sea Rise
For more information, go to searise.nz

What's causing sea level rise? Land ice vs. sea ice

Ice in Antarctica, and other high-latitude areas such as Greenland, takes many shapes and forms.

Sea ice is frozen sea water which is formed when the ocean surface freezes. It floats on top of sea water and usually melts during summer and grows in winter.

Ice sheets are large areas of ice that sit on land. Antarctica hosts three ice sheets, and the largest is the East Antarctic ice sheet (EAIS).

Although all of the EAIS sits on land, a big portion of that land is below sea level. These parts of the ice sheet are directly connected to the ocean and are often called marine-based ice sheets. If the marine-based portions of the EAIS melted, sea level would rise by 20 metres. If the parts of the EAIS that sit on land above sea level were to melt, sea level would rise another 33 metres.

The West Antarctic ice sheet (WAIS) is smaller than the EAIS. Almost all of the WAIS sits on land that is below sea level, so it is vulnerable to changes in ocean temperature and if it melted, it would raise sea level by 4 metres.

Ice shelves are medium to large regions of floating ice that are connected to Antarctica's ice caps and ice sheets. Some ice shelves can be as large as an entire country.

PRACTICAL EXPERIMENT

So which of the different types of ice on and around Antarctica would contribute the most to sea-level rise? Do the following experiment and find out (see graphic on opposite page).

WHAT YOU NEED:

- Three empty ice cream containers (with their lids)
- Three large clear-sided plastic boxes (these need to be bigger than your ice cream containers)
- Three lengths of thin wire, ~20–30 cm long
- a brick or flat rock (if you can't find one, any solid dense block of material will do)
- a clock or a timer
- balance (scales)
- a data table with columns to record time, mass, and water level

STEP ONE: FREEZE!

Fill your ice cream containers with water. Take the wire and make a loop a few centimetres in circumference at each end of the wire - then bend one of the loops so that it lies at right-angles to the rest of the wire. Place the bent loop into the water so that it touches the bottom of the centre of the ice cream container, and tape it to the side of the container (see diagram). This wire will allow you to move the ice block during the experiment without touching it.

Place the filled ice cream containers into a freezer and leave overnight.

STEP TWO: MEASURE!

Take the large plastic boxes and pour water into two of them. The first box needs enough water to float one of the ice blocks so it's not touching the base of the box. The second needs just enough to let the ice block rest on the bottom of the box.

Put the brick into the third box and fill it with enough water to come almost to the top of the brick (but not over the top).

Now take your ice blocks and measure the (mass) weight of each block. Record the values in your table.

Place one block of ice into each box. In the third box, put the ice on top of the brick, making sure the ice isn't touching the water. Mark the water level on the side of each container; this represents 'sea level' at the start of the experiment.

Start the timer. After 5 mins, it's time to see what's happened!

While the ice block is still in the box, note any change in water level on the side of the container. Pick up each block of ice with the loop and place it on the balance (scales) to measure the mass. You can use the ice cream container to keep the blocks steady on the scale, but if you do this, make sure you zero (tare) the scale before you put the ice in!

Record the measurement of each block's mass in the table, and the time.

After 5 mins repeat your measurements. After 30 mins to 1 hour you can measure the mass of the ice block every 15 minutes.

Plot the results on a graph, with ice mass on the Y (vertical) axis, and time on the X (horizontal) axis

- Which box showed the largest difference in sea-level rise?
- Which ice block melted the fastest? Which took the longest to melt?

By **Richard Levy, Kyle Bland, Joe Prebble, Malcolm Arnot, Valerie Stucker, Jessica Williams** *and* **Gary Wilson. For more information, go to searise.nz**

From land-based to sea-based: in this photo, the mighty Byrd Glacier diverges into the Ross Ice Shelf. Originating on the polar plateau of East Antarctica, it drains a catchment area greater than 1 million km². The ice is funnelled into a 20km wide, 100km long fjord through the Transantarctic Mountains, reaching speeds of 800m per annum in the centre line. It transports more ice to the Ross Ice Shelf than any other glacier. *Credit: Charles Goines*

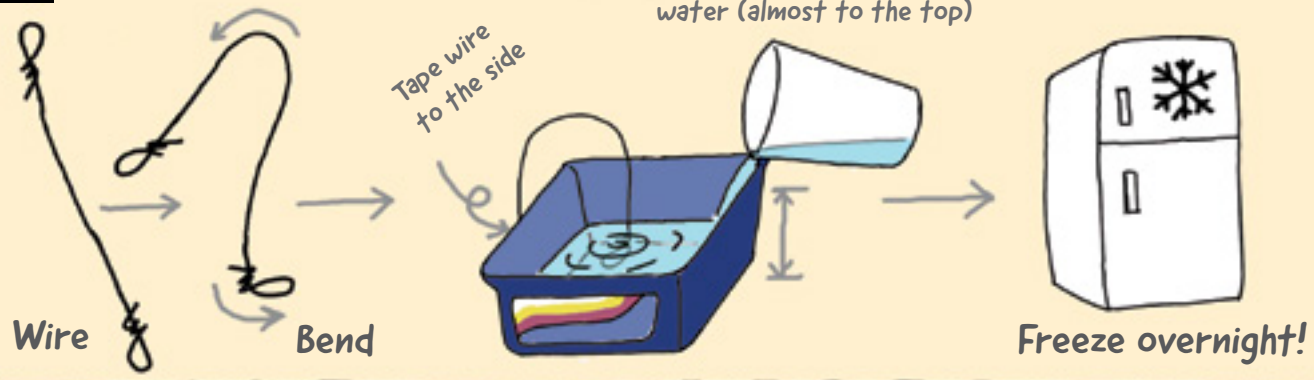
MELTING ICE & SEA LEVEL

CONDUCT YOUR OWN EXPERIMENT WITH YOUR FRIENDS!

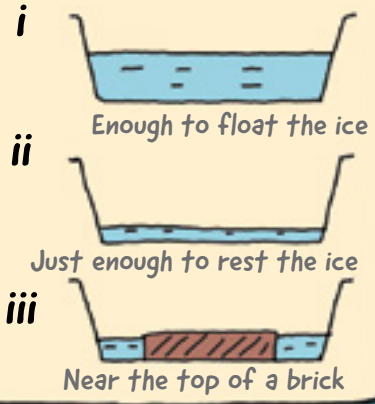
You'll need:

- Three empty ice cream containers
- Three large clear-sided plastic boxes
- Three lengths of thin wire (20–30 cm long)
- A brick or flat rock
- A clock or timer
- A scale
- Notebook and pen

