Australian ANTARCTIC MAGAZINE

supporting BIG PICTURE SCIENCE

8 Autumn 2005

Australian ANTARCTIC MAGAZINE

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The Australian Antarctic Division (AAD), an agency of the Department of the Environment and Heritage, leads Australia's Antarctic programme and seeks to advance Australia's Antarctic interests in pursuit of its vision of having 'Antarctica valued, protected and understood'. It does this by managing Australian government activity in Antarctica, providing transport and logistic support to Australia's Antarctic research program, maintaining four permanent Australian research stations, and conducting scientific research programs both on land and in the Southern Ocean.

Australia's four Antarctic goals are:

- To maintain the Antarctic Treaty System and enhance Australia's influence in it.
- To protect the Antarctic environment.
- To understand the role of Antarctica in the global climate system.
- To undertake scientific work of practical, economic and national significance.

Australian Antarctic Magazine seeks to inform the Australian and international Antarctic community about the activities of the Australian Antarctic programme. Opinions expressed in *Australian Antarctic Magazine* do not necessarily represent the position of the Australian Government.

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FRONT COVER: Supporting big picture science: Hagglunds and quad bikes being used as part of a summer based field project investigating the modern day limnology of epiglacial lakes. Unnamed Lake, Central Masson Range, Framnes Mountains, East Antarctica. Summer 2004/2005 season. © THOMAS PICKARD

BACK COVER: Adélie penguin CHRISTOPHER CLARKE

INSIDE COVER: Crampons WADE FAIRLEY

Supporting big picture science

PETER NINK

This year sees the Australian Antarctic Division (AAD) preparing for a number of ambitious scientific events and projects. Fast approaching is the International Polar Year (IPY), which will span the 2007–08 and 2008–09 seasons. We are now planning for our role in this significant international programme, which includes leading a Census of Antarctic Marine Life. This project will see ships from many nations taking part in a collaborative, large-scale survey of species biodiversity, abundance and distribution in the Southern Ocean. We are also planning our role in a major oceanographic survey, an international climate project, and a number of other projects. The IPY will significantly advance polar research and establish new benchmarks in our understanding of Antarctica and the Southern Ocean.

Our ability to participate in the IPY and to conduct the vast range of scientific research encompassed by the Australian Antarctic programme depends on a range of supporting activities, individuals and tools. This issue of the *Australian Antarctic Magazine* features some of these.

Working behind the scenes, the AAD's Polar Medicine Unit, through its links with the Royal Hobart Hospital and other national and international medical and research facilities, recruits and trains doctors to provide specialised medical support in the unique Antarctic environment. It also supplies training to expeditioners willing to assist doctors in Antarctica and conducts research to improve the health and safety of expeditioners. Without these capabilities the AAD would be unable to pursue its research goals in Antarctica. The unique practice of remote and extreme medicine is also used as a test bed for other remote and extreme environments, including space.

Other unsung heroes of the Australian Antarctic programme are our voyage leaders. These men and women are critical to the smooth transfer of expeditioners and cargo between Australia and Antarctica and to the planning of scientific activities *en route*. Many voyage leaders are drawn from other jobs within the Antarctic programme to meet this critical leadership role.

Tourists too, play an important role in supporting Antarctic science. Through lectures on board cruise ships, for example, thousands of dollars have been raised to support seabird conservation projects. Some of these funds have assisted the development and testing of new longlining methods to help prevent deaths of albatrosses and petrels.

Through the newly established Advisory Committee to the Agreement on the Conservation of Albatrosses and Petrels, and a Threat Abatement Plan, a range of research and conservation initiatives will continue to support Australia's goal to protect these majestic birds.

The 2004–05 Antarctic season saw a number of reviews of Australia's environmental management procedures. Such reviews are necessary to ensure that our activities in Antarctica are not damaging the sensitive ecosystem we aim to protect. Australia also participated in inspections of the infrastructure

and activities of other Antarctic Treaty countries. These were the first by Australian observers for many years. Antarctic Treaty inspections ensure all Parties are upholding their obligations to conduct peaceful scientific research and minimise their environmental impacts in Antarctica.

The introduction of the new CASA 212–400 aircraft, 'Ginger' and 'Gadget', to Antarctica, was not without its teething troubles, but we were able to test and measure the capability of the aircraft and the systems that they operate with. We are looking forward to consolidating our new knowledge in the season that lies ahead and to see the aircraft play a central role in supporting Antarctic science.

This issue also brings you some surprising and exciting results from the Southern Ocean, an Antarctic ice core, the Davis lidar and the seabed near Casey. The discoveries reported in these articles illustrate the important roles technology and cooperation have in improving the amount, diversity and quality of information scientists can gather from their experiments. Robotic 'Argo' floats, for example, repeatedly gather information about the ocean's physical and chemical properties, from its surface to 2000 m below, and beam this information to satellites connected to computers around the world. Five years ago we could not have dreamed of collecting information from such remote and hostile regions of the Southern Ocean. Today, it is saving us time and money and fast-tracking our ability to monitor changes and predict their effect.

As this magazine goes to press I am pleased to report that the Prime Minister's Science and Engineering Innovation Council (PMSEIC) enthusiastically received a presentation and report on future opportunities in Antarctic and Southern Ocean science. Over the coming months my colleagues and I will follow up on initiatives flowing from PMSEIC's engagement with our work, to best position us for the future.

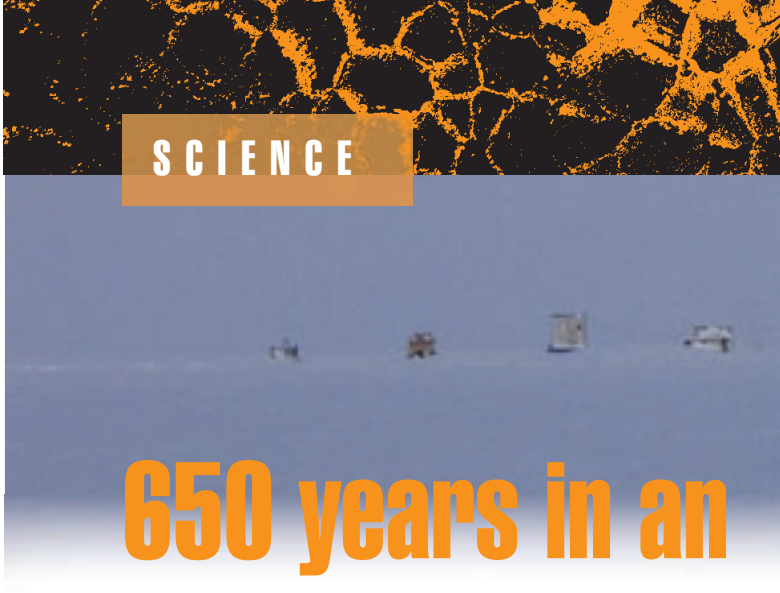
I am also delighted to hear that the May 2005 Federal Budget has announced the Government's commitment of $46.3 million over four years to introduce an air link between Hobart and Antarctica. The air link will revolutionise the way we go about supporting science in Antarctica. I look forward to telling you more about this exciting development in our next issue.

Tony Press

—TONY PRESS
Director, AAD

Setting up the drilling tent.

MIKE WOOLRIDGE



SCIENCE

650 years in an

A 120 m ice core retrieved from Law Dome inland of Casey Station last October will provide AAD scientists with a 650 year record of the Earth's climate. This record covers both natural and human induced changes in the Earth's climate, in particular the natural climate phenomenon known as the 'Little Ice Age'.

Historical records show that Northern Europe experienced the Little Ice Age between around 1400–1850 AD, but the extent to which it may have affected the global climate is not well understood. The sea ice that forms each year on the Southern Ocean around Antarctica may provide a clue, as the extent of the Antarctic sea ice cover varies in response to climate change. However, observations of sea ice extent are limited. Most research to date has used satellite data, ice edge records from whaling ships and even the observations of Captain Cook.

In November 2003 we published an article in Science magazine (*Science* 302:1203–1206) detailing the use of a 'proxy' record of sea ice extent, obtained through the analysis of methanesulphonic acid (MSA) in an ice core from Law Dome. This chemical is produced by certain species of algae associated with sea ice. The more sea ice there is, the more algae, and the more MSA in the ice core. MSA measurements on the ice core produced a 150 year record of sea ice extent. In order to extend the sea ice proxy into the Little Ice Age, however, we needed to obtain a core at least 500 years old.

Before going into the field to drill this ice core, there were a few considerations. Firstly, we needed to choose a drilling location on Law Dome that gave us low enough snow accumulation to get a 500 year record at around 100 m depth. If we chose the wrong site, we could have been drilling up to 500 m to obtain the 500 year record!

Secondly, we had a small 12-day window of opportunity to visit Law Dome and drill the ice core. This tight schedule required good planning, with a range of options, priorities and backups in case of poor weather and the 'A' (Antarctic) factor. With the help of the Operations Branch, Casey Station personnel and a lucky string of good weather, we were able to travel to the drill site, set up camp, assemble the drill, drill 120 m over eight days, disassemble the drill, and depart on schedule.

VIN MORGAN

ice core

Camp ice core

Vin Morgan monitors the ice core drilling process inside the drill tent.

BARBARA SMITH

TAS VAN OMMEN

Ice core chemist, Mark Curran, measures the ECM of the ice core to determine its age.

To work out when we had reached our target date in the ice core (more than 500 years) we used a technique known as 'electrical conductivity measurement' (ECM). Over the past 600 years there have been two gigantic volcanic events, namely Tambora in 1815 AD and Kuwae in approximately 1458 AD. Volcanic activity deposits acid sulphates in the ice core, which can be measured by ECM.

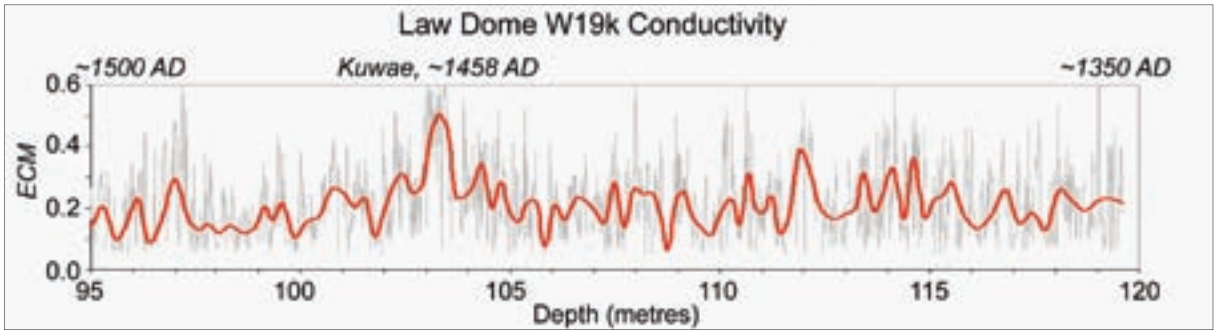
For the drilling season, we modified a laboratory-based ECM instrument that would be easy to use and quick to provide results in the field. The new system worked extremely well in its first field trial, producing an ECM trace within minutes of logging the ice core. It showed the trace corresponding to the Tambora eruption around the depth we expected to see it (32 m) and on day 12 we saw the trace containing the Kuwae eruption (95–120 m). We decided to keep drilling for the rest of day 12 and reached a depth of 120 m, which is dated at around 1350 AD – over 650 years old.

With the retrieval of the ice core completed, the fun part starts – ice core analysis. This analysis will help our team of climate scientists understand the natural changes in the Antarctic climate system through the Little Ice Age period, and to compare the natural warming at the termination of the Little Ice Age with recent warming. Stay tuned…

For more information on this project visit <http://www.aad.gov.au/default.asp?casid=292>

—MARK CURRAN and TAS VAN OMMEN
Ice, Oceans, Atmosphere and Climate Programme, AAD

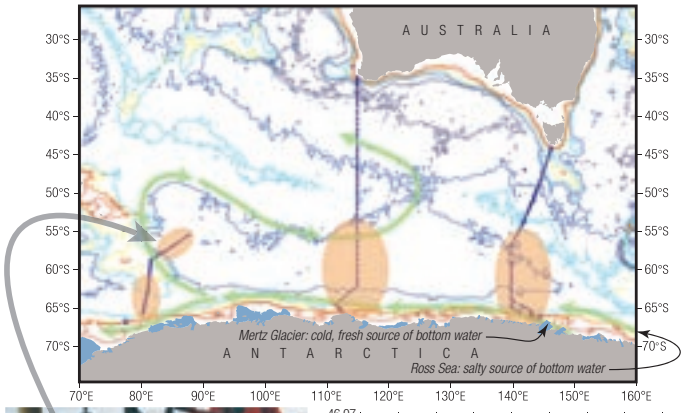
This ECM trace obtained from the ice core extracted between 95 and 120 m detects acid sulphates produced by the Kuwae eruption in approximately 1458 AD.



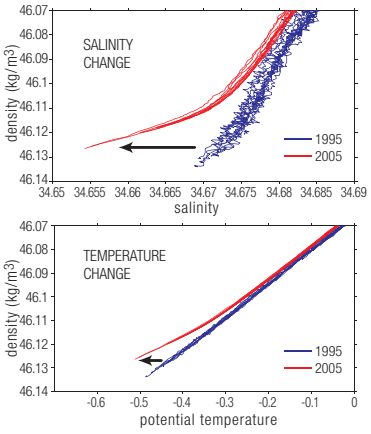
Southern Ocean studies reveal widespread changes

LOCATION OF SOUTHERN OCEAN MEASUREMENTS

The ellipses show where the deep layers of the ocean are cooler and fresher now than they were a decade ago. The green arrows show the path of the deep currents that carry the oxygen-rich bottom water away from Antarctica. The dotted lines indicate the sampling stations.



An array of oceanographic moorings was recovered in the region indicated on the map, adjacent to the Kerguelen Plateau, containing two years of information on current speeds, temperature and salinity.



PETER BOYER/ACE CRC/CSIRO

Schematic showing salinity and temperature change, movement of water, sample sites and mooring recovery.

A two-month marine science and oceanography expedition to the Southern Ocean in January this year, returned home with some surprising results – the deep waters of the Southern Ocean are cooler and less salty than they were 10 years ago.

At every station we sampled in the basin between Antarctica and Australia, the deep waters were 0.015 parts per thousand less salty and 0.1°C cooler than they were 10 years ago. While these changes might seem small, they are 50 times larger than the changes in waters near Perth.

We used to think the deeper layers of the ocean were very stable in their temperature and current patterns. But these new measurements – taken at 4000–5000 m depth – show that the movement of dense (colder and fresher) water produced around the periphery of Antarctica is changing rapidly.

There are two main sources of water supplying the basin – a salty source from the Ross Sea and a fresher source formed near the Mertz glacier in Antarctica. The new measurements suggest that the Mertz glacier may be making a greater contribution to the basin bottom water today, than it did in the past. This change could affect the global pattern of ocean current movement, sometimes called the 'ocean conveyor belt'. This conveyor belt influences climate by carrying heat around the globe, absorbing carbon dioxide and carrying oxygen to the deep ocean.

The challenge now is to understand why the movement of water between the warm, surface waters and cool, deep layers is changing. One possible explanation is that more glacial ice is melting in Antarctica, due to the impact of global warming. But it could also be a natural climate cycle. The next step will be to test our ocean samples to determine the content of glacial meltwater.

