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ANTARCTIC

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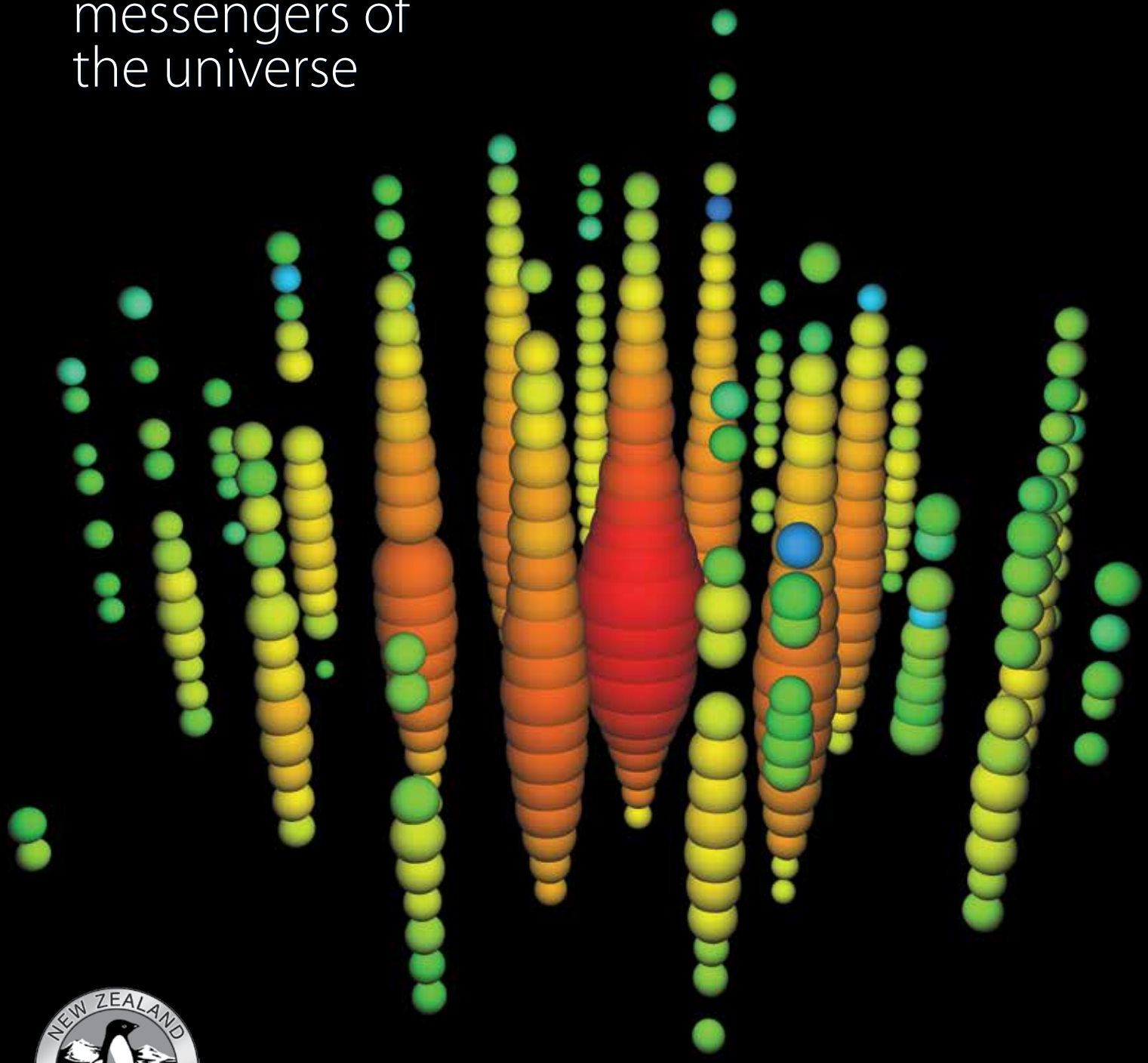
Neutrinos
messengers of the universe



NEW ZEALAND ANTARCTIC SOCIETY

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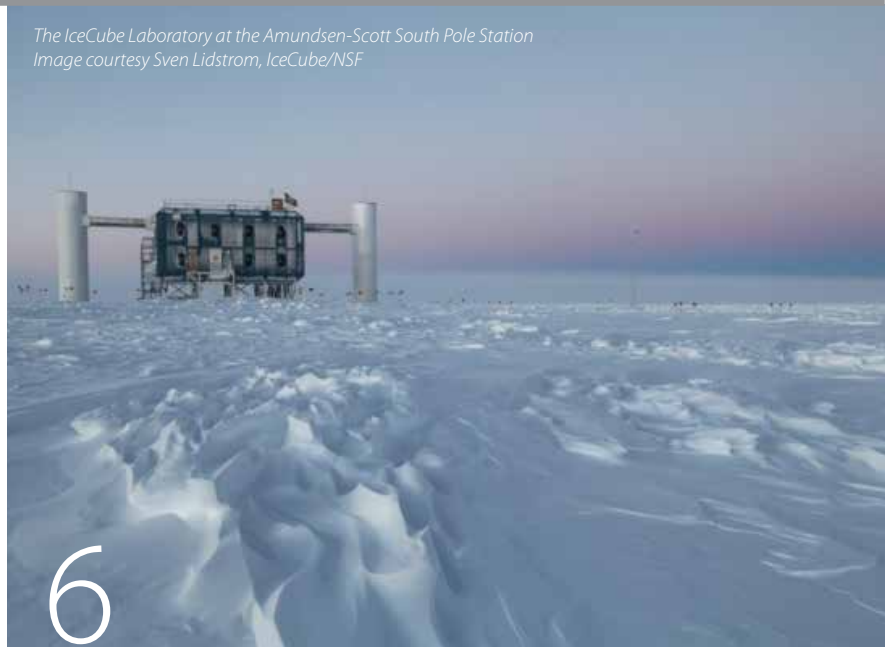


The IceCube Laboratory at the Amundsen-Scott South Pole Station
Image courtesy Sven Lidstrom, IceCube/NSF

Cover photo:
This is the highest energy neutrino ever observed, with an estimated energy of 1.14 PeV. It was detected by the IceCube Neutrino Observatory at the South Pole on Jan. 3, 2012. IceCube physicists named it "Ernie." They named the second highest-energy neutrino ever observed "Bert". Image courtesy, IceCube Collaboration.

Antarctic Round Up

February 2014

An enthusiastic and energetic team of Antarctic Society members spent a few hours shifting the collections of journals, furniture, artefacts and odds and sods from its temporary storage to new shelving at the Canterbury Cultural Collections Recovery Centre at the Air Force Museum of New Zealand. The shelving was purchased through funds received from the Four Winds Foundation. NZAS are very grateful to the Foundation for these funds to purchase this specific industrial strength shelving suitable to store the heavy collection items.

A very grateful thanks goes to all the volunteers who helped.

Update from Council, March 2014

2013 was not without its challenges but we are making steady progress in 2014.

The challenges came in being able to get our group of busy Council volunteers all together, to work through some of the projects we have identified. Over 2013, Council met three times (more frequently than in previous years), with two meetings focused on work-shopping specific issues: revisions to the Constitution and strategic planning. Strategic planning was challenging – the Society needs to have one eye on the future, moving to increased usage of online social networking and electronic publications – and also one eye to our membership who appreciate the hard copy publication and the social aspects of gatherings.

The Council has recognised that our highest priority is serving our existing membership and growing the membership – this is the key to ensuring that the NZAS is sustainable for the next 80 years plus.

There was no Scott Base Volunteer Programme (SBVP) running this year but we will be working with the new CE of Antarctica New Zealand (AntNZ) to see if the scheme can resume in the future. Over the year, I have represented the Society on the Antarctic Heritage Trust Board (AHT) and at Ministry of Foreign Affairs and Trade (MFAT) meetings about the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) fishing marine protected area proposals. The AHT Board have made me feel most welcome and are also keen to collaborate on events and ventures that may be of mutual benefit. I have been appointed to the AHT Audit Committee.

I personally thank Linda Kestle and Nicola Jackson for their work over the years as they resign from the positions of National Secretary and North Island Vice President (respectively) this year. Linda has made a sterling contribution to the running of the Society and will continue to be on Council representing the Auckland Branch. Nicola has been instrumental in the completion of the first stage of the Society's Assets and Archives assessment.

I would also like to thanks our other hard-working members of the Council and special officers for their work over the year.

- Malcolm, for maintaining the website, expanding the digitised records (with the aid of Mike Wing's indexing) and exploring opportunities to develop this presence further.
- Natalie, for managing to still produce excellent publications whilst also working on the Assets and Archives group and resolving our storage needs in Christchurch.
- Lester, for his sound financial management and advice over the year
- Margaret, for her continuing dedication to manage the Oral Histories project and for coming back onto the Council as South Island VP.
- In absentia, John Parsloe for working on the Assets and Archives group and for helping with the relocation of NZAS stores.

The NZAS collection almost stored in its new home. Image courtesy Sue Stubenvol

As a small group of volunteers, we should congratulate ourselves on achieving what we do.