1 MAKE ICE



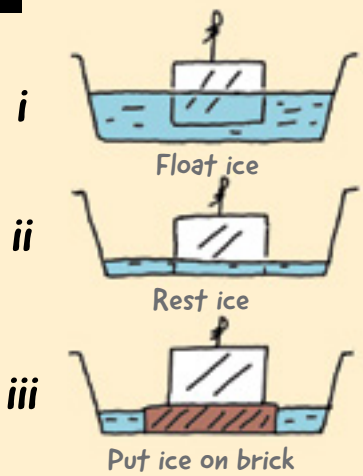
2 FILL 3 LARGE CONTAINERS WITH WATER



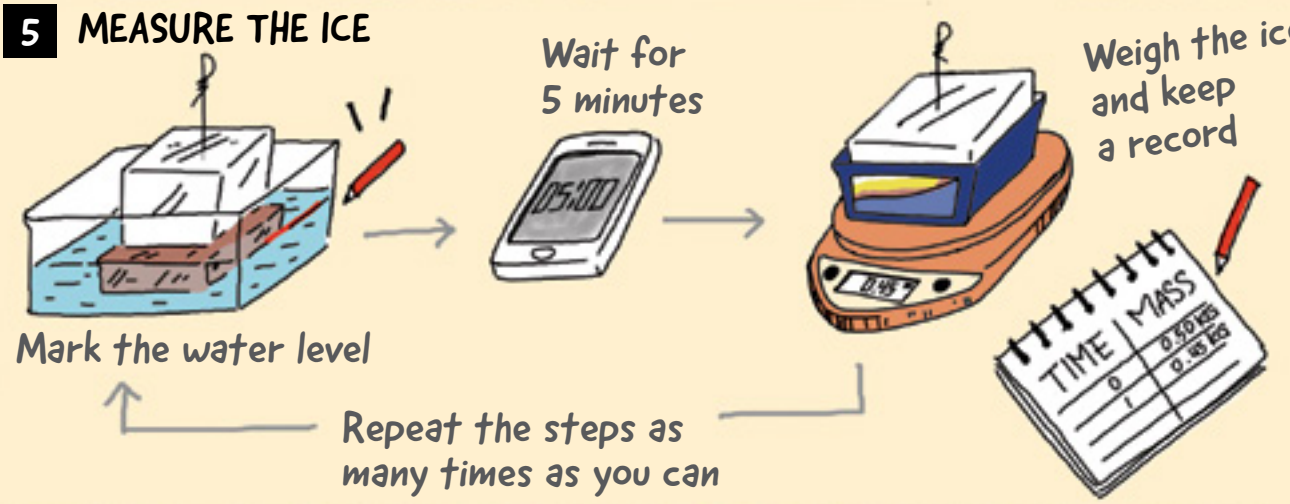
3 WEIGH THE ICE

Make sure to zero the scale before you put the ice on!

4 PUT THE ICE IN



5 MEASURE THE ICE

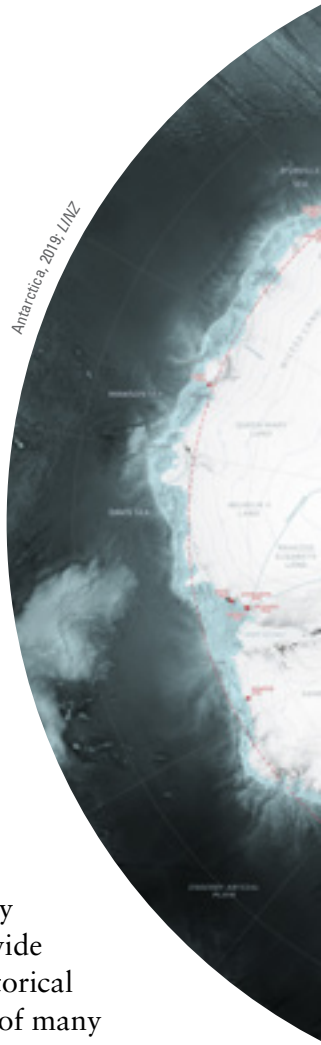


Credit: Katy Kelly

Go to GNS Science website for more information www.gns.cri.nz

Key advances in Antarctic mapping

The new 2019 map of Antarctica, produced by Land Information New Zealand (LINZ) in partnership with the New Zealand Antarctic Society, provides a graphic depiction of how our knowledge and understanding of the continent have vastly improved over time.

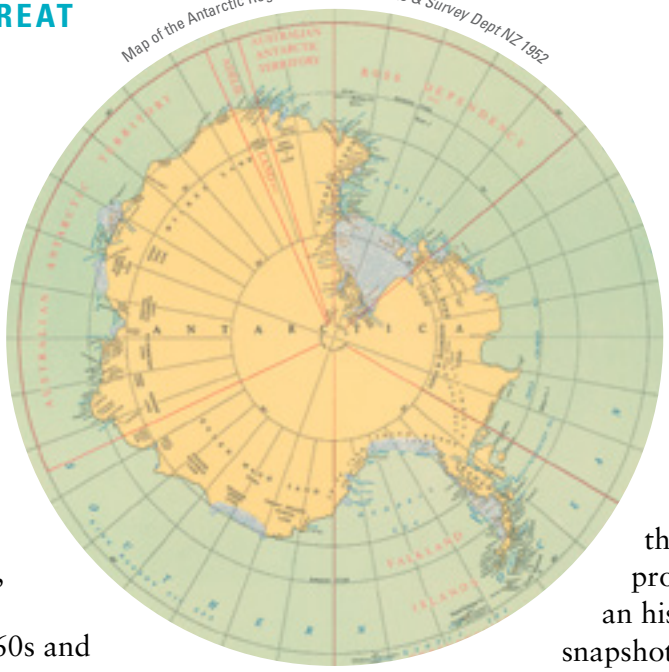


Antarctica, 2019; LINZ

SEISMIC SURVEYS ON THE GREAT TRAVERSES

The International Geophysical Year (IGY) of 1957-58 had the goal of promoting global scientific collaboration that had been hampered by divisions resulting from the Cold War.

Research work begun at the time, and coordinated through the IGY, included over-snow traverses by the US, USSR and France. These traverses included making seismic reflection ice soundings and other geophysical measurements, along with glaciological studies. This geologic work continued into the 1960s and provided substantial data used to approximate snow surface elevation, ice thickness and bed topography, along with mean annual temperature and snow accumulation at the time.



Map of the Antarctic Regions NZMS 94; *Lands & Survey Dept NZ 1952*

LAND SURVEYING

Dogs and dedicated teams of hardy surveyors also greatly increased our knowledge of the continent from the late 1950s. New Zealand began a seven-year long reconnaissance mapping programme in conjunction with the Trans Antarctic Expedition in the summer of 1957-58. The survey teams relied on husky-drawn sledges to explore and map the Ross Dependency section of the 4000km-long Transantarctic Mountains.

AERIAL PHOTOGRAPHY

Between 1946 and 2000, the US Navy collected black and white trimetrogon aerial (TMA) photography of Antarctica. TMA photography is a camera system that collects a left-oblique, on-nadir (straight down), and right-oblique static frame. The aerial photography was used for early topographic mapping efforts (including the USGS 1:250,000 scale map series). Today, they provide an historical snapshot of many parts of Antarctica.