—STEVE RINTOUL

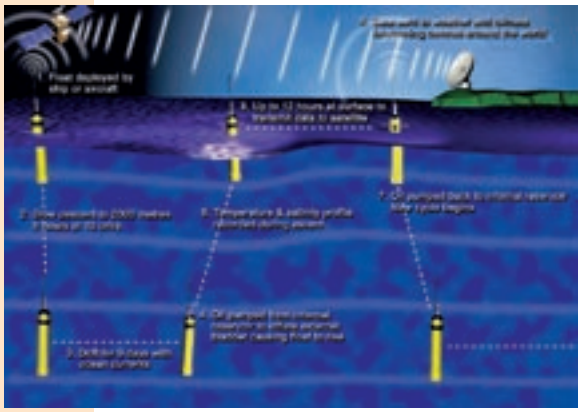
Antarctic Climate and Ecosystems Cooperative Research Centre and CSIRO Wealth from Oceans Flagship

Automated data collectors

Nineteen free-floating ocean robots known as 'Argo floats' were deployed during the Southern Ocean expedition, as part of an international ocean monitoring effort. The floats measure temperature and salinity throughout the water column, between the sea surface and 2000 m below, every 10 days. The information is relayed by satellite to scientists around the world, providing a continuous measure of ocean change; while the drift of the floats provides information on current speeds.

These automated systems will make a huge contribution to our understanding of remote and hostile regions like the Southern Ocean. On voyages like the one just undertaken, we work hard to obtain about 100 ocean profiles over eight weeks – all from one period of the year. The Argo floats will add an additional 190 profiles every 10 days, year-round, and will keep doing so for up to four years.

The expedition also successfully recovered a $1.5 million array of current-meter moorings, measuring the flow of a deep current adjacent to the Kerguelen Plateau. This current carries the dense water produced around Antarctica northward to the world's oceans, as part of a global network of ocean currents that influence the Earth's climate. The moorings had been anchored to the sea floor for two years, measuring current speeds, temperature and salinity. These measurements will allow us to calculate the transport of heat and fresh water for the first time.



CSIRO

JOHN RUNCIE

Shedding light on seaweed

The OctoPAM can measure the photosynthetic rate of macroalgae on the seabed 24 hours a day, using eight pulse amplitude modulated measuring lights. The instrument will help determine whether the absence of macroalgae near the old Casey waste disposal tip is due to contamination or natural environmental conditions.

Supporting scientists in Antarctica requires enormous effort. The activities of many staff at Kingston, the logistics of shipping people across the Southern Ocean and the facilities at our stations, are all necessary to enable scientists to gather information that addresses the important questions of Antarctic science. Thus, anything that increases the ability of scientists to gather data ultimately increases the efficiency of the entire programme. This is particularly true of research that relies on diving under the Antarctic sea ice, as it requires a minimum of five people on site to get a single scientist underwater. The multichannel-PAM (pulse amplitude modulated) fluorometer, a new and innovative piece of scientific equipment developed at the AAD, has been outstandingly successful in increasing our ability to capture data.

The PAM technique is well established in plant science and there are a number of commercial PAM instruments available. However, the new multichannel-PAM is designed to do much more than any off-the-shelf instrument. The PAM technique enables us to measure photosynthetic rates of macroalgae (seaweeds) in their natural environment underwater. It stimulates chlorophyll with a pulse amplitude modulated measuring light and measures how much light is re-emitted as fluorescence. We planned to use the technique to understand why macroalgae do not grow near the old Casey waste disposal tip that drains into Brown Bay and specifically, whether their absence is caused by contamination leaching from the tip, or by other natural environmental conditions.

To maximise the value of every minute underwater, Dr John Runcie conceived of a PAM that could measure eight independent samples simultaneously and could be left on the seabed to run continually for 24 hours, without a diver in attendance. The ability to measure eight samples is important because we need to know how much natural variation there is from one plant to another. The ability to operate around the clock is also important for understanding processes, such as photosynthesis, that vary as light levels change during the course of the day. If this could be achieved we could increase the amount of data from a single dive by nearly 200 times.

The concept became a reality with the help of the talented people in the workshops and design offices of the AAD, and the electronics company Second Harmonic. The prototype, christened 'the OctoPAM', was first deployed in the 2001–02 season at Casey and, after some deft tinkering in the field, was a great success. The ability to measure up to eight samples simultaneously enabled us to confirm that the photosynthetic efficiency of algae under the sea ice declined significantly at midday, even though the maximum irradiance reached only 0.5% of the irradiance on land. This unexpected finding supports the idea that Antarctic algae are well adapted to the low light levels found in sea ice-dominated environments, and take advantage of all the light available as insurance against the possibility that the sea ice might not break up in summer.

The OctoPAM is helping us understand the environmental effects of contaminants from the Thala Valley tip and it may allow us to make predictions about the effects of modified sea ice conditions (created by global climate change) on Antarctic seabed communities.

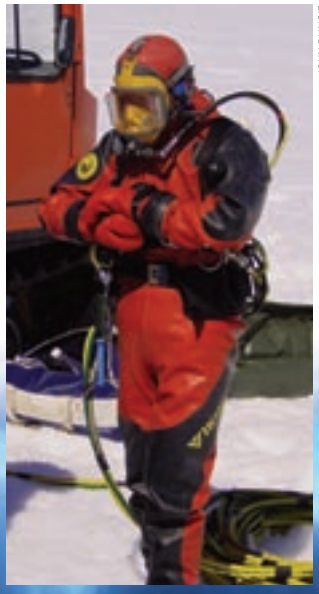
We are now developing the next generation of multi-channel fluorometers, working on a modular basis where sensor heads and logging units are interchangeable. We have increased the amount of replicates from eight to 12 (naturally it is called the DodecaPAM) and are developing a PAM that, on command, can acclimatise a plant to dark conditions before operating. This will enable more sophisticated measurements of the ability of macroalgae to recover from high light stress. It will be used to test the theory that contaminants from the Thala Valley tip reduce the tolerance of seaweeds to high intensity light.

There are few harsher environments on earth for deploying sophisticated electronic equipment than the Antarctic sea. The unique combination of skills and experience of the AAD workshop staff and the engineering consultants they work with, make it possible for scientists to dream up complex experiments to address the important questions of Antarctic science; and for these to be realised.

—MARTIN RIDDLE and JOHN RUNCIE
Impact of Human Activities in Antarctica Programme, AAD

At least five people are required to support divers under the Antarctic sea ice. Here programme leader Martin Riddle prepares to deploy an OctoPAM to maximise the amount of data that can be gathered during the short research season.

Antarctic macroalgae are well adapted to the low light levels under the sea ice.



JOHN RUNCIE

JOHN RUNCIE

This map shows the location of the explosion site in relation to nearby wintering Antarctic stations; Syowa (Japan), Neumayer (Germany) and Molodezhnaya (Russia). The magenta rectangle shows the location of the satellite image of the dust trail. A. KLEKOCIUK, AAD

Cosmic hole-in-one: capturing dust

Picture yourself standing on an ice floe off the Antarctic coast in early spring. The Antarctic continent is about 200 km to the south and the nearest inhabited site is Japan's Syowa station over 900 km east. To catch some warmth, you stand facing the sun, which is low in the north-west. A stiff breeze blows at your back. The wind chill is -30°C.

Instinctively, you turn your head and catch sight of a dazzling second 'sun' moving eastward and trailing a thick cloud of dust. There are two flashes and the fireball quickly fades. Were there pieces of debris falling to the ice in the distance? You watch in amazement as the dust cloud starts to snake away. A minute passes and two thunderous sonic booms ring out across the ice. You have just witnessed the demise of a meteoroid★, roughly the size of a small house and weighing 1000 tonnes – one of the largest pieces of solar system debris to strike the Earth in the past decade.

Fast forward to Davis seven hours later, where the sky is dark and clear. Physicist Joseph Zagari is getting the lidar ready for another observing session. The aim tonight is to probe the stratosphere with laser light to record temperatures during the flight of an ozone-measuring balloon. Joseph has been cleaning some optics and has taken longer than expected to get the lidar fully operating. Finally it's all working. Or is it? A strange signal appears from 30 km up just as the observation starts. Joseph suspects that his cleaning is to blame. He cuts down the received light with a filter and presses on. The strange signal is still there but disappears after 30 minutes. Four hours later the balloon goes up as planned and Joseph packs up and heads to bed.

Alerted by Joseph later that day, we try to find the source of the strange signal. After ruling out instrumental effects, a vapour trail is the prime suspect. We check for stratospheric clouds, satellite re-entries, and close passes by known meteors, but don't find anything. However, the global network of infrasound stations – designed to monitor compliance with the Comprehensive Nuclear Test Ban Treaty – turns up a significant sonic event characteristic of the break-up of a large body high in the atmosphere, which is traced back to the Antarctic coast. Among other sites, the signal has been detected in Germany after propagating a distance of 14 000 km.

Running atmospheric models we start to think that Joseph has scored a cosmic hole-in-one! It looks feasible for dust to

Dust from the meteor explosion on 4 September 2004 was captured by the Davis lidar during Joseph Zagari's ozone observations in the stratosphere. The image shows laser scatter caused by the dust cloud, 28-31 km up, over about one hour. The dust was detected seven hours after the explosion, which occurred 2400 km west of Davis Station. On this scale the normal lidar signal returned from the atmosphere is one unit.

A.R. KLEKOCIUK, AAD

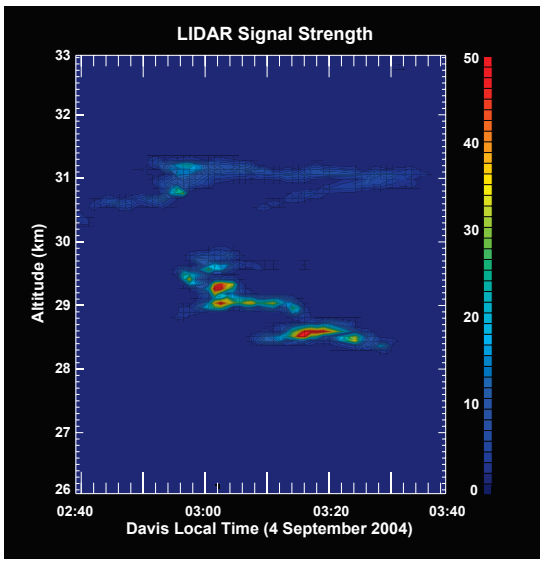
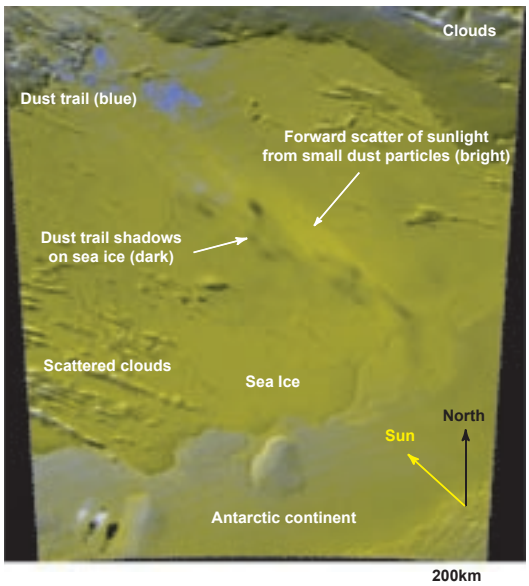


Image from NASA's Aqua satellite of the meteor's dust trail one hour after the meteoroid explosion ('bolide event'). The image has been specially processed to reveal the dust trail, as well as surface shadows and scattered sunlight from the trail. The image is entered at latitude 69°S, longitude 27°E.

A. KLEKOCIUK, AAD; NASA



from a meteoroid's fiery demise

Meteoroid's vital statistics

- 7–10 m diameter;
- Mass of 600 000 – 1.9 million tonnes (the Sydney Harbour Bridge weighs 53 000 tonnes, and the Hoover Dam weighs over 6 million tonnes);
- Energy yield of atmospheric explosion equivalent to 12 000 tonnes of TNT (similar to the yield of the Hiroshima nuclear bomb);
- 'Olivine' composition (magnesium, iron and silica);
- Impact speed of 13 km/s (equivalent to travelling from Hobart to Melbourne in 25 seconds);
- Orbital period: 293 days;
- Frequency of Earth impact by bodies of this size: once per decade.

have been carried over 2400 km from the site of the explosion by high speed winds circling the globe in the stratospheric vortex. Remarkably, these winds are predicted as blowing at speeds of up to 360 km/h – fast enough to explain the time delay between the infrasound and lidar measurements. From our modelling we infer that the cloud must have been remarkably compact by the time it reached Davis, measuring 75 km from east to west and 200 km from north to south. Miraculously, the centre of the cloud passed almost directly over our lidar. Defence satellite sensors put the icing on the cake, revealing precisely the time and point of impact and details of the explosion. This information fits with our atmospheric modelling. The dust cloud is also revealed an hour after the impact at the expected location in high resolution images from civilian satellites.

Delving into the dust

This remarkable event has enabled us to make the first measurements of the dispersal and properties of meteorite dust in the atmosphere. Our measurements tell us several things:

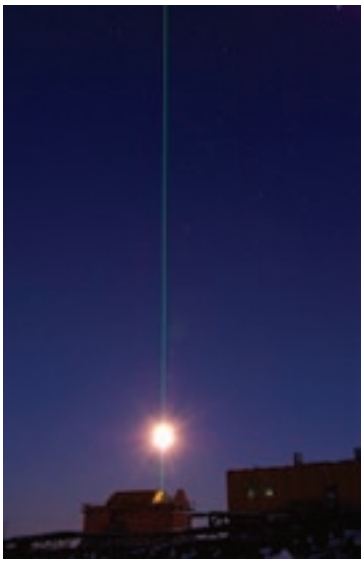
- The dust particles are irregular in shape, but nearly spherical.
- Most of the mass of the dust is due to particles of about one thousandth of a millimetre in diameter.
- The scattering and polarisation properties of the dust suggest it is comprised of olivine, a compound of magnesium, iron and silica that is common to a certain class of meteorites.

Why is this important? Previous research based on theoretical calculations and evaluation of meteorite dust samples collected on the surface (primarily from Antarctic ice), suggested that the fragmentation and ablation (erosion from friction) of meteoroids larger than one millimetre, produced extremely fine dust, typically less than 10 thousandths of a millimetre in diameter. We have shown that for this type of meteor the dust particles are generally much larger. This has consequences (which are yet to be fully explored) for interpreting the surface meteorite dust records, the size distribution of meteoroids encountered by Earth, and the climate effects of a large meteorite impact.

Importantly, our event occurred just inside the Antarctic stratospheric vortex – a region of air that forms over the continent each winter and which is effectively isolated from air at lower latitudes. This means that the dust was confined to the Antarctic region for several weeks, giving the particles time to fall to the surface and be incorporated in the ice record. Thanks to expeditioners at Casey, Davis and Mawson, we have surface samples in which we hope to identify dust particles. These and future samples will be important for confirming the meteor's composition and determining other properties.

The timing and location of the event also allows us to test theories relating to the impact of large meteorites on ozone and climate, as well as validating models of atmospheric circulation. The event deposited the equivalent of three weeks of the global meteorite dust influx in a confined region. While there were no obvious short-term associated changes in regional climate or ozone levels, we are still evaluating the longer term implications. Thanks to Joseph's perseverance, dedication and a sprinkling of good luck, we now have a wealth of new and exciting information to explore.