This year, we will take our work-shopping inputs to the next stage and aim to produce a draft Constitution prepared for the 2014 National AGM and ask for membership growth initiatives to be a concerted focus for all Branches. It can be as simple as bringing a friend to a branch meeting!

Thank you for your continued support and best wishes for forthcoming events in your areas.

Dr Jud Fretter
President, NZAS

Clarification – Janet Bray

In the last issue of *Antarctic* the Editor reported that Janet Bray had resigned as Assistant Editor of the journal. Janet sends this clarification: "In recent years others have done the majority of the editing of the articles that have appeared in *Antarctic*, and I have had infrequent involvement with the publication. I very much enjoyed helping out with the publication from time to time, and I now step aside. I wish Natalie and future editors all the best with their continued work for *Antarctic*.".

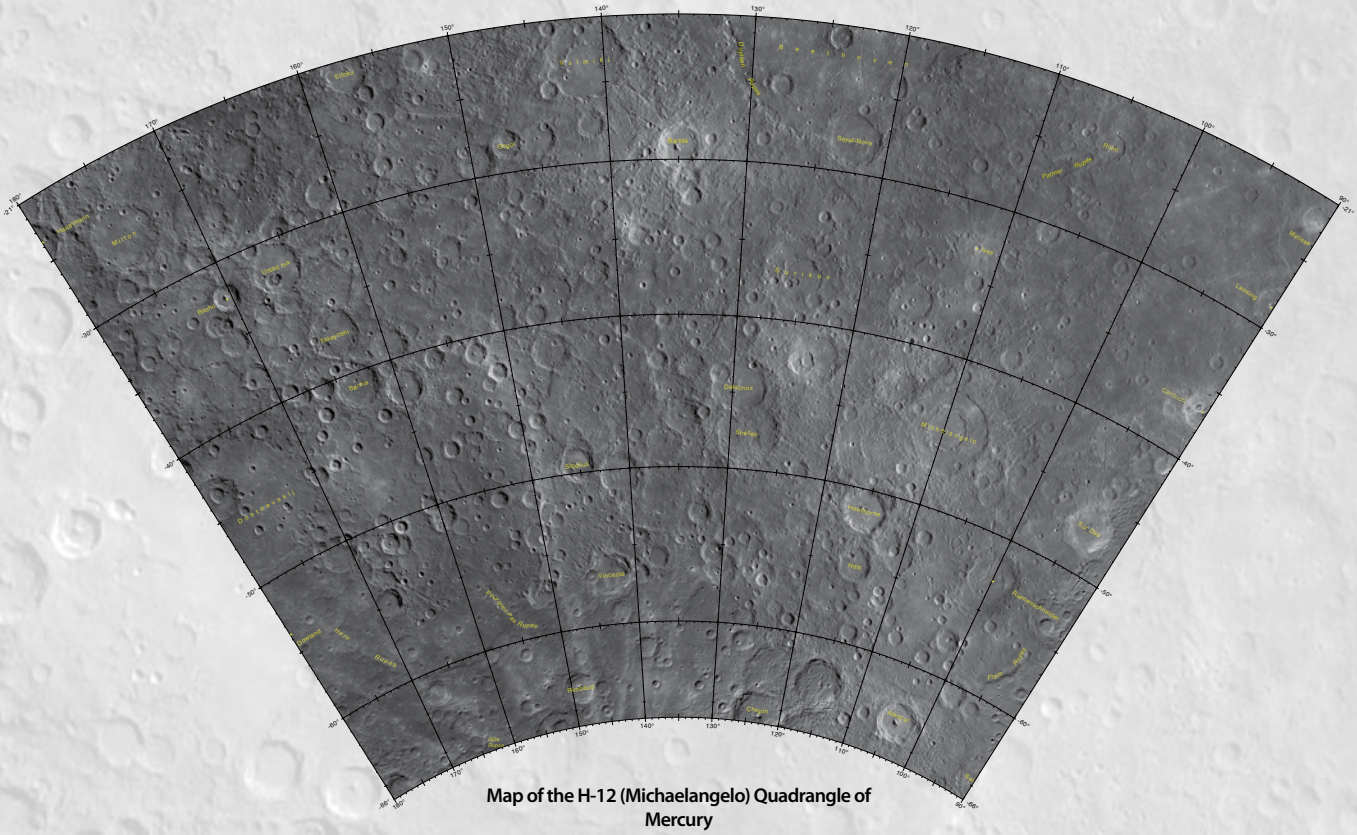
Geological features on Mercury named for Antarctic research and expedition vessels

Article based on National Science Foundation news release.

The R/V *Nathaniel B. Palmer*, an ice-capable Antarctic research vessel chartered for the National Science Foundation (NSF), has routinely braved some of the world's most hostile waters in support of the science carried out by the United States Antarctic Program. Now, a geological feature on one of the inhospitable planets in the solar system bears the ship's name.

The International Astronomical Union (IAU) recently approved a proposal from NASA's Mercury Surface, Space Environment, Geochemistry and Ranging (MESSENGER) science team to assign names to 10 "rupes," long, cliff-like escarpments that formed over major geological faults on the planet Mercury. One is now called the Palmer Rupe.

Of the solar system's four terrestrial planets, Mercury is the smallest, the densest, has the oldest surface, is the one with the largest daily variations in surface temperature and is the least explored. MESSENGER studies Mercury to develop a better scientific understanding of how the planets in the solar system formed and evolved.



Map of the H-12 (Michaelangelo) Quadrangle of Mercury

Scale 1:4,765,000 at -28° and -62° latitude
Lambert Conformal Projection

Satellite image of Mercury geological features.
Fram Rupe bottom right corner – Nathaniel B. Palmer top right corner.
Satellite image from – www.planetarynames.wr.usgs.gov/Feature/15135?__fsk=1608672592

Gazetteer of Planetary Nomenclature home page: www.planetarynames.wr.usgs.gov/
Index for other maps in this series: www.planetarynames.wr.usgs.gov/mercuryAtlas.html
Image credit: NASA/Johns Hopkins University Applied Physics Laboratory/
Carnegie Institution of Washington/USGS

The Belgica anchored at Mount William circa. 1898.
Image from http://www.photolib.noaa.gov/htmls/corp2838.htm

The Nathaniel B. Palmer at McMurdo Station.
Image courtesy Kelly Cheek, National Science Foundation

Since 1976, the IAU has approved names for 27 rupes on Mercury. The latest names are the first new designations for rupes in more than five years. In keeping with the established naming theme for rupes on Mercury, all of the newly designated features are named after ships of discovery, such as the *U.S.S. Enterprise*, which was launched in 1874 and conducted the first surveys of the Mississippi and Amazon rivers.

Michelle Selvans, of the Center for Earth and Planetary Studies at the Smithsonian Institution's National Air and Space Museum, led the effort to name this group of rupes. She explained that while some of the names came from historic vessels, some were proposed for their personal connections to members of the team. Selvans sailed aboard the *Palmer* from December 2006 to January 2007 to conduct marine geophysics research off Antarctica.

"Being in Antarctica on the *Palmer* was a magical experience. The stark, vast landscape, the penguins playing in our wake and the fascinating people I shared the cruise with all made it one of the highlights of my training as a scientist," Selvans said. "Seeing the setting in person, and watching the data come in during my geophysics watch-stander shifts, made the process of studying our little corner of the West Antarctic Rift System that much more exciting."

NSF manages the U.S. Antarctic Program (USAP). USAP coordinates all United States research on the southernmost continent and in the Southern Ocean and provides the logistical support needed to carry out the science. USAP charters the *Nathaniel B. Palmer* to support Antarctic and Southern Ocean research expeditions.

In choosing those rupes to receive names, the team picked from among the longest and most geologically interesting features that have been imaged by MESSENGER. The features are easy to identify in images taken at dawn and dusk, when they throw shadows along their entire length. A crisp shadow that is only about one kilometre wide but hundreds of kilometres long stands out clearly in satellite images.

Along with the *Nathaniel B. Palmer* two other Southern Ocean and Antarctic related ship names were used for the rupes.

Belgica Rupes is named after RV *Belgica*. Built in 1884, this steamship was originally designed as a whaling ship. It was converted to a research ship in 1896 and took part in the Belgian Antarctic Expedition of 1897-1901 under Adrien de Gerlache becoming the first ship to overwinter in the Antarctic.

The expedition was supported by the Belgian government, the Geographical Society of Brussels and through a national subscription programme. The multi-nation crew included Norwegian Roald Amundsen and American Frederick Cook. During the journey to the Antarctic Circle the expedition charted a number of islands before crossing the Circle on 15 February 1898. While attempting to reach the Weddell Sea the ship became trapped in the ice near Peter I Island in the Bellingshausen Sea.

There was not enough clothing or supplies on board for all the crew so penguins and seals were killed for meat and warm clothing was improvised out of available materials and skins. Scurvy was prevalent, morale was low and several crew fell prey to mental illness. Due to illness of de Gerlache, Cook and Amundsen took command of the ship. Most of the crew slowly recovered from scurvy and in February 1899 they managed, by using dynamite, to create a channel in the ice into open water. The expedition reached Antwerp on 5 November 1899. Despite losing several men, and the hardship experienced by the crew, the expedition collected a substantial volume of scientific data and specimens including meteorological observations.