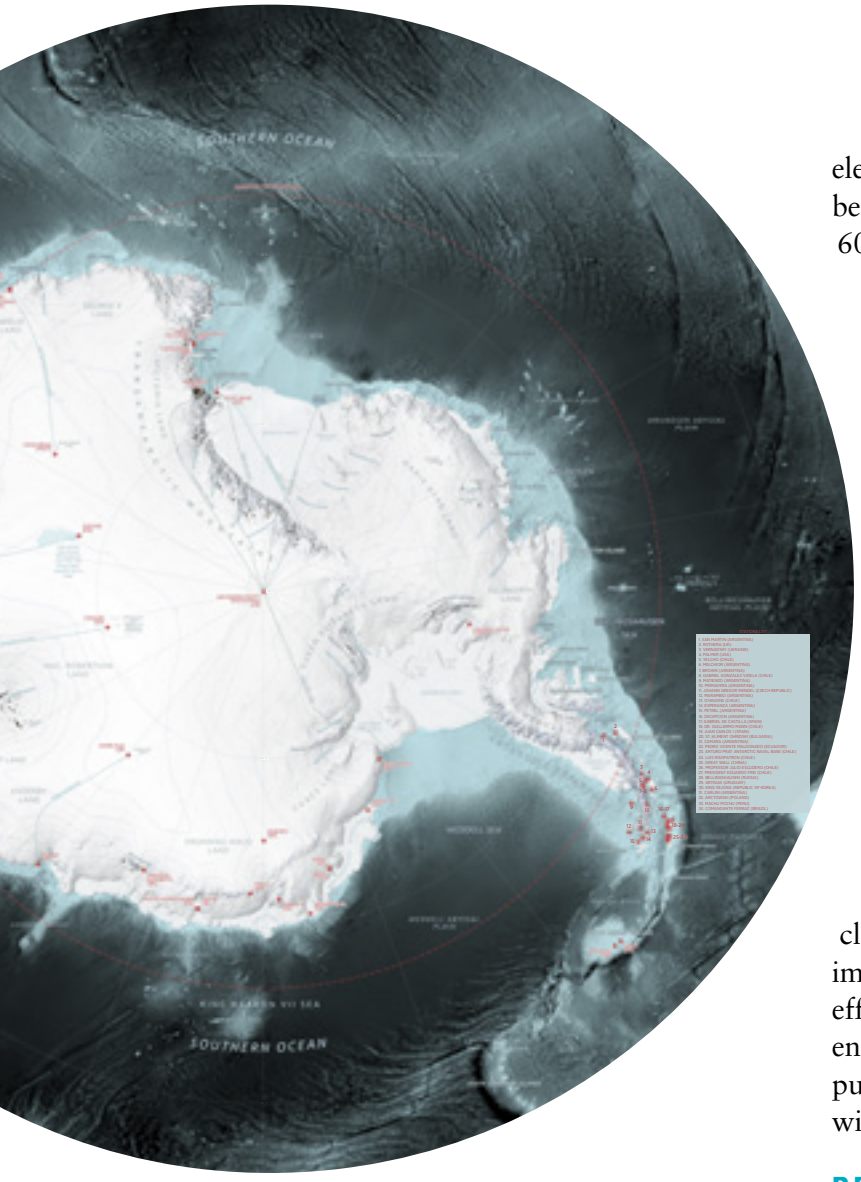
SATELLITE RADAR INTERFEROMETRY

From the 1990s, Satellite Radar Interferometry (SRI) provided an important tool for monitoring the flow velocities and grounding-line positions of ice streams, which are indicators of the response of the ice sheets to climatic change or internal instability. The use of SRI combined with other satellite methods has enhanced the scientific understanding of ice stream mechanics and has helped predict the movements of ice sheets.

RAMP

The Canadian Space Agency's RADARSAT-1 satellite was at the heart of a 1997 joint effort between the CSA and NASA: the RADARSAT

Successive Maps of Antarctica 1952-1994; *Lands & Survey Dept NZ, Dept of Survey & Land Information. These maps are available for download at: geodatahub.library.auckland.ac.nz*



Antarctic Mapping Project (RAMP). For RAMP, RADARSAT was rotated in its orbit so that its Specific Absorption Rate (SAR) antenna looked south towards Antarctica, enabling the first high-resolution mapping of the entire continent.

BEDMAP

Measurements of ice thickness on the Antarctic ice sheet collected during surveys undertaken over several decades were brought together into a single database in a multi-national initiative called BEDMAP, completed in 2001.

Antarctic mapping was taken to a new level with BEDMAP 2 in 2013 which measured surface elevation, ice-thickness, the sea floor and subglacial bed elevations of the Antarctic south of latitude 60°S.

ICESAT SATELLITES

Originally launched by NASA in 2003, the first ICESat mission provided global altimetry measurements for more than six years and contributed to many important scientific studies. This was followed by the 2018 launch of NASA's ICESat-2 which has revealed previously unmapped valleys in Antarctica, filling in details of the terrain that other satellites can't see.

LANDSAT IMAGE MOSAIC OF ANTARCTICA (LIMA)

A major scientific outcome of the 2007-2008 International Polar Year, the Landsat Image Mosaic of Antarctica (LIMA) provides virtually cloudless, seamless, and high-resolution satellite imagery of Antarctica. LIMA is an international effort supporting current scientific polar research, encouraging new projects, and helping the general public visualise Antarctica and changes occurring within its environment.

REFERENCE ELEVATION MODEL OF ANTARCTICA (REMA)

The Reference Elevation Model of Antarctica (REMA) is an 8m resolution digital elevation model, released in 2018, covering 98% of the Antarctic continent. The resulting high-resolution data gives researchers access to better information needed to monitor changes in ice levels and other changes on the surface of Antarctica.

THANKS TO OUR PARTNERS AT LINZ

The NZ Antarctic Society wishes to thank Jonathan Ball and Ian Reese at Land Information New Zealand (LINZ) who made possible the 2019 Antarctic map project.

If you want to know more about the new Map of Antarctica, produced by Land Information New Zealand in partnership with the NZ Antarctic Society, or how to obtain one, please contact: maps@antarcticsociety.org.nz

Marking humanity's footprint – place names in Antarctica

Place names mark humanity's footprint in Antarctica from the earliest explorations to recent scientific discoveries. They create a stronger sense of place through cultural values, referencing people, events, myths and stories, or describing the physical aspects of a feature.

'An evil and brooding appearance', Medusa Peak with naming proposal; *photo: M. Bradshaw via DSIR source: NZGB archive records*

Making place names official provides a consistent frame of reference that supports science and assists with navigation and emergency response. Official naming is an aspect of New Zealand's territorial connection to the southern continent.

New Zealand's national authority on place names, the New Zealand Geographic Board Ngā Pou Taunaha o Aotearoa (NZGB), has officially named places in the Ross Sea region since 1956. It was given the role by a Cabinet directive in preparation for the International Geophysical Year.

The NZGB published the *Provisional Gazetteer of the Ross Dependency* in 1958, compiled by Arthur Helm, Secretary of the Ross Sea Committee. The *Provisional Gazetteer* was a naming baseline produced by scouring maps and publications for all existing New Zealand place names in the Ross Sea region. Many were originally published without coordinates, reflecting ambiguous text-only descriptions, names shown only on photographs, or with dubious locations.

In 2008 the NZGB's governing legislation was updated to specifically provide for place naming in Antarctica. The new Act also made provision for a publicly available *New Zealand Gazetteer*. Today the official record of New Zealand's place names, the *New Zealand Gazetteer* holds nearly **4600** Antarctic place names. Most are the official names for geographic features such as bays, glaciers, and peaks, but also for subglacial features, places, and historic sites.

For their heritage value, the NZGB also preserves names applied to features that no longer exist, such as bays in the ice at the Bay of Whales named during Admiral Byrd's Antarctic expeditions, and in some cases features that never existed.

Anyone can propose a new name or make a proposal to alter an existing name.

Proposals are considered by the NZGB's Antarctic Names Committee (ANC) who make recommendations to the NZGB. Membership of the ANC includes NZGB members, scientific experts with operational experience in Antarctica, and representatives from Antarctica New Zealand, Land Information New Zealand, and the Royal Society Te Apārangi.