—ANDREW KLEKOCIUK
Ice, Oceans, Atmosphere and Climate Programme, AAD
—PETER BROWN
University of Western Ontario, Canada
—DOUGLAS ReVELLE
Los Alamos National Laboratory, USA



IAN PHILLIPS

The Davis lidar (pictured with its laser beam bisecting the moon) is used to study the basic properties of the atmosphere from the ground to the edge of space, including winds, temperature, clouds and dust particles. Measurements from the lidar help scientists understand climate and the structure of the atmosphere, and sometimes even the composition of meteorites.

* *meteoroid – mass of stone or metal in space*

meteor – meteoroid that enters the Earth's atmosphere

meteorite – fragments of a meteoroid that reach the Earth's surface

Impression of the view of the bolide (meteoroid fireball) near the explosion site.

D. RATCLIFFE AND A. KLEKOCIUK, AAD

Dodging Armageddon

Every day some 50–100 tonnes of solar system debris enters Earth's atmosphere. Most of this material, which comes from meteoroids and comets, enters at high velocities (several to a few tens of km/s), and friction reduces the material to smaller fragments and gases. We can see this process in action each night – the 'shooting stars' or meteors we see as brief streaks of light in the sky represent the demise of particles that are usually smaller than a grain of sand. If the parent body is sufficiently large, solid fragments can survive to reach the Earth's surface. These fragments are called meteorites and their study has revealed much about the formation of the solar system.

The largest meteoroids often produce spectacular fireballs and sonic booms due to the release of significant energy during disintegration. These so-called 'bolides' are relatively rare events and are caused by meteoroids typically less than one metre in diameter. Two large and well-documented events that have led to the recovery of meteorite material were at Tagish Lake (Canada) in 2000 and the Sikhote-Alin Mountains (Russia) in 1947. These events were due to bodies of about 10 m diameter.

Meteorites larger than 500 m are believed capable of long-lasting disruption to global climate. During human evolution there have been a handful of such events. The most recent occurred 800 000 years ago when a four kilometre-wide meteorite hit the Indochina region. The movies 'Armageddon' and 'Deep Impact' portray the potential consequences of such an event today.

Several groups of astronomers are scanning the skies in an effort to catalogue and track bodies that pose a risk of collision with Earth. Their main goal is to find greater than 90% of all bodies larger than one kilometre in diameter by the end of this decade. However, objects of a few tens of meters across are also of interest. A meteorite this size produced the largest recorded natural atmospheric explosion near the Tunguska River, Siberia, in 1908. This event devastated a sparsely populated region over 2000 km^2 in area.

To date, the smallest object detected beyond the Earth is the five metre-wide 2003SW$_{130}$. However, at the time of discovery it had passed the point of closest approach. It is extremely difficult to provide any advanced warning of bodies this small, because the objects need to be close by to be detectable and not in the line of sight to the Sun or full moon. As for those rocks that enter the atmosphere unannounced; at this stage we'll just have to hope that the bits land somewhere else.

Further information:

Klekociuk AR, Brown PG, Pack DW, ReVelle DO, Edwards WN, Spaulding RR, Tagliaferri E, Yoo BB. and Zagari J. Detection of Meteoric Dust from an Asteroidal Airburst. *Nature* (in press).

The Tunguska explosion <http://www-th.bo.infn.it/tunguska/>

The Sikhote-Alin meteorite <http://www.meteoritearticles.com/saarticle.html>

The Tagish Lake meteorite <http://aquarid.physics.uwo.ca/~pbrown/tagish/>

NASA's Near Earth Object Program <http://neo.jpl.nasa.gov/neo/ >

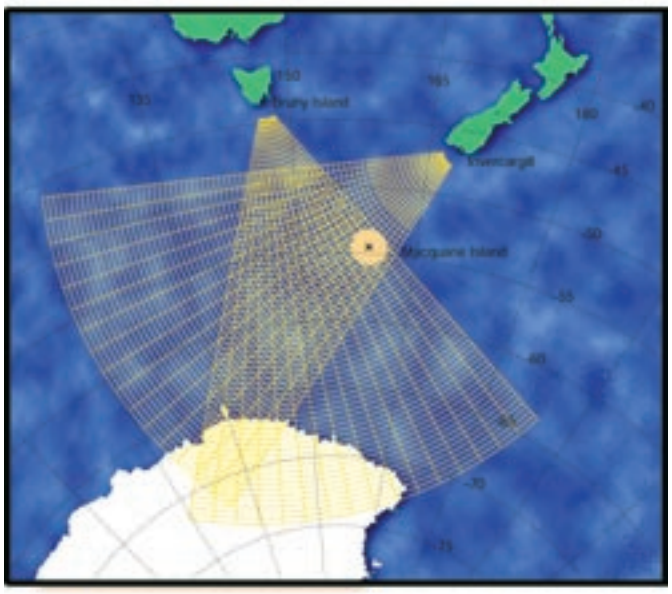
Impact craters on Earth; http://www.solarviews.com/eng/tercrate.htm).

Gallery of images from the Moderate Resolution Imaging Spectroradiometer instrument on NASA's Aqua and Terra satellite <http://modis.gsfc.nasa.gov/gallery/>

New space weather

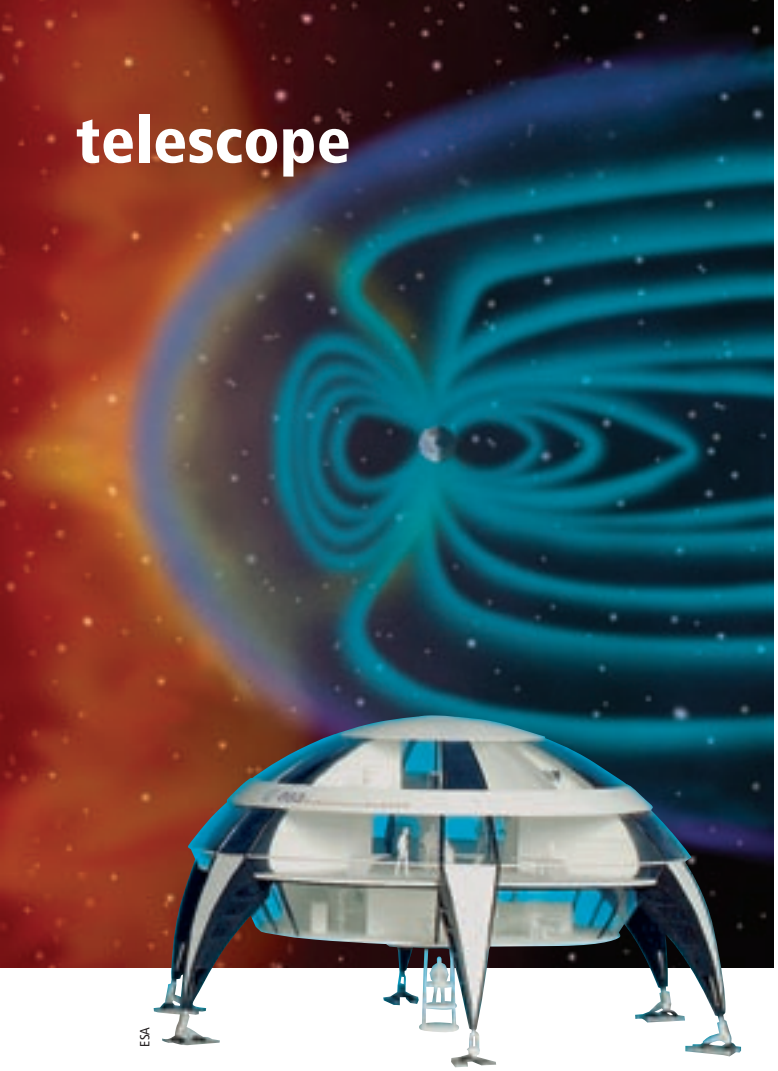
ESA & NASA

The new space weather telescope at Greifswald will warn of sun activity, such as coronal mass ejections (CME). Here a CME blasts off the sun's surface. If travelling in the direction of Earth, after two to four days the CME cloud strikes and is mostly deflected around the Earth's magnetosphere. The magnetic cloud of plasma can extend to 30 million miles wide by the time it reaches Earth. The geomagnetic storms that result from such events can disrupt communications and navigational equipment, damage satellites, and cause black outs.



RYAN HEALY AND DANNY RATCLIFFE

MARK GENTILE



A new space weather telescope will be built in Greifswald, Germany, this year, as part of the European Space Agency's space weather programme. It will join an international network of telescopes – in Australia, Japan and Brazil – monitoring the activities of the sun, in particular coronal mass ejections. These ejections of charged particles (plasma) can cause geomagnetic storms on Earth, damaging communication satellites, power supplies and electronic equipment, and exposing astronauts or passengers in high-flying aircraft to radiation.

The telescope network will allow scientists to forecast the arrival of plasma clouds on Earth up to 24 hours in advance. This will enable potential risks to Earth's infrastructure and human health to be minimised.

The 'muon space weather telescope for anisotropies at Greifswald' (MuSTAnG) will be built by the University of Greifswald and a number of international collaborators including the AAD and Shinshu University in Japan. MuSTAnG will deliver real time information about sun activity to the German Aerospace Centre. It may also support tourism in northern regions by improving the predictability of the polar lights.

—MARC DULDIG
Ice, Oceans, Atmosphere and Climate Programme, AAD

Model of the building in which the MuSTAnG will be housed in Greifswald.

Radars map atmospheric phenomena

A second high frequency Tasman International Geospace Environment Radar (TIGER) was commissioned this February at Awarua near Invercargill, New Zealand. The radar, named 'Unwin' after New Zealand scientist Dr Bob Unwin – a pioneer in auroral radar development – will operate in tandem with the original radar established on Bruny Island, Tasmania, in 1999 (*Australian Antarctic Magazine* 1:27–28). Together, they will map the motions of aurora, meteors and ocean waves in the southern hemisphere.

TIGER operates as a stand-alone dual radar system, but is also part of the international Super Dual Auroral Radar Network, operated by ten nations, which covers southern and northern polar atmosphere regions. The radars survey the ionosphere, 100–300 km above the Earth, to provide measurements of the aurora australis and other phenomena. The information they provide will improve our knowledge of space weather processes, allowing us to better manage radio communications, navigation systems, satellite operations and magnetic mineral surveys. The radars can also derive ocean wave motion from backscattered sea echoes and detect echoes from meteors, which are used to calculate wind speeds at heights around 100 km.

TIGER is operated by a consortium of Australian research institutes headed by La Trobe University and including Monash University, University of Newcastle, AAD, IPS Radio & Space Services, British Antarctic Survey and the Defence Science and Technology Organisation.

—RAY MORRIS
Ice, Oceans, Atmosphere and Climate Programme, AAD

—PETER DYSON
Department of Physics, La Trobe University

The Bruny Island and Unwin radar beams intersect above Macquarie Island, enhancing the value of ground-based experiments on the island. The overlapping radar beams provide accurate velocity measurements of aurora motion within the ionosphere.

The transmitting and receiving antennas of the Unwin radar facility opened on 11 February 2005 in New Zealand. The radar operates at high frequency, between eight and 20 MHz and uses 300 m-long antenna arrays to probe a 52° azimuth sector, with a range from 200–3000 km south.

A developing programme for the International Polar Year

The International Polar Year (IPY), running from March 2007 – March 2009, promises significant advances in polar research. The international programme of coordinated, interdisciplinary scientific research in the Arctic and Antarctic is outlined in A Framework for the International Polar Year at <http://www.ipy.org/development/framework/>.

The IPY is not a stand alone concept, but provides a framework for existing polar activities to plan intensive, coordinated observations over a short period and within six major themes:

- determine the present **environmental status** of polar regions;
- quantify and understand **change** in the polar regions;
- advance our understanding of **connections** between the poles and the rest of the globe;
- investigate the **frontiers** of science in the polar regions;
- use the unique **vantage point** of the polar regions to investigate from the Earth's inner core to the Sun and the cosmos beyond; and
- investigate the **cultural, historical, and social processes** of circumpolar human societies.

There was an overwhelming response by the research community to a call for 'expressions of intent' for IPY projects last year. By the January 2005 deadline, about 880 expressions of intent were received, 60% of which were for Arctic projects, 25% for Antarctic, and 15% for bipolar. The largest numbers of proposals were from biologists (165), glaciologists (145), meteorologists/climatologists (115) and geoscientists (110). About 90 proposals dealt with oceanography, 90 with social science, and smaller numbers with space science, education and data management.

The scope of the expressions of intent ranged from highly coordinated and internationally managed proposals, requiring considerable logistic support; to smaller collaborations between a few investigators. Many of the smaller proposals have synergies with the larger ones and it is envisaged that the IPY implementation will bring these proposals together.

Australians are leading three large, international Antarctic proposals:

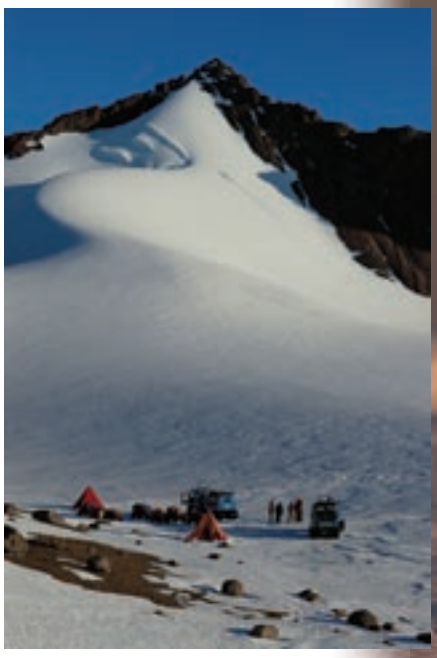
- *A Census of Antarctic Marine Life* (page 11);
- *Role of Antarctica and the Southern Ocean in Past, Present and Future Climate* – an oceanographic, meteorological, glaciological and biogeochemical project in the Southern Ocean and its margins; and
- *Geoscientific Insights of Greater Antarctica in the area from Gamburtsev Mountains, Amery Ice Shelf to Prydz Bay* – a multinational geoscientific project concerned with Earth evolution.

A Joint Committee for the IPY, sponsored by the International Council for Science and the World Meteorological Organisation, has been established to provide overall scientific planning, coordination, guidance and oversight. This committee met for the first time in March 2005, to assess the expressions of intent against IPY selection criteria, and to cluster them into a lesser number of large-scale and truly international core activities. About 40–50 expressions of intent were identified as possible 'lead projects' around which other proposals can be clustered or synchronized to form IPY core projects.

An international project office has also been set up to support IPY planning. This is funded by the UK Natural Environment Research Council and located at the headquarters of the British Antarctic Survey in Cambridge. An executive director of this office will be appointed soon.

While the large numbers of proposals submitted for IPY demonstrate the exciting opportunities for polar science, there may not be adequate resources (money or logistic infrastructure) for all the proposed projects to be undertaken within the short IPY period. IPY is not a funding agency and the management and implementation of IPY projects will need to be funded from various national or bilateral sources. A number of nations have already committed additional and specific research funds for IPY, but many more (including Australia) have not yet done so. More effort and planning is required before much of IPY becomes a reality, but the enthusiasm and commitment of the polar research communities will ensure that IPY does lead to significant new advances.