The third ship with a Southern Ocean connection is arguably less well known. The *USNS Eltanin* after which the Eltanin Rupes was names was launched in 1957 as a non-commissioned United States Navy cargo ship. As the vessel had a double hull it was officially classed as an Ice-breaking Cargo Ship. In 1962, the ship was refitted to perform research in the Southern Ocean and reclassified an Oceanographic Research Vessel. Magnetic field measurements made with the *Eltanin* were critical in validating the hypothesis of sea-floor spreading. Seabed cores collected by the *Eltanin* in the Southern Ocean have been analysed by scientists. Their work on the core samples led to the discovery of the first meteorite impact site in the oceans. *Eltanin* operated a total of 52 Antarctic research cruises from July 5, 1962 thru December 29, 1972.

Computer model predicts vastly different ecosystem in Antarctica's Ross Sea in the coming century

Article courtesy National Science Foundation

The Ross Sea, a major, biologically productive Antarctic ecosystem, "clearly will be extensively modified by future climate change" in the coming decades as rising temperatures and changing wind patterns create longer periods of ice-free open water, affecting the life cycles of both predators and prey, according to a paper published by researchers funded by the National Science Foundation (NSF).

The research was undertaken by a team of four from the Virginia Institute of Marine Science (VIMS) at the College of William and Mary and the Center for Coastal Physical Oceanography at Old Dominion University in Norfolk, Virginia.

To make their predictions, the researchers used information drawn from the Regional Ocean Modeling System, a computer model of sea-ice, ocean, atmosphere and ice-shelf interactions. While conceding that "predicting future changes in ecosystems is challenging," the research team note the changes predicted by the computer model have the potential to create "significant but unpredictable impacts on the ocean's most pristine ecosystem."

The wind and temperature changes will affect the ecological balance at the base of the Antarctic food web – including changes in distributions of algae, krill and Antarctic silverfish – that, in turn, may be expected to cause disruptions in the upper portions of the food web, including penguins, seals and whales, which depend on those species for food.

Walker O. Smith, Jr. the lead author of the study considers that the model suggests that substantial changes in the physical setting of the Ross Sea will induce severe changes in the present food web – changes that are driven by global climate change. Without a doubt the Ross Sea 100 years from now will be a completely different system than we know today.

The researchers noted that over the last 50 years the distribution and extent of Antarctic sea ice have drastically changed. Among these changes are a documented decrease of sea ice in the Bellingshausen-Amundsen sector, but an increase of sea ice in the Ross Sea region of Antarctica.

Observations from the modelling show that the duration of ice-free days on the Ross Sea continental shelf has decreased by over two months over the past three decades, which may have had effects on the current balance of biological productivity and the roles of various creatures and microscopic plants in the ocean ecosystem.

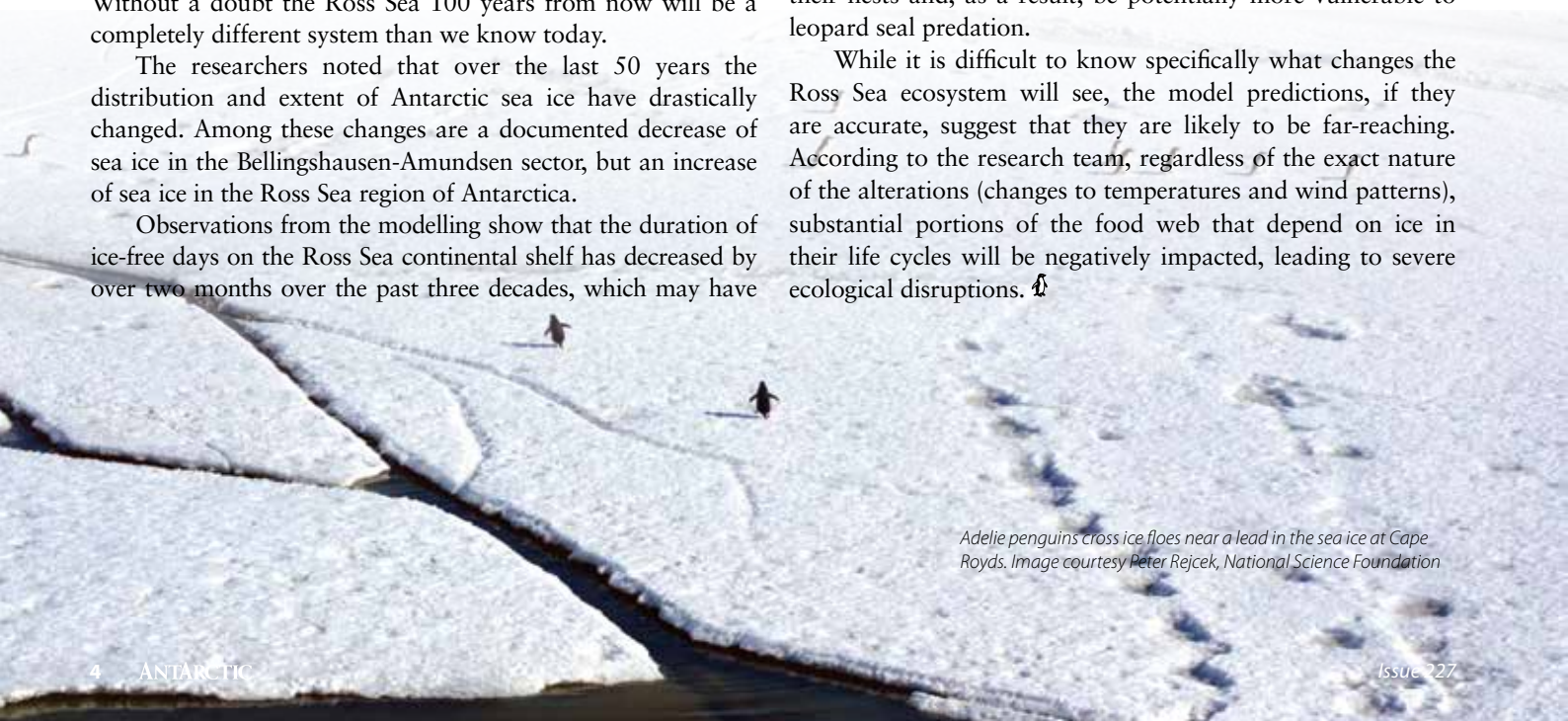
The research team also noted that "future projections of regional air temperature change suggest that substantial warming will occur in the next century in the Ross Sea sector" while wind speeds are predicted to increase in some areas while decreasing in others.

These changes are expected to reverse the sea-ice trends in the future however the projected changes in heat content on the continental shelf and ecosystems dynamics that will occur as a result of such changes remain far from certain.

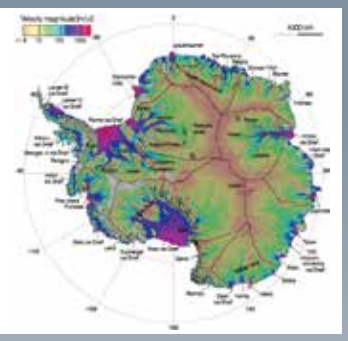
The model indicates that summer sea ice in the Ross Sea could decrease by more than half, or 56 percent, by 2050 and by more than three-quarters, or 78 percent, by 2100. At the same time, the summer mixing of shallow and deep waters in the region as a result of other changes is expected to decrease. While increased open water would benefit diatoms, the preferred food source of many plant-eating predators such as krill, some krill species, such as crystal krill, prefer a habitat with more ice, which they use as a refuge from predators.

In turn, minke whales, Adélie and Emperor penguins and crabeater seals that feed on crystal krill would have less food available if the crystal krill population were reduced. With less sea-ice cover more humpback whales could enter the Ross Sea in the summer, increasing krill predation. Adélies, which prey on silverfish at the ice edge, would have to travel further from their nests and, as a result, be potentially more vulnerable to leopard seal predation.

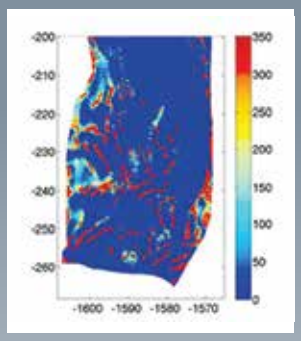
While it is difficult to know specifically what changes the Ross Sea ecosystem will see, the model predictions, if they are accurate, suggest that they are likely to be far-reaching. According to the research team, regardless of the exact nature of the alterations (changes to temperatures and wind patterns), substantial portions of the food web that depend on ice in their life cycles will be negatively impacted, leading to severe ecological disruptions.