Proposed names that are accepted become final following consultation with US-ACAN[1] . They become official by notification in the *New Zealand Gazette*.

NEW DEVELOPMENTS, NEW DATA

The way place names are used and how decisions are communicated has changed with the times. The NZGB's decisions continue to be updated on official documents such as topographic maps and hydrographic charts. However, place names (and information about them) are now a fundamental data product in their own right. The NZGB wants to meet the expectations of the Antarctic community who use place names to map their work and help tell their own stories.

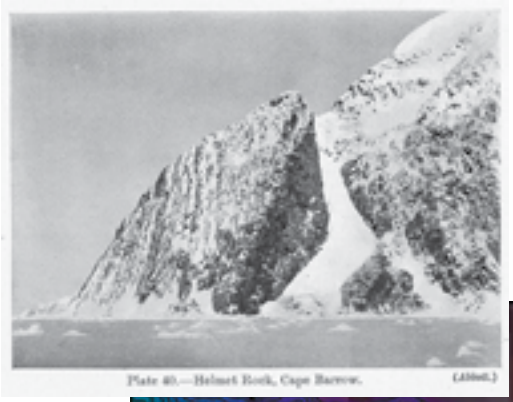
It's important that official names are correct, the positions accurate, the records complete, and the data is openly available. Internationally, SCAGI[2]

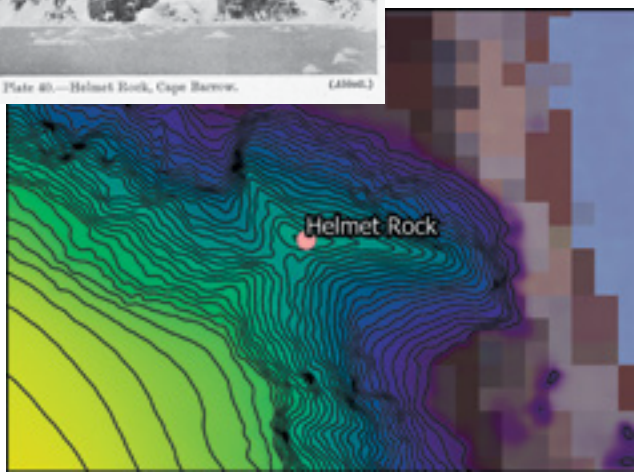
encourages nations operating in Antarctica to improve their geographic information. The NZGB also contributes to the SCAR[3] *Composite Gazetteer of Antarctica* to ensure other nations operating in the Ross Sea region know New Zealand's names to prevent multiple naming for features.

In 2017 the ANC began a project to review all of New Zealand's Antarctic names and confirm, improve, or correct them, particularly for positional accuracy. The efficient and accurate assessment of coordinates is possible due to easy access to the digitisation of many historic records, coupled with recent developments in geospatial data products. Key recent developments include:

- Early Antarctic books, scientific reports, and photographic collections that are well out of copyright, digitised, and text searchable.
- New Zealand expedition photography is digitised and available through Antarctica New Zealand's content platform.
- Aerial reconnaissance photography was marked up with new place names, and is unambiguous compared to some of the coordinates still on record.
- In 2017 all NZMS[4] and L&S[5] maps, including the Antarctic series, were scanned to archival quality. Other historic maps from both New Zealand and international expeditions are digitally available through collections from the Polar Geospatial Center, University of Minnesota, or referenced through the SCAR map library.
- In 2017 highly accurate DigitalGlobe commercial satellite imagery was made available to naming authorities for improving coordinates.
- In 2018 the NZGB scanned its Antarctic Minutes and Correspondence volumes covering 1960-1993, and made it text searchable.
- In 2018 the Polar Geospatial Center, University of Minnesota, released the Reference Elevation Model of Antarctica (REMA). This satellite derived dataset is a leap ahead for continent wide elevation data at 8m resolution, with vertical accuracy better than 1m. 2m resolution satellite strips are also available for even further detail. All REMA data is openly available.

In 2017 Recce Hill, short for Reconnaissance, was corrected from Reece Hill, a name mistakenly published since 1961; *photo: LINZ*





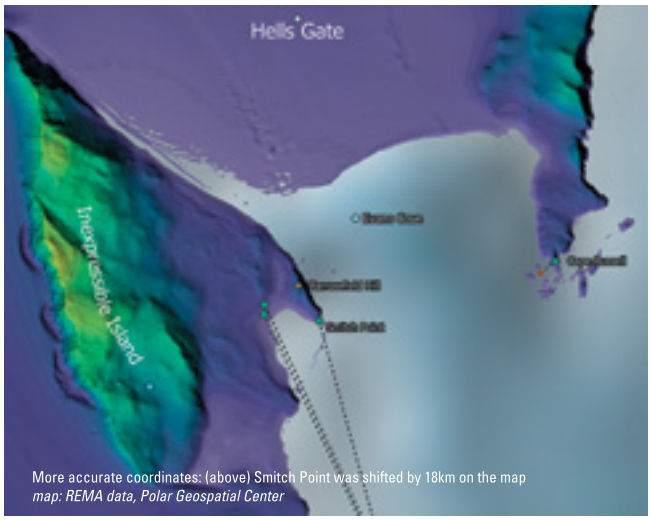
Helmet Rock, more accurate elevation data; *photo: Abbott, published by R.E. Priestley 1923; map: REMA data, Polar Geospatial Center*

The NZGB assesses names by reconfirming the feature it was intended to apply to, looking back to the proposal or the name's original use in historic material. It also reviews maps and scientific publications for any discrepancies. If a position needs to be improved, the NZGB uses the highly accurate satellite imagery and elevation data products to determine the new position.

In 2019 this project has reached its halfway point.

INEXPRESSIBLE ISLAND, TERRA NOVA BAY

The ANC's meeting in March 2019 reviewed all official names in the Terra Nova Bay region from 74°S to 76°S. Coordinate corrections ranged from relatively small adjustments (but still hundreds of metres) centering 'Mount' and 'Peak' names on the highest points of the features, to a 1° error for



More accurate coordinates: (above) Smitch Point was shifted by 18km on the map
map: REMA data, Polar Geospatial Center

Kay Islet (75km). The example above shows just the vicinity of Inexpressible Island[6].

The map is built from the Polar Geospatial Center's Reference Elevation Model of Antarctica, creating hillshading and contours from the data. The coordinates of some names remain fit for purpose, as they were previously improved when Antarctic names were first digitally compiled. Some like Cape Russell only required a small 350m shift.

Others, such as Smitch Point, required much more significant changes moving by 18km.

The NZGB also continues to consider new proposals - the map (left) shows Harrowfield Hill, a new name assigned as official in 2018.