—IAN ALLISON
Co-Chair, Joint Committee for the International Polar Year



WADE FAIRLEY

Census of Antarctic Marine Life

The advent of the IPY in 2007–08 and the international Census of Marine Life currently underway <http://www.coml.org> provides the context for a Census of Antarctic Marine Life (CAML) to begin. CAML is approved by the Scientific Committee on Antarctic Research as an integral part of its Evolution and Biodiversity in Antarctica programme, and will be coordinated by the AAD using a five-year grant provided by the Alfred P Sloan Foundation in New York. A project manager, funded by the grant, has recently taken up duties in the AAD Science Branch.

The census will determine species biodiversity, abundance and distribution in as many places around Antarctica as we have ships available. Attention will be directed towards the animals of the sea floor; on the continental slope and in deep waters; under recently collapsed ice shelves; and in the upper sunlit zones where plankton abounds. Other surveys will focus on krill, whales, seals and sea birds. The census will employ the latest sampling and analytical techniques, including molecular biological assessment of biodiversity through the Barcode of Life programme <http://www.coreocean.org/Dev2Go.web?id=263292>. Remote video imaging will also be used to yield images of this fascinating and virtually unknown ocean realm.

CAML has been assigned preliminary IPY recognition as a core project. In the next 12 months work will begin to secure ship time and to build the detailed plans for the largest Antarctic marine project ever undertaken.

—MICHAEL STODDART
Chief Scientist, AAD

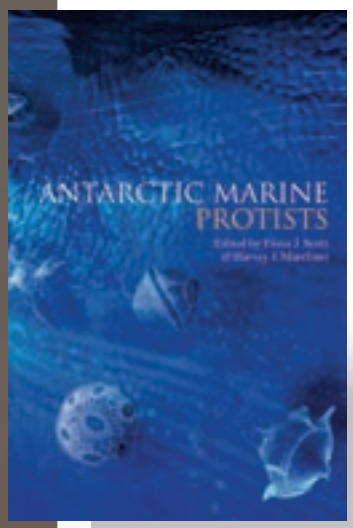
The International Polar Year will provide a framework within which researchers from different disciplines and countries can join forces to investigate questions at the frontiers of polar science.

FIONA SCOTT

THOMAS PICKARD

Antarctic marine protists captured in new book

Protists are arguably the most important organisms in the world's oceans. These microscopic, single-celled plants (phytoplankton or algae) and animals (protozoa) comprise the base of the food web on which, essentially, all other marine life depends. Along with bacteria, they make up more than 95% of the biomass of living organisms in the sea. Marine protists also play a major role in the global carbon cycle, absorbing about 50% of the carbon dioxide produced by living things and producing about 50% of the oxygen we breathe. Some species even produce chemicals which, when released to the atmosphere, promote the formation of clouds.



VANESSA TUCKER

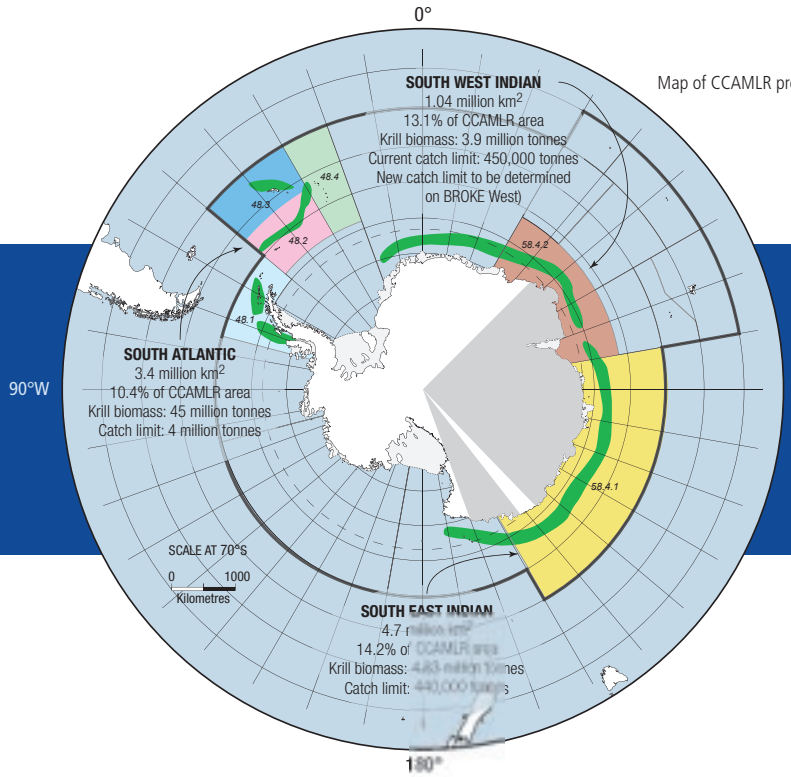
At the level of single-celled organisms the distinction between plants and animals blurs, because of the strategies used to gain nutrients for growth. Plants derive their energy from sunlight, via photosynthesis, while animals gain theirs by consuming other organisms or organic detritus. While protists share these characteristics with either plants or animals, they also differ in many ways. For example, many phytoplankton can feed on bacteria and other algae, while several protozoa that usually graze on other single-celled organisms, generate their own food via photosynthesis. They do this by eating algae and digesting everything except the photosynthetic machinery (chloroplasts), which they sequester in special vesicles.

Protists range in size from less than a micrometre (one thousandth of a millimetre) to over a millimetre, and can only be identified with a light or electron microscope. However, what they lack in size they make up for in species diversity and abundance – with concentrations reaching millions of cells per millilitre of seawater.

The recently published book, *Antarctic Marine Protists*, edited by Fiona Scott and Harvey Marchant of the AAD, describes over 550 species of protist from south of the Antarctic Polar Front. The book was published jointly by the Australian Biological Resources Study and the AAD. It draws together information from the widely dispersed literature and provides descriptions, illustrations and a comprehensive bibliography of these unique organisms.

—HARVEY MARCHANT
Adaptations to Climate Change Programme, AAD

Approximately 40 species of the marine dinoflagellate genus *Protoperidinium* have been recorded from Antarctic waters. This is a scanning electron micrograph of *Protoperidinium incognitum*.



Map of CCAMLR precautionary catch limits for krill (2005) PETER BOYER/STEVE NICOL

Past krill fishing operations

Australian Antarctic Territory

CCAMR boundary

It's BROKE... again

One of the largest ventures of the Australian Antarctic programme will kick off next summer, in a bid to establish accurate catch limits for krill in the Southern Ocean. BROKE-West (Baseline Research on Oceanography, Krill and the Environment) will survey over 1 million km² of ocean between 30° and 80° east in a region designated by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) as Division 58.4.2 (see map). The survey will repeat krill abundance measurements made in 1981, which established a precautionary catch limit of 450 000 tonnes per year. Since that time, however, the methodology and acoustic technology used for estimating krill abundance has changed considerably and doubts about the validity of early estimates have arisen.

As an expanding krill fishery is one of the greatest potential threats to the Antarctic ecosystem, it is prudent to ensure that catch limits in the area of Australia's national interest are based on the best scientific information available. Additionally, there is evidence from other areas of the Antarctic that considerable changes have been occurring in the marine ecosystem over the last 30 years. Consequently, in 2000, plans were laid to conduct a new survey of Division 58.4.2.

BROKE-West will follow in the footsteps of its 1996 predecessor, BROKE, which described krill distribution and abundance in CCAMLR Division 58.4.1 (South East Indian sector). While BROKE-West has been designed around the need to estimate krill distribution and abundance, it is also an opportunity to conduct large scale oceanographic experiments and to collect a suite of ecological information about this little visited stretch of the Antarctic coastline. The dataset will mimic that collected on the 1996 voyage, providing an integrated dataset which will stretch around one third of the Antarctic coast. The results will be used by the Antarctic Climate and Ecosystems Cooperative Research Centre to help determine the relationships between the physical environment and biological processes.

The BROKE-West voyage will sail from Fremantle in early January and begin sampling in the far west of the Division, at 30°E, conducting 11 transects as it moves eastwards, following the direction taken in the original BROKE survey. On every second transect there will be detailed oceanographic and biological sampling of the water column at fixed stations, using nets and oceanographic samplers (measuring salinity and temperature with depth). On all transects, continuous measurements will be conducted using underwater samplers and acoustic (echo-sounding) equipment. Observations of the abundance of seals, birds and whales will be carried out during daylight hours.

Fittingly, BROKE-West will take place during the 25th anniversary of the commencement of the Australian Antarctic marine research programme. It also occurs ten years after the original BROKE survey and many of the original 45 participants in that voyage are likely to devote the summer of 2006 to toiling up and down the Southern Ocean in search of the elusive krill.

—STEVE NICOL
Programme Leader, Southern Ocean Ecosystems, AAD

In 1981 the *Nella Dan* made her debut in the field of marine science, after a significant refit to allow her to undertake marine biological and oceanographic tasks. Her first voyage was part of the international Southern Ocean program BIOMASS (Biological Investigations of Marine Antarctic Systems and Stocks), which aimed to determine the standing stock of krill around the Antarctic continent. Since then, the methodology and acoustic technology for estimating krill abundance has improved. BROKE-West will repeat the krill measurements made in the South West Indian sector in 1981 which, in 1992, was used by CCAMLR to establish a precautionary catch limit of 450 000 tonnes.

STEPHEN BROWN

JEREMY SMITH

Roger Handsworth lowers a tide gauge at Casey Station.

Tsunami detected at Antarctic stations

The effects of the Aceh earthquake on 26 December 2004, and the subsequent tsunami in the Indian Ocean, were detected by tide gauges at Mawson, Casey and Macquarie Island about 12 hours after the earthquake. The tsunami travelled at approximately 720 km/h.

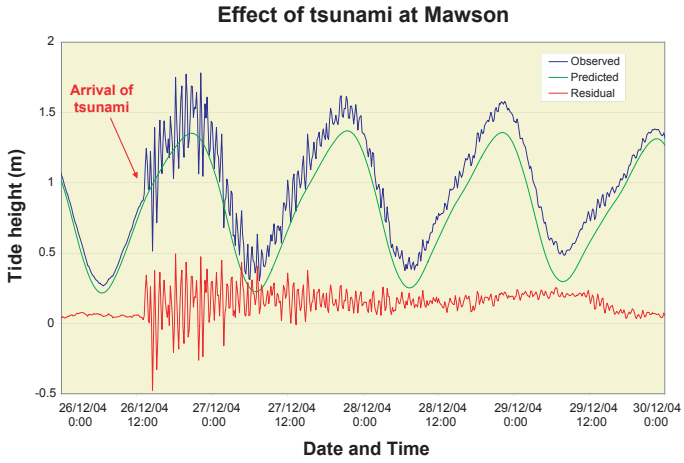
While the effects in Antarctica and the Southern Ocean were small compared to the tragic consequences in nearby coastal areas, detection of the tsunami many thousands of kilometres from the earthquake's epicentre reveals the enormous energy released by the event.

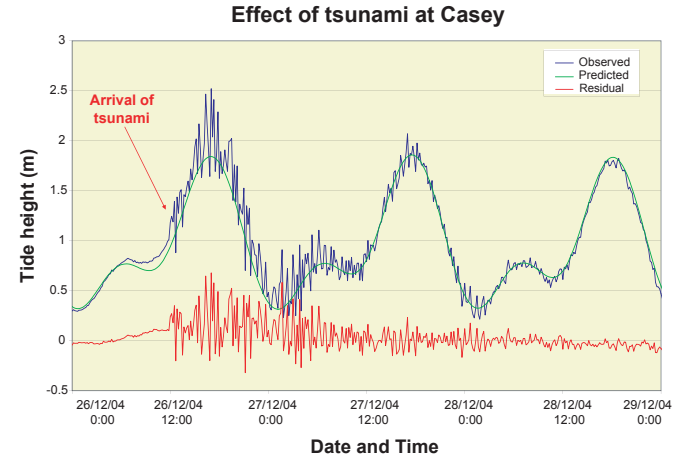
The records showed that after the tsunami hit, there was an increase in tide height of about 500 mm at Mawson, 600 mm at Casey and 200 mm at Macquarie Island. These higher tides continued for several days at Mawson and Casey and about 18 hours at Macquarie Island. Mawson is around 8300 km from the earthquake epicentre, while Macquarie Island is around 9000 km distant. Anecdotal evidence at Casey suggests that the tsunami pushed the ice up the wharf road by several metres.

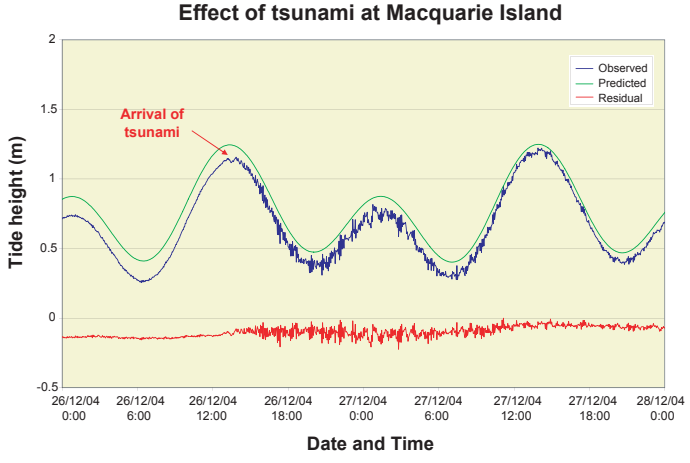
For the past 10 years the AAD has been operating tide gauges at its stations on Macquarie Island, Casey, Davis and Mawson and at the Chinese station Zhongshan, with a view to measuring long-term sea level change and establishing accurate data for shipping operations, charting and mapping. The gauges are accurate to the millimetre and can detect changes in sea level due to storm surges and earthquakes. The tide gauges at Mawson and Macquarie Island are linked via radio modems, landlines and satellite to the AAD headquarters, where they can be downloaded in real time.

For more information on tsunamis visit the National Oceanographic and Atmospheric Administration website <http://www.noaa.gov>. For tsunami propagation around the world visit <http://www.pmel.noaa.gov/tsunami/Mov/indo_gl2.mov>. For maximum computed tsunami heights around the globe visit <http://www.pmel.noaa.gov/tsunami/indo20041226/max_global.pdf >. The site shows peak effects of the tsunami at Heard Island and the Mawson and Casey regions.

—HENK BROLSMA
Australian Antarctic Data Centre, AAD







The charts show the tidal record at Mawson, Casey and Macquarie Island before and after the earthquake. The green, regular wave is the predicted tide – from previous tidal observations we can predict the time and the height of tides to a reasonable degree of accuracy, barring storm surges and extreme lows in the weather systems. The dark blue wave is the observed tide. The irregular red wave ('residual') at the base of the chart shows the difference between the predicted tide and the observed tide. Note how small the difference between the predicted and observed tides is before the tsunami and the rapid increase after the tsunami arrives.

Weddell seals make more kinds of sounds than any other seal. At Davis station alone, Weddell seals have been recorded using 50 distinct underwater call types, including what are colloquially described as 'trills', 'tones', 'mews', 'whistles', 'chirps', 'chugs', 'grunts', 'roars', 'knocks' and 'clicks'.

For the past 15 years our team at the University of New Brunswick has been studying Weddell seal vocal behaviours in collaboration with the AAD, to understand how the seals communicate and as an indicator of broader behaviours. An understanding of call types, for example, may help us determine seal distribution and which populations are isolated from each other. By understanding the normal vocal behaviours we may also be able to monitor seal responses to humans or other disturbances.

Our research has shown that most calls are made between 10 and 40 m under the ice, to avoid transmission interference associated with the under-surface of the ice. This relatively shallow calling depth indicates that most social interactions occur near the surface and that during the day many of the seals would be able to see the intended recipient of their call.