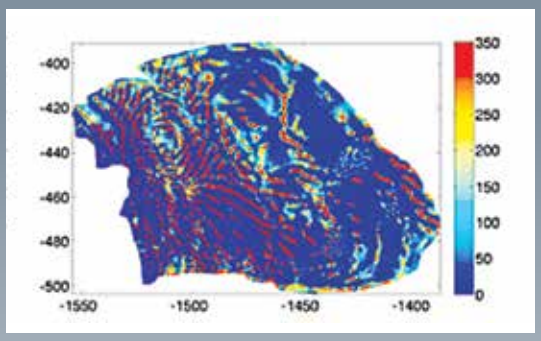


Adelie penguins cross ice floes near a lead in the sea ice at Cape Royds. Image courtesy Peter Rejcek, National Science Foundation



The Pine Island and Thwaites Glaciers, at far left, in West Antarctica. Image courtesy of NASA





Mathematical modeling and data from satellites and ground-penetrating radar infer the existence of stripes (in red) indicating areas of high friction between the glacier and the underlying bedrock at Pine Island (left) and Thwaites Glaciers. Images courtesy of Olga Sergienko.

Olga Sergienko, on the McMurdo Ice Shelf, winter 2006. Photo courtesy of Olga Sergienko

'Tiger stripes' underneath Antarctic glaciers slow the flow

By Catherine Zandonella

Narrow stripes of dirt and rock beneath massive Antarctic glaciers create friction zones that slow the flow of ice toward the sea, researchers at Princeton University and the British Antarctic Survey have found. Understanding how these high-friction regions form and subside could help researchers understand how the flow of these glaciers responds to a warming climate.

Just as no-slip strips on flooring prevent people from slipping on a wet floor, these ribs or "tiger stripes" — named in reference to Princeton's tiger mascot — provide friction that hinders the glaciers from slipping along the underlying bed of rock and sediment according to the research findings.

The researchers discovered these tiger stripes, which occur in large, slippery regions under the glaciers, using mathematical modeling based on data from the National Snow and Ice Data Center and the British Antarctic Survey. The work was conducted by Olga Sergienko, an associate research scientist in Princeton's Program in Atmospheric and Oceanic Sciences, and Richard Hindmarsh, a scientist at the British Antarctic Survey.

Researchers would like to understand what factors determine the flow of glaciers, which are massive, moving ice sheets that, when they flow into the ocean, can contribute substantially to sea-level rise. The scientists studied two glaciers, the Pine Island Glacier and the Thwaites Glacier in West Antarctica, which together contribute about 10 percent of the observed sea-level rise over the past 20 years, despite their small areas. The Pine Island Glacier moves at a velocity of about 2.4 kilometres (1.5 miles) per year, according to the researchers.

Studying the bottom of these glaciers is next to impossible due to the inability to see through the ice, which is over 2.4 kilometres thick. Instead, the researchers used satellite measurements of the ice velocity and ground-penetrating radar collected from airplane flyovers to detect bedrock and surface topography, as well as field observations. Using the data, Sergienko created a mathematical model that calculated what happens inside the glacier as it flows along the bedrock. The model predicted the formation of the tiger stripes or ribs, which Hindmarsh had theorised some years earlier.

The friction at the interface of the bedrock and glacier ice is a major factor in the speed of a glacier according to Sergienko. When friction is high, the glacier moves slowly. When friction is low, as in when melting ice provides a liquid layer that allows the ice to slide over the bedrock, the glacier moves more quickly.

The tiger stripes, which the researchers also call ribs due to their slightly curved structure, lie at roughly 30-degree angles to the direction of the glacier's movement. These ribs arise and decay in response to natural processes over roughly 50 to 100 years, according to the researchers' calculations. The process is strongly affected by how water, which comes from ice melting due to the inherent heat trapped in the Earth, infiltrates the space between the ice sheet and the bedrock.

According to Sergienko the ribs may play an important role in buffering the effects of a warming climate, since they slow the movement of ice that reaches the ocean and contributes to sea-level rise. These changes can happen independently of climate change.

More investigations are needed to verify models of rib formation. Hindmarch thinks that the ribs are related to typical landforms that exist in the formerly glaciated areas of North America and Europe. One great example according to Hindmarsh are the drumlins — raised areas of soil and rock — that make the hills in Seattle or Glasgow.

Scientists not involved in the research have expressed interest in the findings and the potential to open up new research avenues. Douglas MacAyeal, professor of glaciology at the University of Chicago considers that the study reveals new patterns of friction that help control the speed of ice flow and determine the effect of Antarctic ice on sea level. He thinks this is strongly suggestive of a new style of physical controls over friction, like water flow in the thin zone between the rock of the bed and the ice and that the results of this study will drive new theoretical and observational efforts to understand what causes this pattern.

The research was supported by National Science Foundation and the British Antarctic Survey Polar Science for Planet Earth program.

Cosmic finding ushers in 'new age of astronomy'

by Tracey Bryant with additional information from the IceCube Collaboration, University of Wisconsin

Neutrinos can zip right through your body, the walls of your house, entire planets, even emerging from near the surface of black holes. Recently an international scientific collaboration has taken an astronomical step forward in unmasking the origins of some of these high-energy particles, the so-called "messengers of the universe."

Using the IceCube Neutrino Observatory, a unique astrophysical telescope built at, with the support of the National Science Foundation, between 1.4 and 2.4 kilometres depth in the Antarctic ice, the collaboration has observed 28 very high-energy particle events. These observations constitute the first solid evidence of neutrinos coming from "cosmic accelerators" – potentially such sources as exploding stars or accreting black holes. The data provides the first indication of very high-energy neutrinos coming from outside our solar system according to Francis Halzen, principal investigator of IceCube from the University of Wisconsin-Madison. The telescope can detect neutrinos coming through Earth from both the Northern and Southern skies and according to program director, Jim Whitmore the IceCube Neutrino Observatory has opened a new era in neutrino astrophysical observations. The observatory is in the forefront of the entire field of neutrino astronomy, now delivering observations that have been long-awaited by both theorists and experimentalists.

The scientific team is working to pinpoint where these neutrinos are coming from outside our solar system, according to Tom Gaisser, from University of Delaware. Gaisser leads a team of researchers in the Department of Physics and Astronomy who have been instrumental in constructing and maintaining the IceCube Observatory's surface array of detectors known as "IceTop" during the past decade. These detectors help scientists rule out the interference caused by neutrinos produced locally in our atmosphere and to focus instead on more energetic particles produced light years away from Earth, possibly even

The IceCube Neutrino Observatory at Amundsen-Scott South Pole Station with the aurora australis lighting the night sky. Image courtesy Sven Lidstrom, National Science Foundation

in the radiation field leftover from the Big Bang, which most astronomers believe formed the universe.

The universe is transparent to neutrinos. Questions the scientists are looking at include where neutrino's arise from. The scientists are endeavouring to explain if they are remnants from supernovae, or perhaps emanate from gamma ray bursts, or were accelerated from an accreting black hole? According to Gaisser, the scientific team does not have conclusive information about their origin yet.

Gaisser believes the answer will depend on the number of neutrino events captured by IceCube, from which geometric calculations can be made to trace the high-energy neutrinos to specific astronomical sources.

Billions of neutrinos pass through every square inch of Earth every second, rarely interacting with matter because they have no electrical charge. The vast majority of these subatomic particles originate either in the sun or in Earth's atmosphere. Far rarer are neutrinos from the outer reaches of our galaxy or beyond, which have long been theorised to provide insights into the powerful cosmic objects from which they originate: supernovae, black holes, pulsars, active galactic nuclei and other extreme extragalactic phenomena.

IceCube was designed to accomplish two major scientific goals: to measure the flux, or rate, of high-energy neutrinos and try to identify some of their sources. The results from the science team's analysis reveals the first high-energy neutrino flux ever observed, a highly statistically significant signal that meets expectations for neutrinos originating in cosmic accelerators.

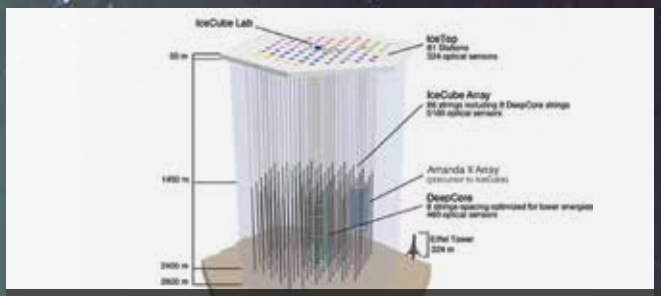
The 28 high-energy events were found in data collected by IceCube from May 2010 to May 2012 and analysed for neutrino events exceeding 50 teraelectronvolts (TeV) coming from anywhere in the sky. The events cannot be explained by other neutrino fluxes nor by other high-energy events, such as muons, which are charged particles produced by the interaction of cosmic rays in the atmosphere.

According to Gaisser this is an important observation as it means that somewhere in the universe, there are high-intensity sources near a 'central engine', and lots of collisions are occurring to produce the neutrinos.