CONTACT

To view all Antarctic names please visit
www.gazetteer.linz.govt.nz

To propose a name be made official use the online submission form
www.linz.govt.nz/antarctic-names#propose

For any enquiries or other feedback please contact us via **nzgbenquiries@linz.govt.nz**

By **Christopher Stephens**
Advisor, New Zealand Geographic Board Ngā Pou Taunaha o Aotearoa
cstephens@linz.govt.nz
0800 665 463

[1] US-ACAN - United States Advisory Committee on Antarctic Names
[2] SCAGI - Standing Committee on Antarctic Geographic Information
[3] SCAR – Scientific Committee on Antarctic Research
[4] NZMS – New Zealand Mapping Service – maps by Lands and Survey
[5] L&S – Lands and Survey
[6] https://gazetteer.linz.govt.nz/place/12549

Inspiring the next generation of explorers

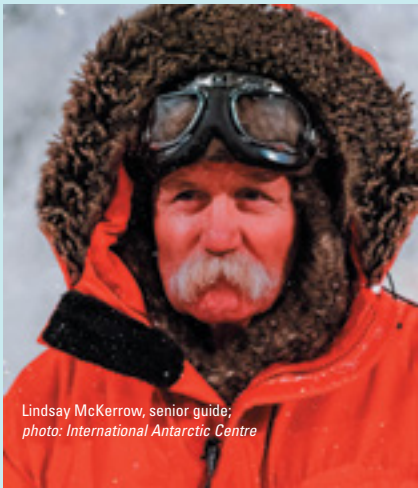
The International Antarctic Centre transports a slice of the world's most remote continent to Christchurch, with a range of immersive experiences that offer visitors a unique opportunity to become an Antarctic explorer and encounter a rich world – full of Antarctic heroes, astonishing wildlife and incredible scientific discoveries.

Brave an Antarctic storm, go off-road in a Hägglunds vehicle, befriend a husky, mingle with the penguins, experience Antarctica from all four dimensions and leave with a head full of knowledge, a heart full of love and the inspiration to take action to shape the future. Just like the explorers before us.

The Antarctic Academy of the International Antarctic Centre helps to educate and inspire the next generation of explorers with a range of interactive curriculum-based education programmes that have been carefully designed to suit the interests and learning needs of the modern students.

More information at: iceberg.co.nz

Hägglunds vehicle;
photo: International Antarctic Centre


Lindsay McKerrow, senior guide;
photo: International Antarctic Centre

NZAS Member Profile: **Matt Jordan**

Why did you join the NZAS?

Firstly, I thoroughly enjoy the events that the Society organise, and I want to give back to the Antarctic community that has been so supportive and welcoming. In my current role at Antarctica New Zealand I work with a large number of present 'Antarcticans', but I see huge value in connecting with those who have been involved in New Zealand's Antarctic program in the past. The Society provides a medium for me to network and learn, but also affords me the opportunity to engage with others who are interested in what is happening at Scott Base, both now and in the future.

What's your job?

I'm a Project Management Professional working at Antarctica New Zealand as the Assistant Project Manager on the Scott Base Redevelopment Project.

What have been your impressions of visiting Antarctica?

My first trip to Antarctica was a 14-day round trip from Ushuaia in Argentina to the Antarctic Peninsula in 2014. On the trip I kayaked between huge icebergs, saw various penguin and seal species, watched whales breach metres from the bow of the ship, visited some of the research stations, and took way too many photos! I went as a tourist, but credit the trip for motivating me to pursue a career in Antarctica.

For the next 3 years, I upskilled in areas that would help me to secure a job with a National Antarctic Program- ideally in an engineering capacity, but I would've started anywhere to get a foot in the door.

I've since had an additional two

Matt Jordan with adelie penguins, Ross Island

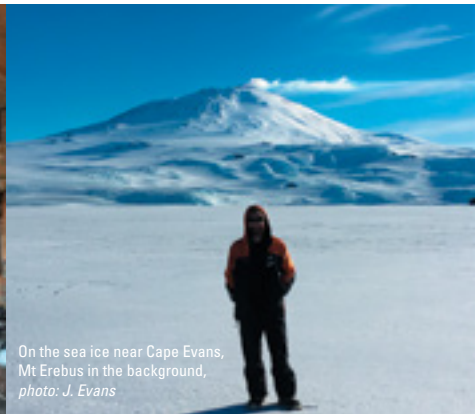
trips to the ice with Antarctica New Zealand. These trips were accompanying our recently appointed Scott Base Redevelopment design team to develop an understanding of the natural environment, Scott Base culture, the logistics chain, and the relationship that Antarctica New Zealand has with the United States Antarctic Program and McMurdo Station. It was also a great opportunity to engage with the science community and learn about how their work is contributing to our understanding of the planet.

Did you always have an interest in Antarctica?

I grew up in Perth in Western Australia but haven't spent much of my adult life there. I have a British father and a Zimbabwean mother, and was brought up travelling from a young age. After school I did a degree in Civil and Construction Engineering at Curtin University. Prior to working for Antarctica New Zealand, I worked in the power generation industry, in Western Australia, the Northern Territory, and in New Plymouth, Taranaki! I then took what was supposed to be a year-long sabbatical (it turned into just under three years) in 2013. I spent a year in South America learning Spanish and teaching English; a year in North America travelling around; and then a summer season in Norway where I worked as a sea kayaking guide. I returned to Australia and the construction industry in 2016, and then secured my job with Antarctica New Zealand. I moved to Christchurch in July 2017.

I love being outdoors and never miss an opportunity to experience what Christchurch, Canterbury, and New Zealand have to offer. I've been an avid rock climber for the last 10 years; and I enjoy snowboarding, sea kayaking, hiking, camping, cycling, running and golf.

Inside Shackleton's Hut at Cape Royds, Ross Island, *photo: J. Evans*



On the sea ice near Cape Evans, Mt Erebus in the background, *photo: J. Evans*

Interacting with Antarctic scientists

Free public events in the evening, every month in Auckland

We live in challenging times. Recently the recognition has been spreading that we are living in a climate emergency. Climate change is not some distant threat to future generations. It is here and now, and today's schoolkids will face major impacts during their lifetimes.

Clearly, it is time to act. But like most people I struggle with the enormity of the challenge. What can I do that will make a material difference?

Recently I have learned that just talking about climate change is key to preparing us as a society to make the changes to our economy that are necessary. And while facts and science are important, I'm learning that our personal stories are even more important. Antarctica provides not only clear evidence of the changes happening, but also the fascinating context for sharing the science through stories and experiences.

In 2016 I was privileged to fulfil a long-held dream of setting foot in Antarctica, as a student in the University of Canterbury's 2016-17 Postgraduate Certificate in Antarctic Studies course. I loved every minute of it. Participants are encouraged to become ambassadors for Antarctica in some form. I love to talk about my experiences there, and how, like so many, I long to go back.

For me, one of the most exciting ways of being an ambassador has been to organise the Antarctic Science Meetup. I want to bring together in Auckland a community of people interested in Antarctic science and its implications.

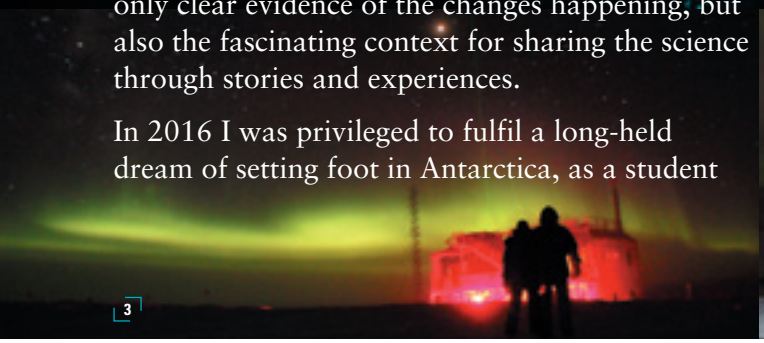
The Antarctic Science Meetup provides a forum for anyone interested to interact directly with Antarctic scientists. The events are deliberately informal, and we have lots of time for questions. We've had more than 20 events in the last two years, with scientists sharing their experience and research of the marine ecosystems, Antarctic geology, the mechanisms involved in the growth and decline of ice shelves and sea ice, as well as a team of winter-overs, and an evening of Antarctic films. Now we regularly have 50 participants. The community is growing.