Calls are produced in the larynx and do not change with depth. The maximum calling depth in deep water off Mawson was 126 m. Calls are also broadcast in a very directional manner, beaming downward and forward from the throat. This should give seals an opportunity to direct their calls towards specific listeners.

The loudest calls are trills (long pure tones or frequency modulated whistles), that start out at a high frequency (often above 20 kHz) and drop down to 80 Hz. These calls can theoretically be detected over 25 km away, if the water is deep and covered by sea ice. Trills have been linked to male seals, but other common call types are made by both males and females. Males use trills to defend breathing holes during the winter and breeding territories in the spring. Some males produce highly stereotyped sets of call sequences (songs) which may enable them to identify themselves on an individual basis.

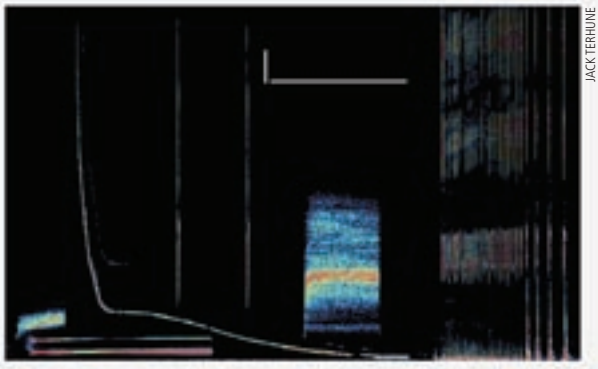
Weddell seals tend to remain near where they were born. This has led to the formation of 'dialects' and the seals at Casey, Davis and Mawson all exhibit a few different call types and usage patterns. These differences suggest that some aspects of the calls are learned and that the seal groups are not interbreeding.

Despite the large number of calls at some breeding sites, seals do not 'jam' or 'mask' each other's calls. Rather, they space the timing and/or pitch of their calls so that they do not overlap each other. Like king penguins calling for their mates, Weddell seals are 'courteous' and do not call at the same time, or pitch, when a neighbour is calling.

One difficulty of studying Weddell seal vocal behaviours is that we usually cannot see the seals that are making the calls, or the behavioural situation that is occurring. By continuing to eavesdrop and, in the future, by including underwater video and on-ice observations, we hope to learn more about what the seals are doing and where and ultimately, determine the relationship between vocalisations, natural behaviours, distribution and population numbers.

—JACK TERHUNE
University of New Brunswick, Canada

A sound spectrogram showing the different underwater calls made by Weddell seals. The call types are, from left, a middle roar, tone (horizontal lines), trill, two ascending whistles, high roar, 28 ascending whistles and four pairs of ascending whistles and grunts. The amplitude of the call is depicted by the colour. The frequency (Y axis) goes from 0-10.9 kHz. The X axis shows the duration of each call. The vertical white bar is 1 kHz and the horizontal white bar is 10 seconds.



JACK TERHUNE

JACK TERHUNE

Call of the Weddell

POLICY

Agreement on the Conservation of Albatrosses and Petrels

Albatrosses and some of the larger petrels of the southern hemisphere are among the most threatened birds in the world. The international Agreement on the Conservation of Albatrosses and Petrels (ACAP) came into force on 1 February 2004, with the aim of achieving and maintaining favourable conservation status for defined albatross and petrel species. The First Session of the 'meeting of Parties' to ACAP was held in Hobart from 10–12 November 2004.

The meeting was attended by five of the six Parties which have currently ratified the Agreement: Australia, New Zealand, the Republic of South Africa, Spain and the United Kingdom. Three 'Signatory' states (Argentina, Brazil and France) and three 'Range' states (states through which albatrosses and petrels range – Namibia, Norway and the United States) were also present, as well as representatives from 10 non-government organisations.

Australia has acted as interim Secretariat for ACAP since February 2001 and at the meeting, offered to host the Secretariat permanently in Hobart. The offer was greeted with unanimous support and a process for the establishment of the Secretariat was agreed. Australia will continue to provide the interim Secretariat until the permanent Secretariat is established.

An Advisory Committee was also established to provide scientific, technical and other advice to the meeting of Parties. The committee will have a role in guiding the implementation of the action plan for the Agreement and ensuring that ACAP is effective and influential internationally.

As required under the Agreement, Parties agreed on criteria to define emergency situations for albatrosses and petrels and assign responsibility for action. An emergency situation is: *an unexpected event that threatens albatrosses and petrels at the population level; requires urgent conservation measures; is of such magnitude that it exceeds the immediate capacity of the affected country to adequately respond; and for which international resources and/or assistance are required.* The emergency criteria were agreed as interim measures and referred to the ACAP Advisory Committee for further consideration.

Mortality from interactions with fishing vessels is the most serious threat to albatrosses and petrels and is a chronic threat, rather than an acute situation to be addressed by emergency criteria. Fisheries interactions were accordingly identified as a priority issue to be addressed under the ACAP action plan. Much work has been undertaken and is ongoing to mitigate adverse effects of fishing activities on albatrosses and petrels. To avoid duplication, the Advisory Committee will be tasked with making recommendations for the integration of ACAP with existing initiatives so as to enhance and advance them.

Establishing effective and positive influence on regional fisheries monitoring organisations is a key challenge. Offers of collaboration have already been received from the Commission for the Conservation of Antarctic Marine Living Resources and the Commission for the Conservation of Southern Bluefin Tuna; and two organisations with ongoing programmes of liaison with regional fisheries monitoring organisations, to promote seabird conservation – BirdLife International and the Southern Seabird Solutions Trust.

Other priority actions identified under the ACAP plan relate to the protection of breeding sites, in particular the adverse effects on albatrosses and petrels of non-native species introduced to some breeding areas.

Australia will host the first meeting of the ACAP Advisory Committee in Hobart in July 2005. The meeting will hear progress reports from working groups established to review the status and trends of albatrosses and petrels covered by the Agreement (in collaboration with the Scientific Committee on Antarctic Research Group of Experts on Birds); and to establish an agreed taxonomy for albatrosses in consultation with relevant experts.

The challenge now is to build on the consensus and co-operation achieved at the first meeting so that progress can be made towards the goals of ACAP. Because of the small number of Parties currently signed up, the funding for the Agreement is modest. The Secretariat will therefore aim to promote ACAP and encourage more Signatory and Range states to ratify the Agreement. The second meeting of Parties is due to take place late in 2006 and the UK hopes to host this meeting.

To find out more about ACAP please visit <http://www.acap.aq> or contact Barry Baker or Helen Riley at the interim Secretariat: barry.baker@aad.gov.au; Ph: +61 3 6232 3407.

—STEVE CAMPBELL and HELEN RILEY
Interim Secretariat to the Agreement on the Conservation of Albatrosses and Petrels

The international Agreement on the Conservation of Albatrosses and Petrels aims to achieve and maintain favourable conservation status for a range of albatross and petrel species including this wandering albatross, *Diomedea exulans*. CHRISTOPHER CLARKE

Addressing fisheries-related mortality of albatrosses and petrels – mainly the incidental capture of birds on hooks set by longline fishing vessels – is a priority of the Agreement on the Conservation of Albatrosses and Petrels (ACAP). The Australian Government meets its obligations to achieve this through the *Threat Abatement Plan for the incidental catch (or by-catch) of seabirds during oceanic longline fishing operations*, under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Planning to protect albatrosses and petrels

The Threat Abatement Plan was prepared in response to the listing of longline fishing as a Key Threatening Process under the EPBC Act. The plan aims to significantly reduce the bycatch of seabirds during oceanic longline operations in the Australian Fishing Zone at current fishing levels.

In practical terms this means:

- supporting research and development of new mitigation measures;
- ensuring (through legislation and education) that effective mitigation measures are used;
- collecting and analysing data to assess the effectiveness of existing measures and improve the knowledge of seabird–longline interactions; and
- educating the community, stakeholder groups, longline operators and international forums.

The Threat Abatement Plan targets areas where current research shows interactions between longline fishing operations and seabirds is most likely. It applies to all such fishing operations in the Australian Fishing Zone (see map), with mitigation measures mandatory in areas south of 30°. Until recently it was believed that at-risk bird species seldom ventured north of this range. However, the limit has now been extended in response to a number of seabird captures during longlining operations north of 30°, and satellite tracking research that shows some seabird species have larger foraging ranges than previously thought. Mitigation measures will soon be applied by all longline vessels operating south of 25°.

Key mitigation measures proposed under the Threat Abatement Plan aim to minimise the interaction between baited hooks and foraging seabirds by making the baits unavailable or unattractive. They include:

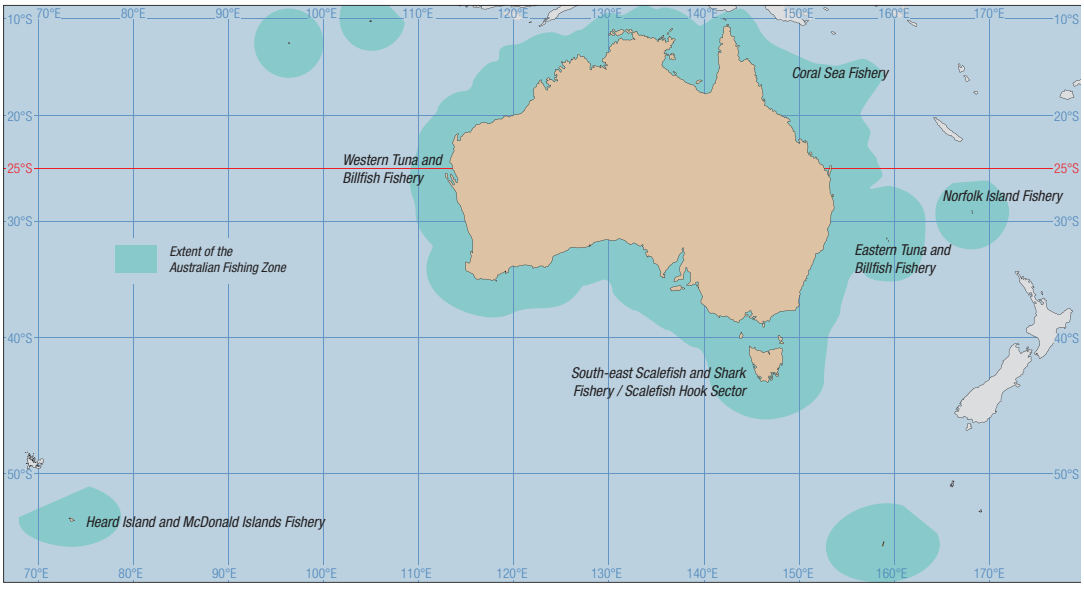
- **Night setting and area/seasonal closures**
  Setting of longlines is restricted to the hours between dusk and dawn, when many seabirds do not forage. In appropriate circumstances, fishing areas are closed during times or at locations where seabird-foraging activity is high.
- **Weighting of main lines and/or branch lines**
  Weight is added to fishing lines to ensure that baited hooks sink rapidly out of the reach of seabirds.
- **Single or twin bird-scaring lines**
  Bird-scaring or 'tori' lines suspended over the area in which baits are set and hauled, can substantially reduce interactions with some bird species.
- **Offal management strategies**
  Strategies to reduce the bird-attracting practice of discarding offal and fish scraps include discharging offal at times other than line setting and hauling, and discharging offal from a point that minimises its availability to birds.

Other mitigation measures include puncturing the swim bladders of bait and thawing bait to speed sinking, using

KIERAN LAWTON

Black-browed albatross, *Thalassarche melanophrys*

The Threat Abatement Plan applies to all longline fisheries in the Australian Fishing Zone, with mitigation measures expected to be mandatory south of 25° soon. The fisheries indicated on the map are areas where seabirds are most threatened.



AUSTRALIAN FISHERIES MANAGEMENT AUTHORITY/PETER BOYER

GRAHAM ROBERTSON

A range of conservation measures and changes to longline fishing practices are helping to protect petrels and albatrosses, such as these black-browed albatrosses (*Thalassarche melanophrys*), from threatening processes.

underwater bait-setting devices, and using devices such as streamers to protect the catch from birds as it is being hauled aboard.

As our understanding and ability to mitigate fisheries–seabirds interaction grows, we will be able to move towards the goal of achieving zero bycatch of seabirds. By developing and refining bycatch mitigation methods, Australia can contribute to the implementation of the ACAP by providing other 'range' states (states through which albatrosses and petrels range) with examples of good practice, and encouraging the uptake and implementation of these measures across the entire area of the birds' distribution.

The current seabird bycatch Threat Abatement Plan, introduced in 1998, is under review. A key aim for 'version two' is to ensure there is flexibility to adequately respond to changing circumstances – for example, if seabird mortality in a particular area of the Australian Fishing Zone temporarily exceeds levels prescribed under the Threat Abatement Plan.

All of the ACAP-listed species that breed in Australia or forage within the Australian Fishing Zone are targeted by a recovery plan, which was introduced in 2001. The plan sets out a number of actions required to achieve its objectives. These include addressing seabird bycatch through the Threat Abatement Plan and other priority actions identified under the ACAP – in particular ensuring the protection of albatross and petrel breeding sites. Published Threat Abatement Plan and Recovery Plan documents are available through the Department of Environment and Heritage website.

Threat abatement plan:

<http://www.deh.gov.au/biodiversity/threatened/publications/tap/longline/legislative.html>

Recovery plan:

<http://www.deh.gov.au/biodiversity/threatened/publications/recovery/albatross/>

—CATHY BRUCE
Antarctic and International Policy, AAD

Antarctic tourists support seabird conservation

The International Association of Antarctic Tour Operators (IAATO) is a 69-member organisation dedicated to sustainable private-sector tourism in Antarctica and the subantarctic. Each year more than 20 000 tourists visit Antarctica with IAATO, with most people travelling by cruise ship. As part of their onboard entertainment, passengers are given a series of lectures by ship staff on subjects ranging from Antarctic clothing to international law and the Antarctic Treaty. In 2002 the AAD provided IAATO with a lecture titled 'seabird conservation in fisheries'. The lecture informs passengers about seabird mortality occurring in longline and trawl fisheries operating in the southern hemisphere, and raises money for conservation efforts. Donations are sent to Birds Australia, the Melbourne-based partner to Birdlife International. The lecture and the fund raising drive fall within the gambit of Birdlife's Save-the-Albatross campaign, a global initiative to reduce the number of albatrosses and petrels that die from interactions with fishing gear.

Each year the availability of funds raised during the previous summer's cruise season is advertised on the internet and Birdlife's web site. Applicants are invited to submit proposals addressing three themes: actions to reduce seabird mortality in fisheries, ecological research on fisheries-vulnerable seabird populations and political actions that underpin conservation efforts. Proposals are assessed by a 10-person advisory group consisting of specialists from Argentina, Chile, Falkland Islands, UK, Spain, USA, New Zealand and Australia. The winning applicants are notified of their award in August each year and funds are distributed via Birds Australia in September. This coincides with the commencement of the breeding season for southern hemisphere seabirds, when many sea-based and land-based conservation projects are likely to commence.

In 2002, the first year of the lecture, passengers donated US$5000 to the campaign. This grew to US$20 000 in 2003 and US$54 000 in 2004. The advisory group has used these funds to support seabird conservation projects in South Africa, Peru, Argentina, Uruguay, the Falkland Islands and New Zealand. Projects include: the development and testing of longlines that sink quickly and minimise the incidence of seabird capture; development of devices to prevent fatal collision by seabirds with trawler net cables; and assessment of seabird mortality levels in critical southern hemisphere fisheries.