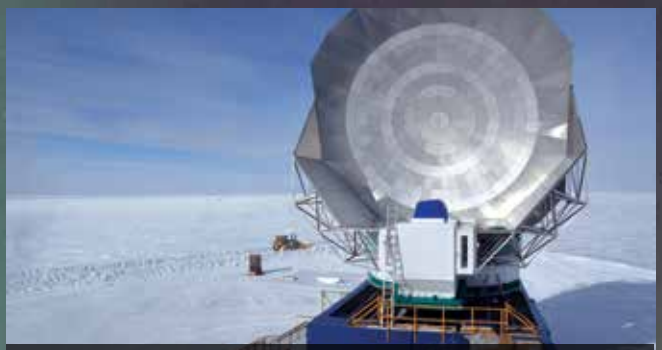
IceCube comprises 5,160 digital optical modules suspended like beads on a necklace along 86 strings embedded in a cubic kilometre of ice beneath the South Pole. An additional 324 optical modules are frozen inside 162 IceTop tanks on the surface. The observatory detects neutrinos through the tiny flashes of blue light, called Cherenkov light, produced when these tiny particles interact in the ice.

Although IceCube is designed to do basic science, it also has yielded an important application — a GPS-based calibration system that tells the time accurately within three nanoseconds across all the observatory's sensors. The IceCube detector was completed in December 2010 after seven years of construction that only could be carried out during the very short Antarctic summer, a period of roughly 90 days. It was built on time and within budget, and in its first three years of performance has exceeded its design specifications.

The University of Wisconsin-Madison is the lead U.S. IceCube institution, and the international collaboration includes 250 physicists and engineers from the United States, Germany, Sweden, Belgium, Switzerland, Japan, Canada, New Zealand, Australia and the United Kingdom.



The IceCube Neutrino Telescope is made up of 86 strings with a total of 5,160 Digital Optical Modules that are used to sense and record neutrino events. Although the telescope is 2,820 metres tall, the average hole is 2,452 metres deep. Image courtesy: Danielle Vevea and Jamie Yang/NSF



The South Pole Telescope. Image courtesy Peter Rejcek, National Science Foundation

Tom Gaisser (left) and James Roth at South Pole during the construction of the IceCube Neutrino Observatory. The UD team was responsible for construction of the surface array of detectors called IceTop. Image courtesy University of Delaware

Footage of the IceCube Neutrino Observatory beneath Amundsen-Scott South Pole Station. Image courtesy NFS

Shown here is the deployment of the 86th and final string holding digital optical modules (DOMs) as the construction of the IceCube Neutrino Observatory the world's largest neutrino detector came to a close on Dec. 18, 2010. Image courtesy Peter Rejcek, NSF

Digging out a seismographic instrument in Antarctica. Image courtesy Douglas Wiens, Washington University in St. Louis

Volcano discovered smoldering under a kilometre of ice in West Antarctica

Based on article by Diana Lutz

It wasn't what we were looking for — but that only made the discovery all the more exciting.

In January 2010, a team of scientists had set up two crossing lines of seismographs across Marie Byrd Land in West Antarctica. It was the first time the scientists had deployed this amount of instruments in the interior of the continent that could operate year-round even in the coldest parts of Antarctica. Like a giant CT machine, the seismograph array used disturbances created by distant earthquakes to make images of the ice and rock deep within West Antarctica.

There were big questions to be asked and answered. The goal, according to scientist and principal investigator Doug Wiens was essentially to weigh the ice sheet to help reconstruct Antarctica's climate history. To do this accurately, the scientists had to know how the earth's mantle would respond to an ice burden, and that depended on whether the mantle was hot and fluid or cool and viscous. The seismic data would allow the team to map the mantle's properties.

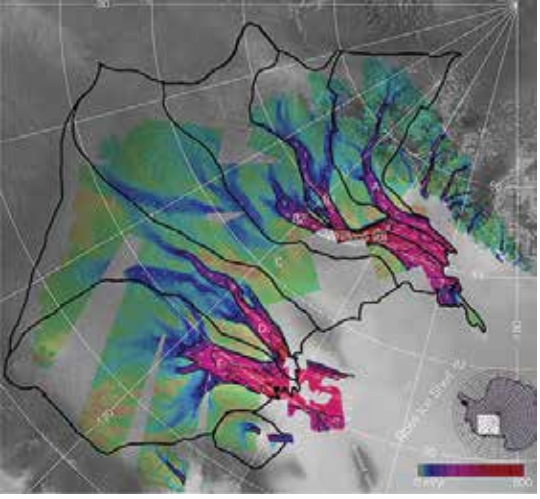
The team also used automated-event-detection software to comb the data for anything unusual. When the software recorded two bursts of seismic events between January 2010 and March 2011, Doctoral student Amanda Lough looked more closely to see what was rattling the continent's bones. Possibilities for what was causing the seismic events included rock grinding on rock, ice moving over ice, or, perhaps, hot gases and liquid rock forcing their way through cracks in a volcanic complex. The seismic events recorded were described by the scientists as "swarms" – thousands of events in the same locations, sometimes dozens in a single day. Uncertain at first, the more Lough and her colleagues looked, the more convinced they became that a new volcano was forming a kilometre beneath the ice.

The location of the seismicity was about 55 to 60 kilometres (34 to 37 miles) south of Mt. Sidley, in an area where current volcanic activity would be predicted to occur based on the geographic locations and the ages of the lava of the known volcanoes in the Executive Committee Range. The seismic swarms were also located near a sub-glacial high – point of elevation and magnetic anomalies which are both indicative of a volcano.

Following the trail of clues

The teams that install seismographs in Antarctica are the first have a chance to analyze the data. Lough had three times travelled to East Antarctica to install or remove stations and so when the instruments were moved to West Antarctica in 2010 she was asked to look at the seismic data coming in, the first large-scale dataset from this part of the continent.

She noticed in the data, events which kept occurring at the same location and realized they were close to some mountains, but not right on top of them. On close investigation Lough realized that the mountains were actually volcanoes and there was an age progression to the range. The volcanoes closest to the seismic events were the youngest in age. The seismic events



Melt water from the new volcano will drain into the MacAyeal Ice Stream. The red areas of the radar image indicate the fast-moving centres of the ice streams and black lines outline each stream's catchment area. By greasing the skids with water, the new volcano might increase the rate of ice loss from the MacAyeal Ice Stream. Image courtesy Earth Observatory/NASA.

Twin Otter aircraft used to deploy sensors. Image courtesy Douglas Wiens, Washington University in St. Louis

Washington University in St. Louis PhD student Amanda Lough during one of her trips to tend seismographs in East Antarctica. Image courtesy Doug Wiens.

Mount Sidley is the last volcano in the chain that rises above the surface of the ice. New volcanic activity has been detected under the ice about 48 km ahead of Mount Sidley in the direction of the range's migration. The finding suggests the source of magma is moving beyond the chain beneath the crust and the Antarctic Ice Sheet. Image courtesy Doug Wiens.

recorded were weak and very low frequency, which strongly suggested they weren't tectonic in origin. While low-magnitude seismic events of tectonic origin typically have frequencies of 10 to 20 cycles per second, this shaking was dominated by frequencies of 2 to 4 cycles per second. There was the possibility that due to their low-frequency the events were caused by glacial processes.

To investigate this theory Lough used a global computer model of seismic velocities to "relocate" the hypocentres of the events to account for the known seismic velocities along different paths through the Earth. This procedure collapsed the swarm clusters to a third their original size. It also showed that almost all of the events had occurred at depths of 25 to 40 kilometres (15 to 25 miles) below the surface. This is extraordinarily deep — deep enough to be near the boundary between the earth's crust and mantle, called the Moho, and more or less ruled out a glacial origin for the seismic events.

It also confirmed that the events were unlikely to be tectonic as a tectonic event might have a hypocentre 10 to 15 kilometres (6 to 9 miles) deep, but a depth of 25 to 40 kilometres was much too deep according to Lough. One of Loughs colleagues suggested that the event waveforms looked like Deep Long Period earthquakes, or DPLs, which occur in volcanic areas, have the same frequency characteristics and can happen at the depths seen in the data. Everything matched up to the events being DLP in origin.

An ash layer encased in ice

The seismologists also talked to scientists Duncan Young and Don Blankenship of the University of Texas, who fly airborne radar over Antarctica to produce topographic maps of the bedrock. The maps showed that there is an elevation in the bed topography at the same location as the seismic events visible in the data. The radar images also showed a layer of ash buried under the ice. This layer appears all around where the cluster of earthquakes had been discovered.

Significantly the ash layer only appeared in the area of the seismic events. Lough initially thought that the ash layer might have evidence of a past eruption from the volcano detected in this study, but based on the distribution of the materials and the prevailing winds Young and Blankenship believe the ash most likely came from an eruption of nearby Mount Waesche, an existing volcano near Mount Sidley about 8000 years ago. It was previously unknown when Mount Waesche was last active but the dating of the ash layer confirmed that the volcano believed to have last been active around 100,000 years ago, erupted much more recently than previously thought.

What's up down there?

The case for volcanic origin had been made. But what exactly was causing the seismic activity?

According to Wiens most mountains in Antarctica are not volcanic except in the Mt Sidley are where the majority of mountains in the area are volcanic. One possible reason for this may be because East and West Antarctica are slowly rifting apart. The scientific team thinks that there is probably a hot spot in the mantle in the area which produces magma far beneath the surface.