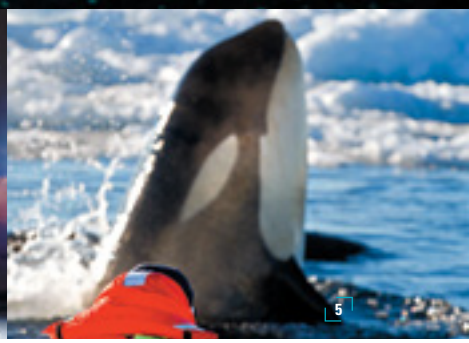
The Auckland Antarctic Science Meet Up provides a forum for anyone interested to interact directly with Antarctic scientists. The events are deliberately informal, and we have lots of time for questions.

We in the NZ Antarctic Society are uniquely placed to communicate with the public about Climate Change. We have personal stories to tell about a place few people will be able to visit, but which fascinates. We can all be ambassadors and act against climate change!

We are currently hosted at Auckland University in their MacGregor rooms with access to a 200-seat lecture theatre if necessary. Do come along and join us if you can – check out the programme on https://www.meetup.com/Auckland-Antarctic-Science/

by **Stuart Grayson**, *initiator, Auckland Antarctic Science Meetup; National Secretary, NZ Antarctic Society*





Photos: Meet Up speakers have included 1 Jenny Hillman, diving beneath the ice in McMurdo Sound; *photo: Pata Degerman / Science Under The Ice* **2** Gary Wilson, drilling beneath the Ross Ice Shelf **3** US scientists at the South Pole, Rob Streeter and Janelle Hakala; *photo: Rob Streeter* **4** Live from Scott Base, winter station manager Jonny Harrison; *photo: Stephen Allinger* **5** Regina Eisert up close with killer whales, at the edge of the sea ice; *photo: Andrew J. Wright (c) TPA*


Tamsin Falconer

NZ Antarctic Society supports 'Our Place in Antarctica'

A Detailed Business Case (DBC) for the Scott Base Redevelopment Project was endorsed by Cabinet in 2018, and this year a 'preferred design' was elected to progress through to 'detailed design'.

In September this year, Antarctica New Zealand commenced a formal procurement process for successful respondents to work with Antarctica New Zealand to better understand expected build costs and project duration.

The primary benefits of the investment as described in the published business case are that it:

- Enables New Zealand to maintain influence in the Antarctic Treaty System
- Provides autonomy to conduct excellent science that will directly benefit New Zealand
- Strengthens international collaboration that contributes to New Zealand's reputation and influence.

Antarctica New Zealand is currently working on Stakeholder Engagement and other planning for the project. The Society has now formed a subcommittee to share the knowledge and input of Society members with the project, and to ensure that Society members are kept informed about the project.

The purpose of the subcommittee is:

1. To represent the membership of the New Zealand Antarctic Society (NZAS), with their interests and expertise, in the Government's Scott Base Redevelopment Project.
2. To support the project's interests in the support of science, the protection and proper management of the Antarctic environment, and the promotion of New Zealand's national interests in Antarctica.
3. To act as a channel for questions, advice, expertise, and concerns from the NZAS membership to the Project, and for information, consultation, and requests for advice to be passed from the Project to the NZAS membership.

The following are members of the subcommittee:

Tamsin Falconer *(chair)* - Deputy Director, Museums Wellington, former administrator, Antarctic Research Centre, VUW, with five seasons in Antarctica, one as project manager

Grant Avery - Director, Outcome Insights (Treasury Business Cases assurance provider and major projects QA/Risks consultant). Winter-over Scott Base 1992, 1994; Winter Manager/SENZREP Scott Base 1994; Government Rep Antarctic cruise vessels 1995, 2001.

Peter Barrett - Emeritus Professor of Geology, VUW, with 25 field seasons in Antarctica, 7 as chief scientist for 4 off-shore drilling projects. Patron, NZ Antarctic Society.

Linda Kestle - Associate Professor, School of Building Construction, UNITEC. President, NZ Antarctic Society, with two Antarctic field seasons.

Karol Laska - Director, LASKA SERVICES LTD. International experience in project management, strategy and governance, and with a strong interest in protection of the Antarctic heritage and environment.

Bill Nye - Drilling fluids engineer with 30 years' international experience – two in Antarctica. Owner/manager, Adventure Books, Oamaru. South Island Vice-President, NZ Antarctic Society.

We will provide updates to future issues of Antarctic, and through the branches and website.

Contact the Chair, Tamsin Falconer
tamsin.falconer@gmail.com

Loss of two prominent Kiwi 'Antarcticans'

The NZ Antarctic Society has been saddened by the loss of ***Arnold Heine***, who was selected as an experienced outdoorsman to be field leader at Scott Base for the first IGY year (1956-57) and several years following. He was awarded the Polar Medal, the Queens Service Medal, the New Zealand Order of Merit (ONZM), and Life Membership of the NZ Antarctic Society. We are also saddened by the loss of another early Antarctican, geologist ***David Skinner***, who first went to the ice in 1960. In this and later expeditions he contributed to the mapping of the Transantarctic Mountains. David was awarded the Queens Medal, and Skinner Ridge is named in his honour. Full tributes of both David and Arnold will appear in the next edition of Antarctic magazine.

Nigel Roberts at Scott Base, 1979

Remembering the Mt Erebus disaster, 40 years on

In the summer of 1979-1980, Nigel Roberts spent four months at Scott Base as Information Officer / Photographer. Here he shares his memories of the 28th and 29th of November 1979.

Credit: Nigel Roberts

On Wednesday, 28 November 1979, the speaker system was on in the Scott Base mess. Snippets of the conversations between air traffic control staff at Willy Field (on the ice in McMurdo Sound) and the crew of an Air New Zealand DC-10 tourist flight could be heard above the buzz of lunchtime conversation. No one in the mess paid much attention when the conversations ceased. Radio blackouts were a fact of life in Antarctica: weather and geography meant that keeping in touch with field parties during the evening radio "skeds" was frequently problematical. It was some hours before most Scott Base staffers realised that the afternoon's radio blackout was something serious and sinister.

My abiding memory of the evening of 28 November 1979 is of noise. Antarctica is a very quiet continent. There's very little traffic; there's no rustle of leaves in the wind. That night (which was, like other summer nights at Scott Base, one of light and sunshine), though, the ceaseless drone of planes on Williams Field warming up, of planes flying, and of planes taking-off and landing will forever be etched on my brain. It was around midnight that the news came through that the wreckage of the DC-10 had been spotted on the lower slopes of Mt Erebus. Eighteen hours later I was on a helicopter that flew up to and over the crash site. As Information Officer / Photographer my instructions were to take black-and-white photographs for the New Zealand news media. When I got back to Scott Base, I went immediately into my darkroom and developed the film I'd used. I made contact prints of all the pictures, and as soon as I saw the picture that I'd taken of the tail of the DC-10, with Air New Zealand's koru symbol on it, I knew that it would – more than any other photograph – come to represent the tragedy in which 257 people were killed. Forty years later that is still the case. *By* **Nigel Roberts**

The Mt Erebus Disaster Oral History Project

Anyone of a certain age, who was in New Zealand at the time, remembers the Air New Zealand plane crashing on Mount Erebus 40 years ago, but there's one story that has never been told:

- Who were the first climbers to visit the crash site to prove no one was alive?
- Who were the mountaineers who helped and supported the Police Recovery Team, the Air Accident investigators and all visitors, kept them safe and fed them on the mountain?
- Who at Scott Base saw all that went on after the recovery, and before the bodies were flown out and still remember the horror?