Projects such as these directly and indirectly help reduce the number of seabirds that die needlessly each year in the world's oceans. Passengers onboard IAATO vessels have contributed substantially to efforts to make fisheries more seabird-safe and are to be commended for their continued generosity and support for this worthwhile initiative.

More information is available on the Birds Australia website: <http://www.birdsaustralia.com.au/albatross/intro.html>

—GRAHAM ROBERTSON
Southern Ocean Ecosystems Programme, AAD

GRAHAM ROBERTSON

Biologists Jeffrey Mangel and Joanna Shigueto were recipients of IAATO-derived funds in 2003 and 2004. Jeffrey and Joanna work for the Asociacion Pro Delphinus (APD), a non-profit group headquartered in Lima, Peru. APD's charter is to implement an integrated approach to marine fauna conservation in Peru, a country where few marine conservation programs have so far been initiated. Jeffrey and Joanna have used their IAATO awards to determine the level of seabird bycatch in artisanal longline fisheries in Peru and to educate fishermen on the use of seabird-friendly fishing practices.

Seabird-safe longline fishing at Heard Island

Bullers and white-capped albatrosses fight over fish lost from a longline.

Australia manages a fishery in the waters around Heard Island and the McDonald Islands (HIMI) for the valuable Patagonian toothfish, which lives near the seabed 500–2500 m deep. Patagonian toothfish are usually caught in nets towed from trawlers, or by baited hooks attached to longlines set on the seabed. When the HIMI fishery commenced in 1997, longlining was banned because of its potential threat to the survival of seabirds.

In 2003, however, a scientific licence was granted to the Australian company Petuna Seafoods Ltd, of Devonport, Tasmania. This decision was based on an increased knowledge of the dynamics of the fishery from scientific observations made on trawl vessels since 1997, the need by industry to access deeper waters (trawling is usually limited to 800 m depth), and improved knowledge of measures to avoid seabird bycatch. The licence was granted under a provisional arrangement that required assessment of the possible impacts of fishing on the fishery and other components of the marine environment.

Petuna operate a single longline vessel in the fishery – the FV *Janas* – under a joint venture agreement with the vessel owners, Sealord Group, New Zealand. The licence agreement required that the *Janas* operate in a manner that would minimise the risks to seabirds. In the first year of fishing the requirements were:

- restriction of fishing to the period 1 May–31 August to avoid the summer breeding season for seabirds, when risks increase;
- retention on board of fish offal and waste (the *Janas* converts offal into fish meal for subsequent sale);
- use of lines bearing streamers (trailed behind vessels to deter seabirds from baited hooks) during line setting operations;
- the setting of longlines only at night, when risks to many seabird species are reduced;
- the sinking of longlines at no less than 0.3 m/s to reduce the chances of fatal interactions with gear (achieved by attaching weights to longlines); and
- use of a curtain of streamer lines around the line hauling area of the vessel, to deter seabirds from attacking baited hooks during line hauling operations.

This combination of measures was the strictest for any legal longline vessel operating in waters managed through the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). However, our aim is to take an adaptive approach to management whereby requirements can be relaxed, step-wise, if empirical or circumstantial evidence suggests change would be unlikely to increase risks to seabirds. It is also important that the vessel is not forced to use measures that are not required, especially if they are operationally difficult or reduce fishing efficiency. This approach provides for the continual assessment of risk to seabirds, the

GRAHAM ROBERTSON

These white-chinned petrels (*Procellaria aequinoctalis*) are the commonest seabird killed by longlines in the CCAMLR area and one of the most difficult species to deter worldwide.

GRAHAM ROBERTSON

Seabird-safe fishing measures are allowing longline vessels to fish for the lucrative Patagonian toothfish in the waters around Heard Island. This 2.1 m-long monster of the deep, shown beside a scientific observer, was caught by longline in 1700 m-deep water off southern Chile in December 2004. The fish is estimated to be at least 50 years old.

contribution of individual mitigation measures to total mitigation response and the performance of the vessel. It also creates incentives for industry without compromising conservation values.

In 2003 the *Janas* set 630 000 hooks and caught no seabirds. In 2004 the vessel set 2.2 million hooks and again caught no seabirds. Clearly, efforts to protect Heard Island seabirds were successful. This success was partly due to the low incidence of longline-vulnerable seabirds on the fishing grounds in winter and partly to the professional approach by the ship's crew to the use of conservation measures.

As part of the adaptive approach to management, changes have been made to the conservation measures. Prior to the 2004 season, the Threat Abatement Plan team approved the use of integrated weight (IW) longlines in the fishery. These lines sink fast, reducing the time available for seabirds to snatch baited hooks (see *Australian Antarctic Magazine* 5:14–15). They sink with a more even profile than normal lines with clip-on weights, increase fish catch rates and improve operational efficiency.

Other changes to the conservation measures, approved by Australia and CCAMLR and effective from May 2005, are the extension of the fishing season to 14 September and removal of the requirement for night time setting of longlines. This allows the setting of lines at any stage in the day/night cycle. While night setting is a proven seabird conservation measure, the case for the change was supported by the success of experiments on the effectiveness of seabird-friendly techniques (IW longlines, streamer lines) conducted off southern New Zealand. These experiments occurred under conditions that presented a far higher risk to seabirds (in daylight hours during the seabird breeding season) than those that occur in the HIMI region.

Appropriate safeguards have been established. Licence conditions stipulate that during the two-week season extension, if three birds are caught, fishing must cease. Also, if three seabirds are caught during day setting operations the vessel must revert to night setting. With these changes there is scope for discretion by the fishing master. For example, if the number of longline-vulnerable seabirds in the vicinity of the vessel is judged to be high, or birds are thought likely to interact with gear, the onus is on the skipper to delay the onset of day setting until the situation improves.

It will be interesting to see how the vessel performs in the winter of 2005. Naturally we are hoping for a zero score card, not only in the interests of the conservation of Heard Island seabirds, but to be able to promote proven conservation practices to other fisheries in the southern hemisphere where longline-vulnerable seabirds occur.

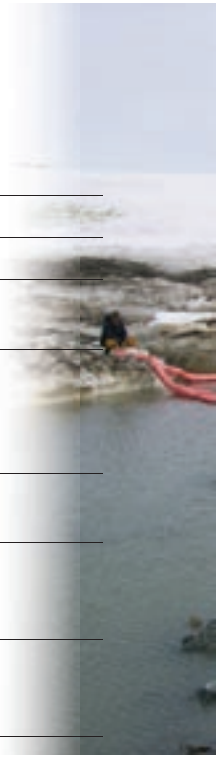
—GRAHAM ROBERTSON
Southern Ocean Ecosystems Programme, AAD

Protecting the Antarctic environment

In the early days of Antarctic exploration little was known about the sensitivity of the region, and the approach to the environment was based on the norms of the day in countries far different from Antarctica. Rubbish was dumped into tips or the ocean or burnt in the open air, native animals were culled as a food source, there were no controls on the introduction of alien species, and little was done to control the potential effects of contamination and pollution. If these practices had continued, the resulting environmental changes may have been irreparable.

Through its role in delivering the Australian Government's Antarctic policy interests and goals, the AAD has a responsibility to protect the Antarctic environment. Since the 1950s the AAD has led or taken part in numerous initiatives to change how humans interact with the local environment. One of the most recent of these was certification of its ISO 14001 Environmental Management System (EMS), which emphasises the continual improvement of environmental practices wherever the AAD operates. The AAD also conducts a programme of research into the effects of human activities on the Antarctic environment, while engineers are developing new designs and construction techniques for buildings, in order to reduce heating needs and fuel usage.

The following timeline highlights significant events in the protection of the Antarctic environment:



1950s	Australia is a key player in the development of the Antarctic Treaty and one of the 12 original signatories in 1959.
1964	Antarctic Treaty Parties adopt *Agreed Measures for the Conservation of Antarctic Fauna and Flora*.
1966	Australia proposes Antarctica's first Specially Protected Areas at Taylor Glacier and the Rookery Islands near Mawson, and Ardery and Odbert Islands near Casey.
1970s	Station personnel halt harvest of wildlife for food to supplement station rations. Australia actively supports the bans on whaling in the Southern and Antarctic oceans (1979). Station rebuilding programme includes waste management infrastructure such as waste water treatment plants and high temperature incinerators (1979–1994).
1980	Australia ceases the killing of seals for dog food. Introduction of the *Antarctic Treaty (Environment Protection) Act 1980* for Australia.
1982	The Convention on the Conservation of Antarctic Marine Living Resources comes into force, taking an ecosystem approach to ensuring the sustainability of exploitation (principally fishery). AAD Environment Committee formed and meets quarterly for the next 20 years.
1985 –1988	Commencement of formal environmental training for expeditioners (1985). First incinerators installed at Davis (1985), Mawson (1986) and Casey (1988). All solid waste not incinerated is returned to Australia. Australia's first 'bunded' (secondary containment in case of leakage) bulk fuel storage commissioned at Casey.
1990s	Early quarantine controls including the inspection of fruit and vegetables and restrictions on the use of poultry products in the field, to prevent possible disease transmissions.
1991	Introduction of the Protocol on Environmental Protection to the Antarctic Treaty, inclusive of five Annexes: environmental impact assessment, conservation of Antarctic flora and fauna, waste disposal and management, prevention of marine pollution, and area protection and management. Soft drink dispensers provided to stations, reducing glass waste by 40%.
1993	Last huskies leave Mawson as required by Annex II of the Madrid Protocol.
1994	Formation of Environmental Management Section in the AAD. Development of the Waste Management Strategy, including waste minimisation measures and recycling.
2000	Formalised quarantine controls commenced for people and cargo destined for Antarctica, to prevent introduction of alien organisms – a perceived high risk.
2002	Implementation of an Environmental Management System (EMS) certified to the Australian/New Zealand Standard 14001. Australia is the first nation to gain EMS certification for its Antarctic programme. Commencement of clean up of disused Thala Valley tip at Casey. Commencement of the AAD State of the Environment Reporting System for Antarctica.
2003	Wind turbines commissioned at Mawson Station to greatly reduce fossil fuel use.
2004	External auditor visits and audits Casey, Davis and Mawson stations.

—NEIL SORENSEN, TOM MAGGS and SHAUN WALSH
Environmental Policy and Protection, AAD

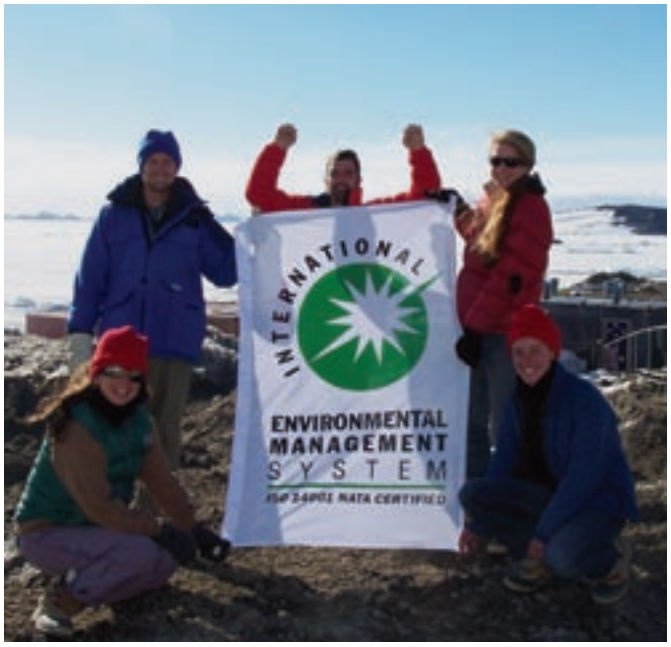
CAL YOUNG

Since the development of the Waste Management Strategy in 1994, Australian Antarctic stations recycle much of their waste.

The Thala Valley site at Casey was once used for landfill. Since 2002, teams of expeditioners have been monitoring, treating or removing polluted water and soil.

BRIAN HAROLD

SHAUN WALSH



(L-R) Expeditioners Clare Hynes, Angus Munro, Andrew Cunningham, Elanor Bell and Tania Ritchie celebrate the successful audit of Mawson Station's Environmental Management System.

Australian Antarctic stations comply with strict environmental procedures

Australia's Antarctic stations at Davis and Mawson were audited by independent Environmental Management System (EMS) auditor Mr Phil Crosby, in January this year, as part of Australia's internationally certified (ISO 14001) environmental management accreditation. Mr Crosby was accompanied by Leslie Frost and Shaun Walsh of the AAD.

As well as testing compliance with established environmental procedures, the audit provided an opportunity for an independent assessor to make recommendations for improvement.

In the executive summary to his report Mr Crosby said '… this audit covered a wide range of processes and activities, most of which were carried out, not only to be in accordance with AAD policies and guidelines, but often as a personal standard of the leader, expeditioner, or scientist. It was especially noted and pleasing to see the pre-departure training and Environmental Code of Conduct, being seriously fulfilled and delivered by new and departing personnel'. He said the EMS is currently most effectively implemented within the AAD's Operations Branch, which is responsible for implementing most of the procedures and processes that impact on the Antarctic environment.

Mr Crosby identified a number of areas for improvement including:

- The need for some revision and expansion of procedures in the EMS Manual;
- The need for better document control to ensure that everyone uses the current authorised version of environmental procedures, and to ensure these procedures are available on the AAD's intranet;
- Improvements on stations relating to fuel storage, the labelling and re-use of 200 litre drums and storage of cement boxes; and
- Improvements to internal environmental audits to meet the ISO standard and to be effective tools for management.

The report also contains many observations to assist the AAD to improve environmental management. The AAD will prepare Action Plans to respond to the findings of the audit report. Our response will then be re-assessed in three months time and again at the re-certification audit in August this year.

—SHAUN WALSH and LESLIE FROST
Environment Advisor and EMS Coordinator, AAD

Treaty inspections – still important 40 years on

For the first time in over a decade, a party of Australian officials in Antarctica has inspected the stations, activities and equipment of many of their Antarctic Treaty partners.

In January this year, a three-person observer party visited Ross Island to inspect New Zealand's Scott Base and the United States' McMurdo Station – stations not inspected since the adoption of the Madrid Protocol. The observer party also inspected the US air fields on the Ross Shelf, the US research vessel *Nathanial B Palmer,* and protected areas and tourist activities on Ross Island.

A second inspection in February was conducted jointly by the United Kingdom, Peru and Australia, supported by the Royal Navy icebreaker *Endurance*. This inspection party visited 14 operational stations, eight closed stations and five historic sites on the Antarctic Peninsula and King George Island. Stations operated by Argentina, Brazil, Bulgaria, Chile, China, the Czech Republic, the Republic of Korea, Russia, Spain, the Ukraine and the United Kingdom were inspected, as well as the Russian tourist vessel *Professor Molchanov.*

The right to conduct inspections is established by Article VII of the 1961 Antarctic Treaty, which states that all areas of Antarctica (including stations, equipment, and all ships and aircraft at points of discharging or embarking cargoes or personnel) be open at all times to inspection by observers appointed by another Party. Findings must then be reported to other Parties through the annual Treaty meeting. The inspection provision aims to ensure transparency in the conduct of research and support activities in Antarctica and was an important feature of a Treaty negotiated during the 'cold war' period – a time of tensions over military ambitions. Today inspections are as much about environmental protection as they are about ensuring peaceful scientific study, thanks to the adoption of an environmental protocol by the Treaty in 1991.