Scientists aren't really sure what causes DPLs according to Lough as it seems to vary by volcanic complex, but most agree it's the movement of magma and other fluids that leads to pressure-induced vibrations in cracks within volcanic and hydrothermal systems. According to Lough the new volcano will definitely erupt. In addition she thinks that because the radar shows a mountain beneath the ice, it has erupted in the past, before the rumblings recorded by the team. It is unlikely however, that any eruption would punch through the kilometre or more of ice above the volcano. The scientists calculated that an enormous eruption, one that released 1,000 times more energy than the typical eruption, would be necessary to breach the ice above the volcano.

On the other hand, a sub-glacial eruption and the accompanying heat flow would melt a lot of ice. According to Wiens the volcano erupting would create millions of litres of water beneath the ice. This water will rush beneath the ice toward the sea and feed into the hydrological catchment of the MacAyeal Ice Stream, one of several major ice streams draining ice from Marie Byrd Land into the Ross Ice Shelf. The heat of the eruption could increase the rate of ice loss from one of the continent's major ice streams. In addition by lubricating the bedrock, the speed of flow of the overlying ice will increase which may then increase the rate of ice-mass loss in West Antarctica.

The scientists were not expecting their findings and have published a research paper on the discovery of the volcano in the journal *Nature Geoscience*. The research was funded by the National Science Foundation, Division of Polar Programs.

A biology teacher too cool for school in Antarctica

by Sarah Johns

Sarah Johns experienced Antarctic research as part of a Royal Society funded Endeavour Teaching Fellowship.

Being awarded the Royal Society Endeavour Teacher Fellowship gave Sarah Johns a once-in-a lifetime opportunity to actively engage in an authentic scientific research in one of the world's most extreme environments, Antarctica. Sarah spent three weeks including Christmas and New Year working alongside Regina Eisert from the University of Canterbury and Jonathan Banks from the Cawthron Institute on the Top Predator Alliance's project, *Whales, seals and penguins: defining functional roles and trophic dependencies of key top predators in the Ross Sea*.

Sarah contributed to a multinational, multidisciplinary collaboration that is examining the effects of climate change and commercial fishing on the diets of predators such as Weddell seals and Adélie penguins in the Ross Sea region. Results from the study will contribute to the sustainable management of the fishery in the region, and model the effects of climate change on Antarctica's unique wildlife.

Sarah started her fellowship early by travelling to Scott Base to check remote monitoring equipment, collect faecal samples from Weddell seals and assist with ice fishing. While in Antarctica, Sarah interacted with her student through her Facebook page "*Biology in Antarctica with Mrs Johns*". Students, friends and family were able to follow her daily entries on the Facebook page, see photos and participate in real-time by asking questions online. Participating in the project has given Sarah not only a rare insight in to Antarctic research, she also acquired new skills such as riding a snowmobile and drilling holes through three metre thick ice for fishing.

Weddell Seal. Image courtesy Jonathan Banks

Sarah Johns has worked as a Secondary Science and Biology Teacher for the past 14 years. She is currently teaching at Nelson College for Girls and will be hosted for the next six months at the Cawthron Institute to analyse samples collected in Antarctica.

In Sarah's words "It has been unparalleled by anything I have done so far in my life." She is looking forward to continuing her fellowship in the lab over the next six months. Sarah will extract DNA from seal and Adélie penguin faecal samples collected during the season and prepare the DNA for advanced "next generation" sequencing to identify the predators' prey. "Ultimately this experience will enhance my teaching when I get back to the classroom. I will have skills and knowledge that I never had before. Students need inspirational stories that they can connect with that help them aspire to achieve."

Sarah Johns and Jonathan Banks. Image courtesy Jonathan Banks

Artist conception of the future McMurdo station. Image courtesy NSF

National Science Foundation plan to guide development of McMurdo Station

Article courtesy National Science Foundation.

The National Science Foundation (NSF) has released a master plan for updating its largest Antarctic research station, McMurdo, on Ross Island that will, among other goals, increase energy, logistical and resource efficiency while being able to adapt to the evolving nature of Antarctic science.

McMurdo is one of three year-round Antarctic stations operated by NSF, through its Division of Polar Programs. Polar Programs manages the United States Antarctic Program (USAP) in accordance with a 1982 Presidential Memorandum Regarding Antarctica.

McMurdo Station serves as the gateway to the continent for scientists supported by the USAP and federal mission agencies such as National Oceanic and Atmospheric Administration (NOAA) and the National Aeronautics and Space Administration (NASA). The station also serves as a hub for science support, logistics and operations that include fixed-wing aircraft and helicopter flights as well as ship-borne resupply of cargo and fuel.

McMurdo has been in operation since the early stages of preparations for the International Geophysical Year in 1955. Since that time, the station's footprint has grown in response to first expeditions and later Antarctic research needs.

The master plan is the first step in applying long-range investment planning for the USAP generally, and McMurdo Station specifically. The need for investment planning was cited in a July 2012 report on USAP logistics conducted by a Blue Ribbon Panel. In its report, *More and Better Science in Antarctica through Increased Logistical Effectiveness*, the panel made numerous specific recommendations for streamlining, improving and modernizing USAP-supported science and science support in Antarctica and the Southern Ocean. The report is the result of the second phase of a two-part independent review of the USAP, which is managed by NSF. A 2011 report issued by the National Research Council asserted that in the next few decades, enhancing science in the Antarctic region will require substantial organizational changes, broader geographical spread, increased international involvement, and a growth in the quantity, duration and networking of observations.

Although no specific timeline for completion is contained in the master plan, it is intended to be implemented in discrete phases that preserve the ability to conduct key functions during construction. Designs showing the proposed building arrangement reflect a more compact arrangement than currently exists.

The existing McMurdo Station

The core of the station, as envisioned in the report, centres on a central axis with several inter-connected structures, including the existing Albert P. Crary Science and Engineering Center, the largest laboratory on the continent; a food, storage, administration and operations centre; and dormitory-style housing. At the periphery of the core area are separate facilities for power generation and water treatment, as well as facilities for trades work, vehicle maintenance, cargo handling and warehousing space. This consolidation will allow for more efficient workflow generally, including the flow of cargo through McMurdo to field sites and Amundsen-Scott South Pole Station.

The master plan also focuses on increasing flexibility so that facilities may be adapted to meet the evolving nature of Antarctic science. It aims to reduce the "footprint" of the station to increase energy efficiency, along with logistical and resource efficiency; improve the living and working experience of individuals at McMurdo Station; and make information-technology improvements to decrease complexity and increase reliability. While the focus is on McMurdo Station the Blue Panel members recognised the role of the station in supporting the other two NSF maintained year-round stations on the continent, the two icebreaking-research vessels and more than 50 distributed field sites, along with the transportation platforms needed to support them, including channel-clearing icebreakers, fixed and rotary wing aircraft, and other vehicles.

The Executive Summary of the Blue Ribbon Panel report recognises that international engagement is paramount in continuing Antarctic and Southern Ocean research and emphasises that the master plan will "serve as a guide to future development of McMurdo" and act as a "living document, adaptable through time to serve a dynamic set of needs."

Tribute – Philip (Phil) M. Smith

(1932–2014)

Phil Smith, known to Scientific Committee on Antarctic Research (SCAR) members as the leader of the review that led to major restructuring of SCAR in the early 2000s, passed on February 16, 2014.

In his early years, he was active in cave exploration, and helped establish the Cave Research Foundation. Phil was an active outdoorsman, and throughout his life explored the rivers and mountains of the American West, Alaska, the Appalachians, and Africa. He was a member of the team that famously staged in 1960, in New Zealand-designed jet boats, the first and only up-canyon run of the Colorado River through the Grand Canyon.

An ardent supporter of the arts, he was a theatre, classical music and dance devotee, and an avid art collector. He was actively engaged in promoting young artists, and as part of his endowment to NMA is the creation of the Namingha Institute-an annual master class retreat for emerging artists to study with masters of contemporary art. A native of Springfield, Ohio, Phil held a Bachelor of Science and Master of Arts Degrees from Ohio State University and an honorary Doctorate from North Carolina State University.

Phil began his involvement in the Polar Regions when, as a young United States of America Army Lieutenant, he was sent to Greenland as a navigator for the heavy tractor "swings" then traversing the Greenland Ice Sheet. Phil was trained by Major Palle Mogenson and Captain Bert Danielson for his work in Greenland.

When his tour of duty in the Arctic was completed, Phil made the decision to volunteer to join the United States efforts in the International Geophysical Year 1957-1958 (IGY) in Antarctica, and there he joined with Bert Crary and others utilising heavy tractors to haul materials for the construction of the US bases established as part of IGY.

After returning to the US, Phil became an early member of the Office of Polar Programs that was established in the National Science Foundation to continue the scientific efforts begun as part of the IGY. Bert Crary was the Chief Scientist and Phil served as the Deputy Director of Office of Polar Programs for a number of years.

His abilities were soon recognised by his colleagues in Washington, DC, and in following years he worked as associate director of the White House Office of Science and Technology Policy and the Office of Management and the Budget for three Presidents; Nixon, Ford and Carter, followed by over a decade of leadership in the National Academy of Sciences and the National Research Council.