This is what this project is about: recording the memories of a small group of New Zealanders during a very difficult time, and preserving their memories for future generations.

Over the last two years, a team at the NZ Antarctic Society, led by Margaret Bradshaw and Lester Chaplow, has been undertaking an oral histories project on the Mt Erebus disaster, with the support of oral historians Pip Oldham and Jacqui Foley. They have interviewed and recorded the memories of the nine surviving members of the initial search team, as well as five individuals who were at Scott Base, including Nigel Roberts, during those traumatic days.

How to make a donation:

The project has been supported by the Lotteries Commission, the NZ Antarctic Society and private donations. However the team still needs further funds to complete the project. As the NZ Antarctic Society is a registered charity (CC27118), donations are tax-deductible in NZ, with up to 33% refunded by IRD. In the event that the Society receives more funds than the current programme requires, it will continue with related interviews. Donations may be made on the NZAS web site, antarcticsociety.org.nz, from the 'Donate tab' shown on every page (please add a note in the "Other information" box at checkout); or by cheque directly to the Treasurer, New Zealand Antarctic Society, PO Box 90-325, Victoria St West, Auckland 1011. For further information, please contact:

OralHistory@antarcticsociety.org.nz

First women at the South Pole, 12 November 1969. New Zealander Pam Young at left. *Photo: US Navy, with special thanks to Bill Spindler*

50 years: NZ women scientists in Antarctica

This year marks a significant milestone for the role of women scientists in Antarctica: 50 years ago on 12 November, the first women reached the South Pole, six in fact. Five were scientists, one a science writer, and all bar one were American. The sixth was a New Zealander, biologist Pam Young. That summer, Pam had become the first New Zealand woman to work in Antarctica, as a field assistant to her biologist husband, Euan Young, at Cape Bird. She was invited to join the five women on their historic visit to 90°South.

Just a year later, in 1970 Rosemary Askin became the first NZ woman to work in Antarctica as a field scientist. She spent three months in Victoria University's 15th expedition to the mountains west of Scott Base, led by Peter Barrett. After another field season on the ice, she completed a PhD on Gondwana fossil plants, and went on to the US for a career as a leading Antarctic paleobotanist.

Fast forward nine years, and in 1979 Dr Margaret Bradshaw, Life Member and former President of the NZ Antarctic Society, became the first woman to lead a deep field science event in Antarctica, while Thelma Rodgers became the first New Zealand woman to spend an entire winter in Antarctica.

Along with Pam Young and Thelma Rodgers, Margaret has a science laboratory named in her honour, in the newly refurbished Hillary Field Centre at Scott Base, along with a peak in the Transantarctic Mountains, Bradshaw Peak. She is the first New Zealand woman to receive a Polar Medal, in fact the second woman ever to receive one. This year, the City of Christchurch made a presentation to Margaret recognising her life long contribution to Antarctic research and Christchurch's Antarctic Gateway status.

In September, one of New Zealand's foremost sea-ice scientists, Professor Pat Langhorne of Otago University, was invested with the New Zealand Antarctic Medal (NZAM) by Governor-General Dame Patsy Reddy.

A member of the NZ Antarctic Society, Pat has been travelling to Antarctica on research for more than 30 years, with the New Zealand and Australian Antarctic programmes. In 1985 her research supported the use of sea ice runways for large aircraft, a development which has assisted the operations of many Antarctic organisations.

New Zealand women scientists continue to achieve at the highest level, with congratulations to Dr Georgia Grant of GNS Science and Co-Chair of the NZAS Wellington branch. She spent a field season on the Ross Ice Shelf in 2017-2018.

A study which Georgia co-authored with Tim Naish, supported by the Marsden Fund, was published in the prestigious Nature magazine earlier this year. It showed that up to one third (~20 m sea-level rise) of Antarctica's ice sheets melted three million years ago, under atmospheric carbon dioxide levels of 400 ppm, the same as today.

1 Dr Margaret Bradshaw at the 2019 Antarctic Season opening in Christchurch, flanked at left by Emeritus Professor Peter Barrett, Patron of the NZ Antarctic Society, and at right, her husband and fellow 'Antarctican', Professor John Bradshaw. *photo: Michelle Rogan-Finnemore* **2** Dr Rosemary Askin **3** Governor-General Dame Patsy Reddy at right, presenting the New Zealand Antarctic Medal to Professor Pat Langhorne **4** Dr Georgia Grant, GNS Science; *photo: Image Services, Victoria University of Wellington*

Action-packed year for NZ Antarctic Society

"The times they are a changin' ", as the song goes – and it is certainly a truism of the direction the NZAS is heading to be sustainable into the foreseeable future. This is evidenced by the New NZAS Strategic Plan (2019-2022) ratified at the October 12th 2019 National AGM, the financial streamlining led by our Treasurer and Finance Manager and the approach taken for the Antarctic this time.

This edition of the Antarctic is one of two planned double issues in the 2019/20 financial year, and includes a limited edition - first in 24 years - LINZ Antarctic map. This has all been possible thanks to our NZAS Comms group, led by Nicholas O'Flaherty (our new Editor), by ensuring added-value for our membership. They have done this by securing financial and advertising support, in parallel with Council's aim to diversify the NZAS membership, and engaging with youth via educational institutes as a first step.

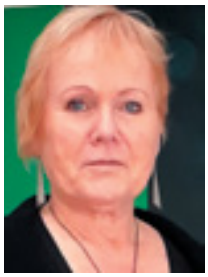
The last 12 months have been particularly power-packed for the Council and associated project managers on several projects. One that is drawing to a successful close is the Mt Erebus Disaster Oral Histories Project led by Margaret Bradshaw and Lester Chaplow, with completion early next year.

In the last year the NZAS Council decided to be more proactive in addressing Antarctic policy and governance issues, as well as supporting science, protection and management of the Antarctic environment, and promotion of NZ's national interests in Antarctica. It therefore set up two subcommittees, with roles and membership to be reviewed:

1. A sub-committee on science directions comprising senior members convened by Patron Peter Barrett to provide input on science. They have been meeting with Antarctica New Zealand, Antarctic scientists and MFAT, for input and feedback on Antarctic science strategy, and will report in the next issue of Antarctic.
2. A Scott Base Redevelopment (SBR) sub-committee chaired by Tamsin Falconer in response to an invitation from the SBR project to Antarctic stakeholders (NZAS is a key stakeholder). There's more on this sub-committee in this issue

The Antarctica NZ /NZAS Scott Base Volunteer Programme is unfortunately not being offered in 2019, due to McMurdo and Scott Base Redevelopment projects taking logistical and accommodation precedence. However, check our website for NZAS exhibition space at the Husky Base Camp, near Templeton (South Island) very soon, driven and curated by South Island Vice-President and Adventure Books man, Bill Nye.