Inspections are an important part of the Antarctic Treaty system, encouraging compliance with the obligations Parties have imposed on themselves, and improving the broader transparency of how activities are undertaken in Antarctica. Australia is a strong supporter of the inspection system. However, with our activities focused on east Antarctica, well away from the concentration of activities on the Antarctic Peninsula and the Ross Sea region, it has been difficult for Australia to actively contribute to inspections. Our recent efforts address this issue. Our inspection reports will be considered by the Committee for Environmental Protection and the Antarctic Treaty Consultative Meeting in Stockholm in June.

—ANDREW JACKSON and TOM MAGGS
Antarctic and International Policy, AAD

The Australian observer team presents a commemorative certificate to Brian Stone, National Science Foundation representative at McMurdo Station. L to R: Dr Conall O'Connell, Mr Chris Moraitis, Mr Brian Stone (US) and Mr Andrew Jackson.

CHRIS MORAITIS

Extreme medicine in Australia's Antarctic programme

The operational capacity of the AAD's Polar Medicine Unit provides one of the many support functions necessary to achieve Australia's goals in the Antarctic, Southern Ocean and subantarctic. The unit is highly specialised and efficient, yet not prominent till a serious health or medical event occurs.

Its critical functions include recruitment of wintering, deep field and voyage medical practitioners; medical, dental, laboratory and surgical training; preparation for deployment; provision and maintenance of medical supplies and equipment; and comprehensive medical and dental screening of expeditioners and ship's crew. The unit also conducts research into biophysical and psychosocial aspects of human health in Antarctica.

The key to the success of Australia's Antarctic medical support is the appropriately trained, generalist procedural medical practitioner – on station or on the ship – who is capable of dealing with a broad spectrum of medical possibilities, from appendicectomy to treatment of a broken leg, and the diverse range of mind and body ailments in between. However, the Polar Medicine Unit is also acutely aware of the limited sophistication of medical care possible by the lone doctor in Antarctica. The complete isolation of an Antarctic winter and the risks and potential impacts of summer operations do not allow for medical or operational complacency. These same risks are felt by those planning for space travel.

Comprehensive pre-departure medical screening is essential to our operations, given the limitations of the current medical support and logistics framework. Interestingly, the medical checklists and screening examinations over the past 15 years have produced consistently low numbers of unsuccessful candidates (see graph). Similarly, despite the extreme environment and potential risks for serious events, the consultation rates for both injury and illness from a trivial to a serious nature, have declined from 2–4 per person per year in the early 90s, to 1–2 per person per year today (for details see < http://aadc-maps.aad.gov.au/aadc/soe/display_indicator.cfm?soe_id=49>).

Satellite communication links to medical practitioners at head office, who have all wintered in Antarctica, enable critical e-health support on a 'store and forward' telemedicine basis, via narrow bandwidth networks. This allows telephone consultation and digital transmission of X-rays and clinical images 24 hours a day.

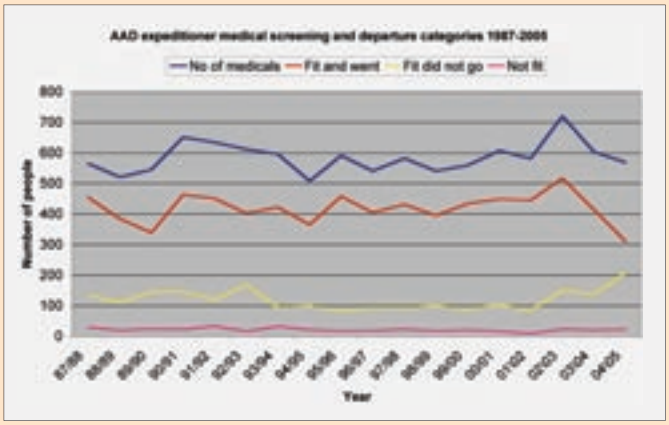
As technology advances, our doctors – on station or ships – are increasingly able to access professional and continuing education support. Technology also facilitates contact with a network of medical and dental specialists, many of whom have spent time in Antarctica. These advances aim to improve the health care of expeditioners from afar. E-health projects such as implementation of the AAD electronic health record will lead to further improvements in care.

In response to the changing needs of Australia's Antarctic programme, the Polar Medicine Unit recently designed and implemented a 'containerised medical facility' on chartered ships. It has also recently implemented an Antarctic aeromedical capability for deep field retrieval to stations, using the intra-continental CASA 212–400 aircraft, in case of emergency.

The Polar Medicine Unit contributes to the Australian Government's Antarctic goals of maintaining Australia's influence in the Antarctic Treaty system and undertaking work of practical, economic and national significance. It also contributes to Australia's national research priorities by promoting and maintaining good health, conducting research in an extreme environment and supporting the safeguarding of Australia's southern territories.

The AAD Human Biology and Medicine research programme, led by the chief medical officer, investigates human responses to, and interactions with, the Antarctic

This graph shows the results of medical screening and deployment as part of Australia's Antarctic programme. It shows the total number of medical screening examinations undertaken (blue line) and individuals that did not go south because of medical reasons (pink line) or other personal or organisational reasons (yellow line). The red and yellow lines also include medical screens for the Australian Customs Service Southern Ocean fisheries patrols, after 2002. In 2004–05, 569 medicals were completed and only 22 participants were deemed unfit.



ANARE HEALTH REGISTER ASAC 12 (DR PETER GORMLY)

environment. The more we delve into the nature of small Antarctic groups arriving from temperate climates, the more questions arise. For example, what is the effect on the immune system of this geographic change? Is the observed immunosuppression and viral reactivation caused by psychological, hormonal or neuronal stressors? What triggers the changes in thermal physiology to cause acclimatisation?

The research programme also conducts psychosocial studies on small groups and individuals in isolation, and their positive resilience factors and adaptation responses, both on Antarctic stations and back home. These studies may provide insights into optimal psychological support at selection and during an expedition. They may also assist re-integration of expeditioners on return to Australia. Application of the research findings to humanitarian, military, disaster and other challenging environments is possible.

There are many other questions. How can we operate more safely and improve the health and wellbeing of expeditioners, and mankind in general, in challenging environments? Are the observed changes impacting on the health of Antarctic expeditioners in the short or the long term? Are they reversible or irreversible? How can we apply these findings to other extreme environments; to frontiers of industry and ultimately, space travel?

In the International Polar Year (2007–08), the Scientific Committee on Antarctic Research Expert Group on Human Biology and Medicine has proposed a multidisciplinary Arctic-Antarctic health research project. The project will provide an extraordinary opportunity for all polar researchers to study physiological, public and occupational health in polar regions, and to scale up studies of small populations in both the Antarctic and Arctic. The study will provide a legacy of ongoing databases, education and outreach, and will answer significant research questions on many facets of polar human biology and medical research.

For further information on the IPY visit <http://www.ipy.org>. Further information on the IPY research proposal, *Taking the Antarctic Arctic Polar Pulse*, is available from the AAD Chief Medical Officer – jeff.ayton@aad.gov.au.

— JEFF AYTON
Chief Medical Officer, Polar Medicine Unit, AAD

Assistant anaesthetist Megan Tierney monitors anaesthesia equipment during a training session at Mawson Station. The equipment includes, from left to right: Ulco anaesthetic machine, manual suction apparatus (in case of electricity failure), Campbell anaesthetic patient ventilator (for artificial breathing) sitting atop an anaesthetic ventilator and medical gas compressor, Lifepak10 defibrillator and heart monitor, Datex anaesthetic vital signs monitor, Critikon blood pressure monitor (blue box at right) and an ATS automatic tourniquet cuff system (to assist with bloodless limb surgery and regional anaesthesia).

JOHN SMITH

JOHN SMITH

ICE

Committing to work as a doctor in Antarctica can be a disruptive and challenging career move. Doctors may have to sell a practice or put unforgiving training schedules on hold. They are then sent to one of the most isolated regions on Earth where, if a medical emergency arises, their only assistance is from a small band of willing volunteers and experts at the other end of a satellite phone. With the right attitude and effective use of the time, opportunities and facilities available, doctors can gain great personal and professional benefits from a stint in Antarctica. Two doctors, recently returned from the ice continent, describe their experiences.

Dr John Smith's experience at Mawson Station in 2003 was professionally and personally rewarding.

JOHN SMITH

Dr Tanya Kelly medivacs a patient from Casey Station to the RSV *Aurora Australis* under the support and coordination of the Polar Medicine Unit.

AAD

DOCTORS

Dr JOHN SMITH MBBS, DRACOG
Mawson 2003, Ship's doctor (*Oceanic Viking*) 2004

"When I applied for a job in Antarctica I'd been doing general practice in the same place for 20 years. I was a country GP in Gawler in South Australia. I did a bit of everything there, including surgery and obstetrics. Obstetrics was an exciting part of the practice, but I'd given it up about five years before and was getting a little bored.

I was naïve about what Antarctica would be like. But what started as a bit of irrationality has ended up being a very positive move for me, professionally and personally.

The fact that you're on your own as a doctor down there could be a worry. But all the expeditioners made me feel comfortable about my role. They didn't have unrealistic expectations. They were also well dressed and well versed in protecting themselves from the cold and other potential injuries, so my medical skills weren't put to the test. That's the way it should be. Having said that, it was nice to be able to do the few things I did do well, and gain their confidence. If something did come up that I needed advice on, I was able to talk through the problem with doctors back in Australia via satellite phone. So even though you're the only doctor on site, you're not alone.

Continuing education is straight forward as Australia's Antarctic stations have internet access. There is also a comprehensive medical library at each station. And even if your medical skills aren't called upon for some time, they take a very long time to disappear – as I recently discovered! This was not as apparent to me prior to my southern experiences.

The medical facilities at Australia's Antarctic stations are probably the best on the continent. Over the years the Polar Medicine Unit has developed a good idea of the sorts of things that are commonly consumed and required, and they supply us with the latest drugs and equipment where appropriate.

Younger doctors may find going south a retrograde step if they are in their training years. Certainly I did not go south with the intention of gaining significant medical experience. However, as it turns out, the exercise was very beneficial for my career path. I've since been offered a job with the Royal Flying Doctors' Service. Ultimately though, I intend to finish my working years as a country locum. As a result of my Antarctic experience I feel well prepared and able to cope with medical problems I might face in remote and rural areas."

Dr TANYA KELLY MBBS, BMedSc
Casey 2004

"I was interested in becoming an anaesthetist and was working at the Prince of Wales Hospital as an anaesthetic resident when I applied to go to Antarctica. I had decided that it was a good time in my career to do something out of the hospitals, before commencing further study, and I was attracted to the opportunity to practice a broad range of medicine (and dentistry) in a remote location.

In the pre-departure training I was able to undertake (amongst other courses) an eight-day intensive dental course at the Royal Dental Hospital in Melbourne, intensive surgical training at the Austin Hospital in Melbourne, a radiography course in Launceston and a hyperbaric medicine course at the Royal Adelaide Hospital. There was also specific training at the Polar Medicine Unit in Antarctic medicine, cold injuries and hypothermia. Few mainstream doctors would have the opportunity or, more importantly, the time, to undertake such a wide variety of training. I also completed a fire fighting and fork lift driver course!

I encountered many and varied medical problems while in Antarctica, including several significant dental problems and eye injuries. Most of the work consisted of general GP work, counselling, physiotherapy and rehabilitation after musculoskeletal injuries. There were many opportunities to run preventative medicine initiatives and be involved with public health – such as testing the station water supply each month. Undertaking medical training for the volunteer theatre and anaesthetic assistants was also a highlight and helped me to maintain most of my skills.

Working so closely with such a small group has improved my interpersonal skills, especially in terms of understanding and tolerance. With no other professional medical staff available, such as nurses, physiotherapists and laboratory technicians, I certainly gained a greater appreciation of the enormous amount of effort and skill required to run a small hospital – to keep medication cabinets up-to-date; to maintain equipment; to clean and sterilise instruments; and to keep the resuscitation bay ready for any possible emergency.

Australian doctors in Antarctica are incredibly well supported by the Polar Medicine Unit and specialists from around the country, particularly Tasmania and Victoria. During my year in Antarctica the doctors at the Polar Medicine Unit were available 24 hours a day, seven days a week, to advise and coordinate any assistance necessary. It was a great opportunity to participate in telemedicine over the phone and internet.

There were many resources available on the internet to assist with clinical decision-making and continuing medical education. I would suggest, however, that anyone considering studying for specific exams whilst in Antarctica, should take their own study materials and understand that (as hard as this is to believe) life and work in Antarctica is quite busy and free time can often be a rare commodity.

Some of my colleagues asked me if I was concerned about the effect of heading to Antarctica on my future career. On return from Antarctica however, I have received nothing but positive feedback from other doctors, who have asked questions about my year with great interest and enthusiasm. One of my senior colleagues said to me the other day, 'you will look back on your year in Antarctica as invaluable'. I believe the challenge of remaining approachable and available every minute of every day for expeditioners that are your patients, work-mates and friends, can only make you a better doctor in the long run and more valuable to the greater community."

Dr Tanya Kelly encountered many and varied medical problems in Antarctica.

AAD

Medical emergency at sea

A life and death drama unfolded in the Southern Ocean last December as Australian Customs and Fisheries personnel and AAD doctor, John Smith, fought to save the life of a Portuguese fisherman.

The drama began when the Customs and Fisheries patrol vessel, MV *Oceanic Viking*, was diverted from its patrol of Australia's Exclusive Economic Zone, to respond to a medical distress call by the Spanish-flagged fishing vessel *Arnela*. On board was a 46-year-old fisherman with a bleed from a stomach ulcer.

'By the time we picked him up, he'd been unconscious for three days,' Dr Smith said.

'Things looked pretty grim and I was surprised when he responded to treatment. We managed to stabilise him, but he remained unconscious for the duration of the trip back to Perth.'

Dr Smith said the fisherman needed blood transfusions and fluid resuscitation. The crew of the *Oceanic Viking* donated blood, while Dr Smith, a Customs paramedic and a team of medical volunteers administered intensive care treatment.

Dr Smith, a general practitioner with previous experience as a doctor in Antarctica, said it was a challenging experience.

'When I first got the call about the fisherman I was told he had gangrene of the leg. So I was busy looking up how to amputate legs and thinking that was the first thing I would have to do. Fortunately that wasn't the case. But then we needed to get blood quickly, so I had to determine the fisherman's blood type and grab people from the crew with matching blood types.

'All of a sudden I was the doctor, nurse and orderly. I have renewed admiration and respect for intensive care nurses. The team I was working with were fantastic, but it was a very prolonged exercise. It was eight days before we got him to Perth Hospital.'

The medical team were fortunate to have a top quality medical facility aboard the *Oceanic Viking* – which was designed and equipped by the AAD's Polar Medicine Unit – and round the clock telemedical support from the Polar Medicine Unit and its network of specialists.

The Minister for Justice and Customs, Senator Chris Ellison said the ability of the *Oceanic Viking* to respond to the emergency and provide high-level medical care was a reflection of the excellent preparation that had gone into the operation. Royal Perth Hospital intensive care staff also passed on their congratulations for a job well done.

The ship has since returned to duties patrolling the Southern Ocean for illegal fishing. The fisherman has returned to his family in Portugal; and Dr Smith has returned to his country practice in Gawler… at least for now.

AUSTRALIAN CUSTOMS SERVICE

The Australian Customs paramedic and retrieval team transfers the sick fisherman from the *Arnela* to the *Oceanic Viking*.