In the late 1990s Phil was asked by the then president of SCAR to conduct a review of that organisation. At that time, SCAR was operating on the same "plan" that was instituted when it was formed in the late 1950s, and the increase in size and activities were not reflected in the SCAR system of operation, leading to pressure to change from some quarters. After some reflection, Phil agreed to lead a review committee, and it is as a testimony to his wise and skillful chairmanship that reforms which might well have been controversial met with wide approval. Indeed, SCAR as we see it today is largely a result of that review.

More recently he was asked, and agreed to chair, a "review of the review" for a fine tuning of the operation of SCAR. He was elected as an Honorary Member of SCAR to recognise his contributions to the organisation. He was also involved in helping plan the U.S. portion of the International Polar Year in 2007-2009.

Anyone who has worked with Phil knows that he was a unique individual. Outstanding leadership skills, the ability to get diverse groups to work together, but most importantly, he had the ability to see years ahead and to have an understanding of what was to come. He has been called a "futurist" by some.

Phil Smith Image from www.aurora.aero/media/press

Smith was an avid outdoor adventurer throughout his life, and celebrated his 80th birthday in 2012 by leading an expedition of friends to the Galapagos. In describing his life to fellow travelers on the trip, Smith wrote, "There have been two guiding principles in [my] public policy and expeditionary lives, namely, optimism is the first principle of management strategy and life must be lived to the fullest daily."

Phil's contributions to the continued growth and development of SCAR as an important organisation in the international arena cannot be ignored. SCAR members owe a great debt to Phil and those of us who knew him well, some for over 50 years, will miss his skills, humour, and leadership. SCAR today is a far better and more relevant organisation due largely to the efforts of Phil Smith. The Polar world and SCAR have lost a great friend.

Tribute based on National Academy of Sciences and SCAR obituaries for Philip Smith.

Tribute – Barrie (Barry) Clayton Waterhouse

(1929-2014)

Edited from tribute by David Skinner (GNS Science)

Barry Waterhouse 1970 (after Scott Glacier Expedition). Image courtesy David Skinner.

Barry Waterhouse's career in the New Zealand Geological Survey of the Department of Scientific and Industrial Research (DSIR) progressed from technician through to District Geologist in Auckland, making major contributions to understanding the geology and geohydrology of Northland.

Barry's first venture into Antarctica was the 1965 Balleny Islands Expedition to assess and sample the geology, sea floor, flora and fauna of the area. They visited and sampled other basaltic volcanic islands of the western Ross Sea and landed at Cape Hallet and Robertson Bay. Barry described the 'thrill' of jumping off a landing craft onto guano covered ice cliffs on Coulman Island, and his experience of helicopter 'harness and winch' landings to a rocky outcrop SE of Sturge Island.

In 1957 the New Zealand Geological Survey Tucker Glacier Expedition placed a row of snow poles across the Edisto Glacier. Barry with two New Zealand Surveyors resurveyed the poles to determine the movement of the glacier. During the expedition Barry had to be extracted from a crevasse. Barry landed on Duke of York Island, the first visit since Scott's Northern Party in 1911.

On the way home, the *USS Glacier* stopped at Macquarie Island where Barry took a sample of thick sludge from the engine cooling water intake filters. In New Zealand this was identified as pumice from an eruption on the South Sandwich Islands that had taken place some 13 months previously and swept by the circumpolar currents into the southern ocean.

Barry's second expedition was the Scott Glacier expedition 1969/70. Led by geologist Rudi Katz (New Zealand Geological Survey), the expedition aimed to traverse the Scott Glacier from the Polar Plateau down to the Ross Ice Shelf, in order to undertake a geological survey and to study soil development.

Pol(l)eing Day at Cocks Glacier (the Skelton-Koettlitz Glaciers Expedition).From left to right – A cold Scott Base Public Relations Officer, Barry Waterhouse, David Skinner, Ken Sullivan, & Gary Brehaut casting his vote! Image courtesy David Skinner

Barry and Rudi worked somewhat independently, using Meade tent 'fly camps' to climb and record the geology of Mt Blackburn. Temperatures hovered between -20° and -30° C with extreme wind chill and geological work became almost impossible. Barry recorded that the cold penetrated their down-filled clothing, and froze their fingertips.

To quote Barry from his book, I apparently said to him in 1975 "Come with me and I will take you to the banana belt of Antarctica". This invitation to the Skelton and Koettlitz glaciers expedition, so near to McMurdo, and with helicopter support, helped to blot out Barry's memories of his previous expedition experiences. The expedition aimed to extend previous geological exploration and investigate if the lower grade Skelton Group meta-sediments would grade north and eastwards into the higher grade Koettlitz Group metamorphic rocks.

The team helicoptered in to the north side of Cocks Glacier, sledged into the Skelton Glacier worked south across to Teall Island, then up west past Dilemma Bluff, crossed to the east side at Hobnail peaks and back to the Cocks Glacier. They then back tracked up Cocks Glacier to Mt Cocks and over into the Koettlitz Glacier and down past Hooper Crags to Foster Glacier. With Barry's leadership qualities, the support of field assistants, and a US helicopter, the challenging plan was accomplished.

The interesting geology meant long hours in incessant wind traversing the area between the Baronik and Cocks glaciers. This routine was disrupted by the 1975 General Election, when DSIR organised a public relations exercise, flying in voting papers, a "Pol(l)ing Booth", and photographer.

In November 1975, they sledged down the Cocks Glacier nevè until they reached the lower icefall. Toboggans were belayed and Barry drove them in pendulum arcs across ice ridges between large crevasses and seracs. Barry's resilience was tested as he was several times thrown from the sledge, sending him cart-wheeling across the ice. A few days later I was injured in a sledge accident and Barry ably took over the leadership fulfilling the rest of the objectives on the Skelton Glacier. The expedition team was eventually air-lifted back to Scott Base.

Thus, for Barry's last Antarctic trip, we had passed from the wind and cold of the Skelton-Cocks glaciers through to the relative "banana belt" weather of the Koetlitz Glacier. To quote Barry's own words from his book, "After 77 days in the field without washing or changing our clothes, the return to Scott Base demanded a certain level of social acceptability, which we gladly embraced. The bath and clean clothes ensured our acceptance in the mess and elsewhere on base and at McMurdo Station."

It has been a real pleasure and privilege to spend so much time with Barry over my many years of knowing and working with him. Barry was indeed a true Gentleman Explorer and Scientist.

A Story of Antarctic Co-operation; 25 Years of the Council of Managers of National Antarctic Programs

By Gillian Wratt

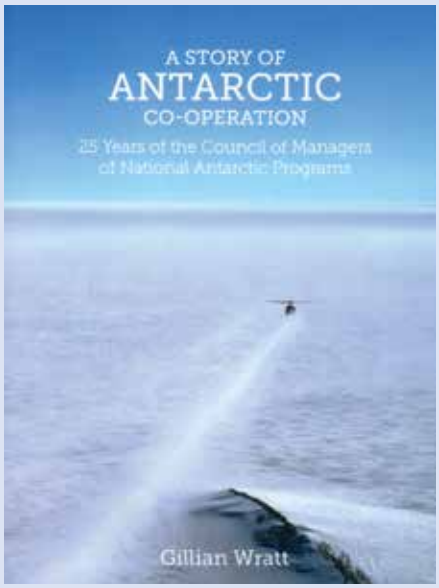
Reviewed by Matthew O'Sullivan

A Story of Antarctic Co-operation is a comprehensive history of the first quarter-century of the Council of Managers of National Antarctic Programs (COMNAP).

COMNAP came into being in 1987 to bridge a gap between the Antarctic Treaty Consultative Meeting (ACTM) and the Scientific Committee on Antarctic Research (SCAR), effectively the governance and scientific elements respectively of Antarctic operations. The origins go back to the International Geophysical Year (1957-58) and the original Antarctic Treaty.

The author, Gillian Wratt was Chair of COMNAP 1997 – 2001 and previously, the Director of the New Zealand Antarctic Programme (1992 – 1996) and Chief Executive of Antarctica New Zealand (1996 – 2002). She is perfectly placed to write a history of COMNAP. There are numerous breakout pages on a variety of subjects like *COMNAP and SCAR – Getting the 'Federal' Feeling, Ross Island Wind Energy Project: Sustainability Through Collaboration and Making an Impact – Communications, Public Engagement and Outreach*. Each breakout is written by a different individual involved in COMNAP, SCAR or individual National Programmes and each compliment the chapter in which it appears.

The book is lavishly illustrated with very high quality photographs sourced from entries in the SCAR-COMNAP



Images from the Great White South Photographic Competition and Exhibition. The reproduction quality is high and the image quality is even higher, exhibition quality.

Part 2 is a series of two-page "snapshots" of the member countries' Antarctic Programmes. This, for me, was more interesting than Part 1. Each snapshot outlines the member countries involvement in Antarctica, their integration into COMNAP and the research work carried out by them. I was surprised by some of the member nations; I wasn't aware that Ecuador, India, Spain or Uruguay had an interest in Antarctica. Often the newer nations piggy-back on other, more established nations' programmes, using their facilities and air or sea support. Italy and France, for example, share a station at Concordia, in the interior. Each section has reference to a website of that countries' Antarctic Programme for more detailed information.

The appendices record lists like COMNAP meetings, working papers, publications, workshops and symposia, committees, subgroups and expert groups. All are chronological and include the names of people involved and locations of meetings.