On a congratulatory note - the Mayor of Christchurch - Hon. Lianne Dalziel made a presentation to Margaret Bradshaw at the season opening in October 2019, recognising her significant life-long contribution to Antarctic research and to Christchurch's Antarctic Gateway status. Margaret was also the first New Zealand woman to receive a Polar Medal.



Wishing you all season's greetings as December races towards us. Enjoy the Antarctic, and please get involved on local and national NZAS events.

By **Linda Kestle, President,** *NZ Antarctic Society*

NZAS honours two new life members

The NZ Antarctic Society has appointed two new life members, Lester Chaplow and Max Quinn. Lester is a long serving member of the NZAS, our former Treasurer as well as Editor of Antarctic magazine for the last four years. Max is a well known New Zealand film-maker, who has spent many a season in Antarctica capturing wonderful footage for Natural History NZ. We are grateful for their service to the Society, and the passion they bring to the dissemination of Antarctic knowledge, research and history to the wider community. The next edition of Antarctic magazine will feature profile articles of both Lester and Max.

BOOK REVIEW: "Fifteen Million Years in Antarctica"

by Rebecca Priestley, Wellington, 2019, Victoria University Press

Rebecca Priestley, *photo: V. Birkinshaw*

A fine contribution to current Antarctic literature, New Zealander Rebecca Priestley's book "Fifteen Million Years in Antarctica" is written with knowledgeable clarity and from an engaging personal viewpoint. Readers immersed in this story become Antarcticans, learning current science, knowing what it's like dealing with that elemental cold, and interpreting what we see and feel while on the Ice.

Attentive to detail, the author's accounts of experiences and interactions with colleagues offer a wider perspective. Her responses to nature during three trips to Scott Base also lead us to reasons why so many become dedicated to protection of Antarctica. Honest and open, Rebecca is not afraid to confess, even embrace her anxieties, to blend an internal dialogue with work and survival concerns.

What runs throughout is that ominous blue crevasse of climate change that diverts our trail. Rebecca's book celebrates competent scientists who are guiding informed awareness of these dangers towards a future with ways around them. We develop a kinship with Rebecca, arriving with attuned self-awareness, someone who notices her reactions and carries fragile emotions close to the surface. She can cry at many turns in the road, and yet keeps us smiling as we see a bit of ourselves in the picture. Varieties of worry slip into her internal dialogue, and we share many, like family and climate, yet a sprinkle of irreverent Kiwi humour and language helps regain our balance.

Priestley might be anxious about flying, but she notes anxiety is also closely akin to excitement, off to the Ice or flying back home. There's a lot to enjoy, Antarctican or not, brightly sharp details bring us there, camp or field, and we're left with new appreciations of life, work and interactions discovered, cherished. We read about science study and theories, and yet her story also becomes a shining example of exploration through creative description.

We need Antarctica for many reasons, a world treasureland we may explore physically, scientifically and culturally. Perhaps we need to slake that thirst for knowledge just as much as we need lyrical and artistic interpretations of our interactions with Antarctica's natural world. Alongside Science, we need Art programmes too, and Rebecca's creative voice brings the Antarctic experience into focus. Whether appreciating colour and wild beauty, solitude or cooperative companionship, maybe we need expressions from our creative voices now more than ever.

By **Bill Nye,** *Antarctic veteran ANDRILL Project, and owner of Adventure Books, Oamaru*

Buy an Antarctic gift at the NZ Antarctic Society online shop

Like hidden treasure, the NZAS shop includes iconic items and collectibles. Access the shop online by clicking on SHOP, it's on the very top line of the website - **www.antarcticsociety.org.nz**

Add the Society patch to your back pack or pack strap, or pin the lapel badge on to your hat and share your unique style with us on Facebook.

Take a simple pack of postcards, either the retro of the 70's and 80's, the historic ships, or Colin Monteath's modern imagery, and arrange to have them postmarked at the Lyttleton post shop with the Ross Sea Dependency postmark - what a unique gift for the Antarctican in your life.

Dream a little of Shackleton, the ship Endurance and his team of ever ready men as you read Worsley Enchanted. The book is based on Henry Worsley's journey as told by Douglas Stewart in verse.

Antarctic photography by Colin Monteath/www.colinmonteath.nz

Schools can be members too!

Additional benefits: Sign your school up to membership of the NZ Antarctic Society for 2020!

NZ Antarctic Society at Miramar Central School; *credit: Natalie Robinson*

School membership includes educational resources for both primary and secondary school levels.

In 2020, schools will receive educational posters on penguins and ice sheets, obtain access to the rich online resources of the Society's 50 years of publications, as well as receive two double issues of the magazine through the year, and the ability to attend events and hear from Antarctic scientists directly. In addition, upon joining, each school will receive two additional wall maps of Antarctica!

The annual fee for school membership is $135 (incl gst). To sign up, please contact: schools@antarcticsociety.org.nz

The West Antarctic Ice Sheet meets the Southern Ocean; *credit: Robert Larter, British Antarctic Survey*

Emperor penguins near Cape Evans, McMurdo Sound / *www.colinmonteath.nz*

Become a member of the New Zealand Antarctic Society

Anyone can join!

antarcticsociety.org.nz

Sign up online at:

antarcticsociety.org.nz/membership

Or contact:

membership@antarcticsociety.org.nz

Established in 1933, the New Zealand Antarctic Society brings people together who are interested in Antarctica to share their knowledge with others, foster interest in the region, and support the protection of the Antarctic environment.

Become a member and you can:

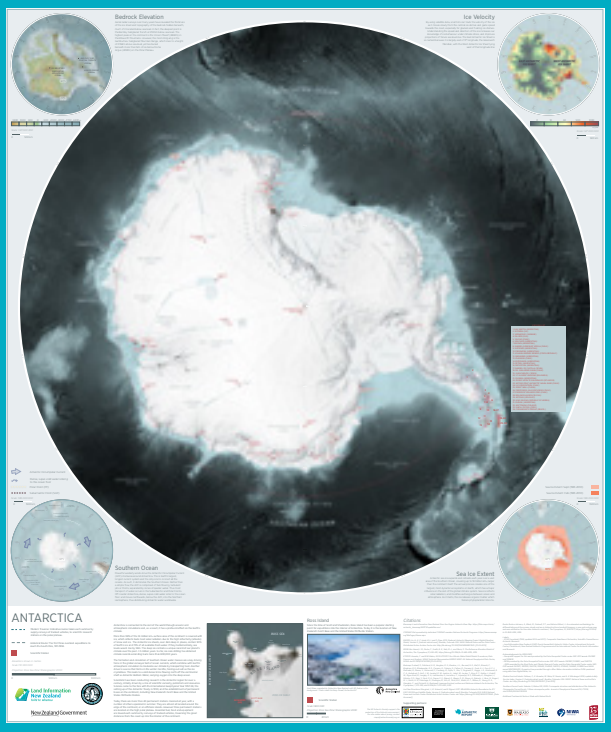
Access a rich online resource

Attend events

Ask a scientist!

Connect with Antarctic veterans

Learn the history



A curious young Weddell seal swimming in a tidal crack in the sea ice of McMurdo Sound;
photo: R. Eisert, University of Canterbury/@TPAonIce