This is not a book for light reading; rather it is a scholarly work. The use of acronyms is liberal, although if they weren't used the text would be far too wordy. Note it does take some time to be able to read through these easily. More scholarly readers though, will have no problem. I believe it will be essential reading for scholars of Antarctica. This is the complete work chronicling the responsibilities and tasks of COMNAP and should stand on its own with regard to this part of Antarctica's history.

Published by COMNAP
ISBN 978 0 473 24776 8

Antarctic Adventure

by Barry Waterhouse and Susan Nemec

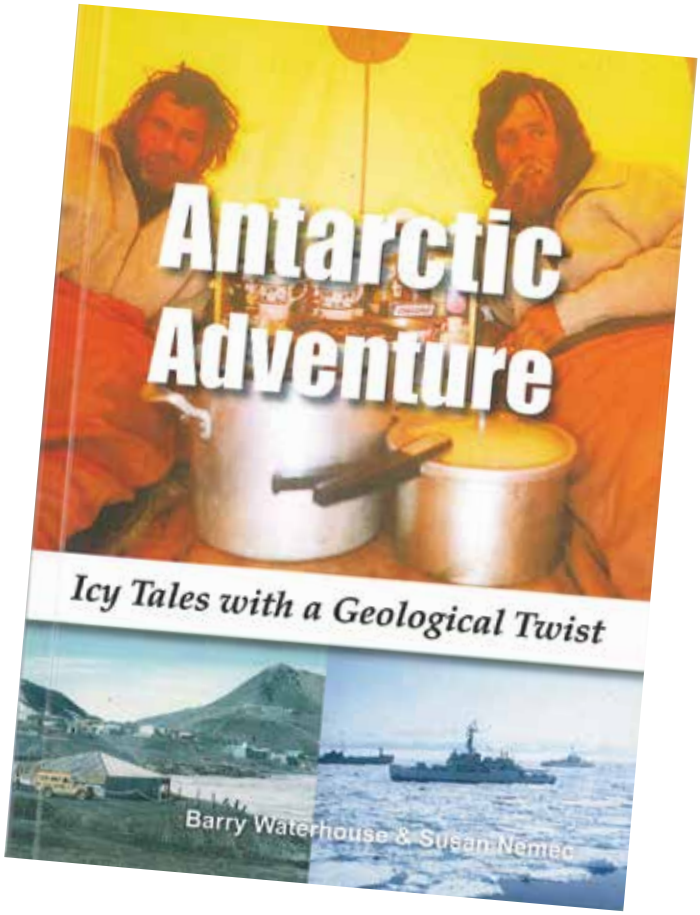
Review by Bruce W. Hayward, Geologist

I've just read a jolly good yarn written by the late New Zealand Geological Survey geologist Barrie Waterhouse with journalistic help from his niece. The book comes in three chapters, each the account of one of three geological expeditions that Barrie made to Antarctica and the Southern Ocean.

I started with chapter three, because of my greater affinity with sea-based research expeditions and difficult landings on rocky island coasts. This tells of an expedition by *USS Glacier* in 1965 from McMurdo Sound back to New Zealand with the goal of undertaking a wide variety of research, including Barrie's geological sampling, on all the islands en-route, especially the Balleny Group. Then I read the two Antarctic field trip chapters on the Robert Scott Glacier geological mapping expedition led by Rudi Katz in the summer 1969/1970, and the Skelton-Koettlitz Glaciers geological mapping expedition led by David Skinner in the summer of 1975/1976. In the centre of the book are 31 mostly black and white photos taken during the expeditions by Barrie that are valuable historic records and help bring the stories to life.

All three accounts are highly readable with sufficient simple geological explanations to explain why they were visiting various outcrops but none of the detailed results. I've known many colleagues who have been on these Antarctic summer expeditions, but Barrie's accounts reinforce my decision not to volunteer for one myself. His descriptions of the shaking and tremendous noise from the howling winds, the freezing cold, the icicles showering down on you inside the tent, days on half rations, the constant darning and repairing of gloves and clothing, and the many days hunkered down waiting for the latest white-out storm to pass, paint vivid images that clearly show these trips were not a walk-in-the-park.

I had not realised that some of these expeditions were delivered into the field by Hercules aircraft that flew around looking for a place to land on the ice to drop them off. He describes one occasion when their Christmas food drop was obliterated when the parachute delivering it didn't open, but then the Hercules landed to pick up the parachute to see why it had not opened – at least it took back their rock samples. Similarly I was unaware how prevalent were the snow-covered crevasses that these expeditions had to cross with their toboggans and sleds with collapsing ice-bridges seemingly a daily occurrence. On several occasions they had close shaves and had to recover their sledges from precarious positions. He also describes the event where David Skinner was thrown from a toboggan and run over by it and had to be picked up by a helicopter and replaced by a back-up geologist while he recuperated for a week.



I read this book in one evening and I could not put it down from start to finish. Whether you've been on one of these Antarctic expeditions or not, there is a lot in this book that Antarctic enthusiasts will find of historic interest or to reminisce over. For an informative and entertaining read I recommend this book to Antarctic visitors from the past and the present. We sometimes forget how fieldwork was carried out in the days before OSH and GPS, and often for days without even radio contact with the outside world.

Antarctic Adventure, by Barry Waterhouse and Susan Nemec, self published, 110 p., 2012, Available from Susan Nemec, email: nemecedgar@clear.net.nz, $25.

New Zealand IceFest is Bringing Antarctica to the World…

Our tagline is *Bringing Antarctica to the World*. We'll certainly be living up to it.

From 26 September to 12 October 2014, the IceFest team is transforming our Christchurch Central City site into what is, for all intents and purposes, a little slice of Antarctica. It gives this most mysterious of continents the creative, interactive, enlightening festival it deserves, all nestled in the heart of one of New Zealand's most dynamic cities.

It's bold, it's cold, it's two years old.

New Zealand IceFest celebrates the importance of Antarctica to the world, as well as New Zealand's and Christchurch's unique relationship with Antarctica and the Southern Ocean. The inaugural festival in 2012 delivered a strong programme of Antarctic-themed activities and set New Zealand IceFest on track to become an internationally recognised biennial festival, unique in its subject matter and multi-disciplinary programming.

Each of the festival's three weekends focuses on a different aspect of Antarctica – Industry and International Relations, Adventure and Heritage and Art and Culture. Integral to Antarctica and the Southern Ocean, the Science and Environment programme runs right through the festival. Some of the biggest draws include…

Headline Speakers

Adventurers and charming rapscallions Kevin Biggar and Jamie Fitzgerald present First Crossings – the first unsupplied, unsupported New Zealand expedition to the South Pole. It is the account of their gruelling journey, on foot, 2200 kilometres from the Antarctic coast to the South Pole and back. Their story is funny, dramatic and always fascinating – and New Zealand IceFest lets you hear it first-hand.

Gen-i presents *Talk to Scott Base*

Come and talk live to real Antarcticans currently living at Scott Base! For 30 minutes on select days, you'll be able to chat with scientists and technicians coming to you live from the ice via our video-conference setup.

The Big Issues

Experts from science, policy and industry tackle those big, controversial, critical issues facing Antarctica in three debates.

Antarctic Time Travel

It's a jungle out there! This specially-created interactive exhibition lets you zap through geological time, from 65 million years in Antarctica's surprisingly leafy past to its distant future.

Ice Lab: New Architecture and Science in Antarctica

This is an international touring exhibition that illustrates how innovative contemporary architecture is – enabling scientists to live and work in one of the most extreme environments on our planet.

Antarctic Air Day

Join United States Air Force and Royal New Zealand Air force crews as they take you inside some of the world's largest aircraft before they fly to Antarctica.

NEW ZEALAND ICEFEST
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Christchurch City Council

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Antarctica New Zealand

New Zealand Antarctic Society Membership

The New Zealand Antarctic Society Inc was formed in 1933. It comprises New Zealanders and overseas friends, many of whom have been to the Antarctic and all of whom are interested in some phase of Antarctic exploration, history, science, wildlife or adventure.

A membership to the New Zealand Antarctic Society entitles members to:

- *Antarctic*, the quarterly publication of the Society.

It is unique in Antarctic literature as it is the only periodical which provides regular and up to date news of the activities of all nations at work in the Antarctic, Southern Ocean and Subantarctic Islands.
It has worldwide circulation.

- Attend meetings, educational and fun events which are held by the Auckland, Wellington and Canterbury Branches of the Society.

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New Zealand Antarctic Society Inc.
BNZ, Christchurch Branch

Penguin
by Prianka Chand

Emperor Penguin
Keeping the egg warm and safe
Standing patiently

Emperor Penguin
by Prianka Chand

Emperor penguin is the world's largest penguin.
Many chicks die from the cold.
People study the Emperor penguin.
Each penguin takes turns to feed the chick.
Racing through the icy water
Orca whales waiting
Rookery crowded with birds

Photo above: *Emperor penguins (Aptenodytes forsterii) Riiser Larsen colony, Weddell Sea. Image courtesy of photographer Colin Monteath: Hedgehog House, www. hedgehoghouse.com*