Containerised medicine

A shipping container modified to house a complete medical and surgical facility successfully completed its first return trip to Antarctica aboard the *Vasiliy Golovnin* last February.

The 'containerised medical facility' was designed by the AAD's Polar Medicine Unit and engineers, to allow doctors to deal with life- and limb-threatening medical and surgical emergencies on board ship. Injuries most commonly seen on ships include fractures and crush injuries to limbs.

KEN BARRETT

The facility contains all the equipment needed to provide the AAD's high standard of medical care in the remote Antarctic and Southern Ocean environments. This includes a filtered water supply, uninterruptible power supply, anti-static flooring, air filtration, X-ray machine, an adjustable trolley-cum-operating table and an alarmed pharmacy fridge to keep drugs at a constant temperature. The container itself is also alarmed for fire and major temperature changes.

As most ships don't cater to our medical requirements, the containerised medical facility will increase the AAD's flexibility in ship-based operations. As the AAD moves towards more flexible science delivery in deep field, similar containerised modules could provide the medical support needed.

—JEFF AYTON
Chief Medical Officer, Polar Medicine Unit, AAD

From penguins to patients

What's it like for medical assistants in Antarctica – people with no previous medical training? Penguin researcher and PhD student, Megan Tierney, went to Antarctica in 2002–03 to collect biological samples from Adélie penguins for dietary analysis, and to study the effects of krill fluctuations on Adélies and other krill-dependent predators. She also volunteered to become Mawson Station's anaesthetic assistant, under the supervision of Dr John Smith.

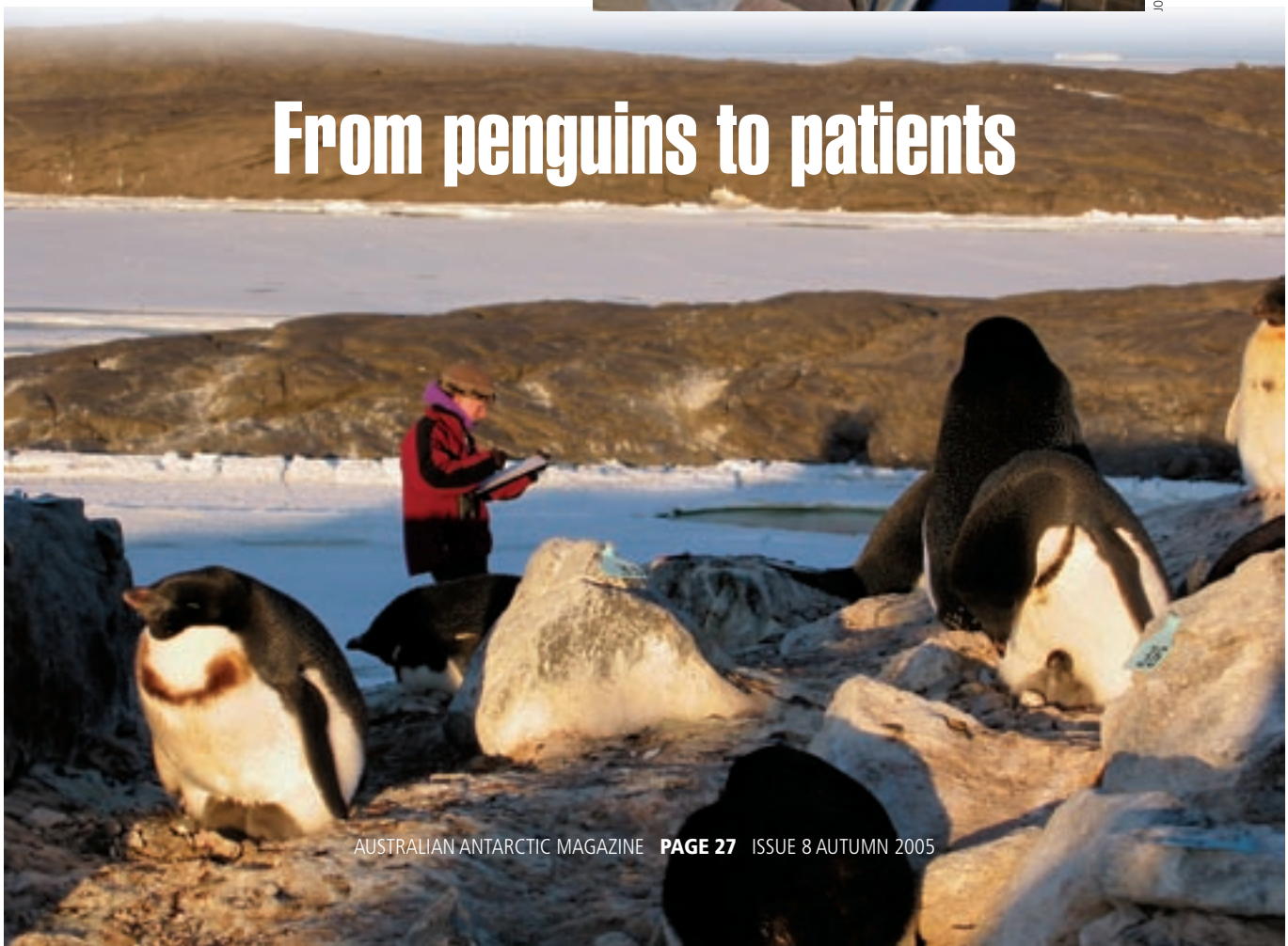
I first became interested in Antarctica when I was about 10 years old. It amazed me that anything could survive there and I wanted know how those penguins and seals did it and how those early explorers managed. After completing my honours year at the Institute of Antarctic and Southern Ocean Studies, at the University of Tasmania, I was selected to run the field component of the Royal Penguin Breeding Success and Foraging Behaviour Monitoring Programme on Macquarie Island. Following that I started working with the AAD on the Adélie Penguin Programme, where I have been fortunate to spend four summers and a winter at Mawson.

Everyone on station takes on extra duties in addition to their normal role, so that the station runs smoothly. Volunteering for medical duties appealed to me because it was a chance to learn something new and acquire skills that could be handy back in the real world. Being a biologist by trade I also liked the idea of seeing how the human body works. Each expeditioner registered their interest in the extra station duties and these were then divided up among them. Obviously anyone with prior medical training would be encouraged to volunteer for the medical team.

The medical training I had was a little different to the rest of the assistant medical team. Usually volunteers undergo several weeks training at the Royal Hobart Hospital, which is a highlight of the pre-departure training and critical to our

JOHN SMITH

Assistant anaesthetist Megan Tierney monitors anaesthesia equipment during a training session at Mawson Station.



CHRIS TICKNER

Megan conducts an Adélie nest census at the field site on Béchervaise Island.

Megan's usual work involves collecting faecal, blood, feather and preen-gland oil samples from Adélie penguins and analysing them for clues to the birds' diets. If these samples prove useful in identifying dietary components, they may provide an alternative or additional means of analysing seabird diets. The current practise of stomach flushing has a number of biases and ethical issues associated with it.

Megan is also involved in the Béchervaise Island Penguin Monitoring Programme. This environmental monitoring programme is using Adélie penguins to gauge the effect of changes in krill density in the Southern Ocean, on krill-dependent predators. Krill is the primary food of Adélies and many other Southern Ocean animals, but there is also the potential to harvest krill for human use. By understanding the natural patterns in krill fluctuations and the resulting impact on Adélie penguin breeding success and population size, the programme hopes to help establish sustainable catch limits on krill if a fishery was to re-open in the Mawson region.

JUDY CLARKE

medical support. But when Mawson's assistant anaesthetist had to return to Australia unexpectedly, I put my hand up to take on the role. As a result, all my training was undertaken on site in the Mawson surgery, where I was put through my paces with our doctor, John Smith. 'Doc' (as he invariably became known around station) was a great instructor – very calm, down-to-earth and thorough – and he always emphasised that if we weren't sure of anything all we had to do was ask.

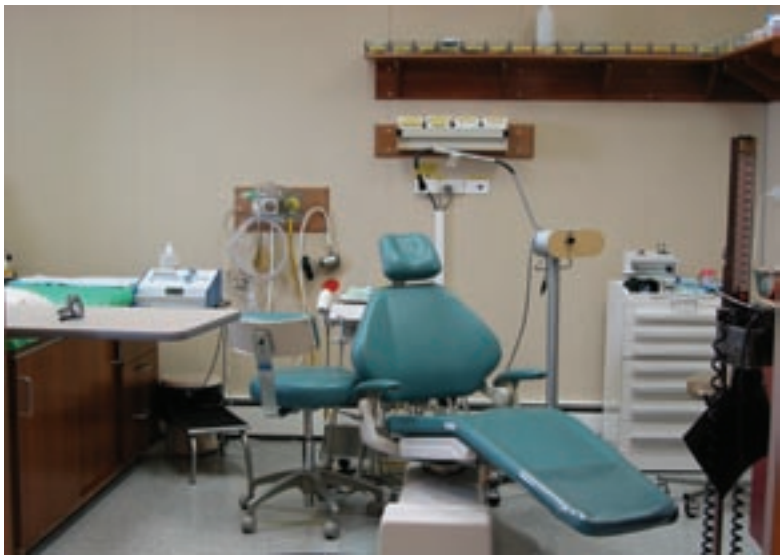
There were two assistant anaesthetists on our medical team, plumber Greg Liddle and I. Between the two of us we would prepare the anaesthetic machinery and get the various bits like drugs, needles and endo-trachea tubes ready to put a patient under anaesthetic. Prior to any operation or surgical procedure we would assist in preparing the patient (by putting drips in or monitoring vital signs, for example). During the procedure we would assist in putting them under anaesthesia and then we would monitor them throughout, under the supervision of the doctor, ensuring they were sufficiently sedated, safe and in no pain.

To have the opportunity to do something so left field of my normal work life and the daily routine was great. I think we might have all been a bit nervous if a serious situation had arisen, because we would have known the patient well. However, I know that with the training and direction we were given by Doc, our team would have been more than capable of making any operation as successful as possible.

The opportunity to see how an operating theatre works, from patient preparation, through to post-operative care and clean-up, was fantastic. Even now it amazes me that I know the principles of putting someone under anaesthetic (under guidance and supervision, of course!), and it still shocks my family and friends that everyday people like plumbers, diesel mechanics, chefs, meteorology observers, scientists, electricians and carpenters, are the doctor's assistants in Antarctica. 'Where are the trained nurses?' they ask. But in Antarctica you have no choice. I would have trusted any of our medical team to look after me and if I get the opportunity to do another winter I'd love to be part of it again.

—MEGAN TIERNEY
Southern Ocean Ecosystems Programme, AAD

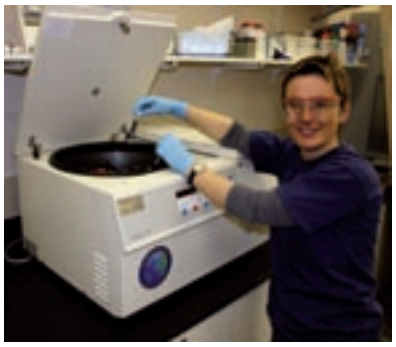
Australia's Antarctic stations are comprehensively equipped to stabilise and manage most medical, surgical and dental emergencies as these pictures of Mawson Station's emergency bay (left) and dental suite (right) demonstrate.



JOHN SMITH

Antarctic expeditioners assist bone loss study

DAVE TAYLOR



NOEL PATEN

Macquarie Island doctor, Andy Williams, takes blood from station chef, Meredith Nation, for the vitamin D study.

Casey Station doctor, Eve Merfield, demonstrates the final steps in the preparation of blood for the vitamin D study. The blood is spun in a centrifuge at 4°C to separate the serum and red blood cells. The serum is then stored in 'cryotubes' at -80°C for return to Australia and analysis of bone metabolites (to establish turnover rates) and vitamin D levels.

A new study by the AAD's Polar Medicine Unit and the Austin Hospital in Melbourne aims to determine whether Antarctic expeditioners have a greater risk of developing osteoporosis (brittle bones) in later life as a result of vitamin D deficiency.

Vitamin D deficiency is caused by a lack of exposure to sunlight, which can be due to latitude, sun protection practices, the cultural or religious practice of covering the body, or institutionalisation. In Antarctica, wintering expeditioners endure months of darkness or twilight; while in summer, the angle of the sun limits the amount of ultraviolet radiation reaching the ground. Then there's the cold, which forces expeditioners to cover up.

Without vitamin D the body cannot absorb as much calcium, so it turns to the supplies of calcium in bone. Under normal circumstances the body will naturally extract and replace calcium in the bone; digging small holes and then refilling them so that the total amount of bone remains the same. When vitamin D levels are low, however, the rate of digging and refilling increases, producing more holes in the bone. As people age, the body's ability to refill these holes decreases, resulting in bone loss. One of the key questions we hope to answer in the Antarctic study is whether this bone loss is transient or irreversible.

As people over 40 naturally experience a degree of bone loss we hypothesise that older expeditioners, particularly menopausal women, will experience accelerated bone loss in Antarctica and that this bone loss will be irreversible. Younger expeditioners, however, are likely to experience a smaller degree of bone loss, which will be remedied on their return to Australia.

Our two year pilot study, which began in the 2003–04 Antarctic summer, involved 53 expeditioners departing for a year in Antarctica. Before departure, we took blood samples to determine normal vitamin D levels and bone turnover rates (how quickly holes are being dug and refilled). Every three months, doctors at Australia's Antarctic stations collected blood samples. These were returned to us in April and are now being analysed for vitamin D levels and bone turnover rates. We also had expeditioners complete three-day diaries, which recorded their diet and possible exposure to other light sources such as those used to grow hydroponic vegetables at the stations.

A small number of blood samples were returned to us earlier in the year and these have revealed some interesting preliminary results. While the normal concentration of vitamin D in the blood is 30–100 mmol/l, after three months the mean vitamin D concentration in the expeditioners' blood was 29 mmol/l. After six months, this had dropped to 24 mmol/l, which was significantly lower than when they arrived in Antarctica. The rate of bone turnover was also found to have increased at six months. Analysis of the remaining blood samples will confirm whether the rates of bone turnover are significantly elevated. We will also collect blood from expeditioners, six months and 12 months after their return to Australia, to see how quickly they return to their pre-departure bone turnover rate.

In the next phase of the study we have enlisted the help of Professor Graeme Jones of the Menzies Centre for Population Health Research in Hobart, to conduct bone density testing on expeditioners before they depart for Antarctica, when they return, and one year after their return. This will provide a definitive answer on changes in bone density.

This research will help not only future Antarctic expeditioners, but other people at risk of vitamin D deficiency, particularly nursing home residents. If the study shows bone loss is an issue in Antarctica, we will again enlist expeditioners' help to identify the most effective and least time-consuming combination of preventative measures. In the case of expeditioners, this could include vitamin D supplementation, weight bearing exercise, time spent under an ultraviolet lamp or tending hydroponic crops and/or a megadose injection of vitamin D before departure. For the elderly and other at-risk individuals in Australia, it could include vitamin D supplements or time in the sun.

—SANDRA IULIANO
Melbourne University and Austin Hospital
—JEFF AYTON
Chief Medical Officer, Polar Medicine Unit, AAD

Medicine for MARS

"Outside one is in touch with the sternest of Nature – one might be a lone soul standing in Precambrian times or on Mars – all is desolation and hard in the durest."

—*Sir Douglas Mawson*
9 April 1912

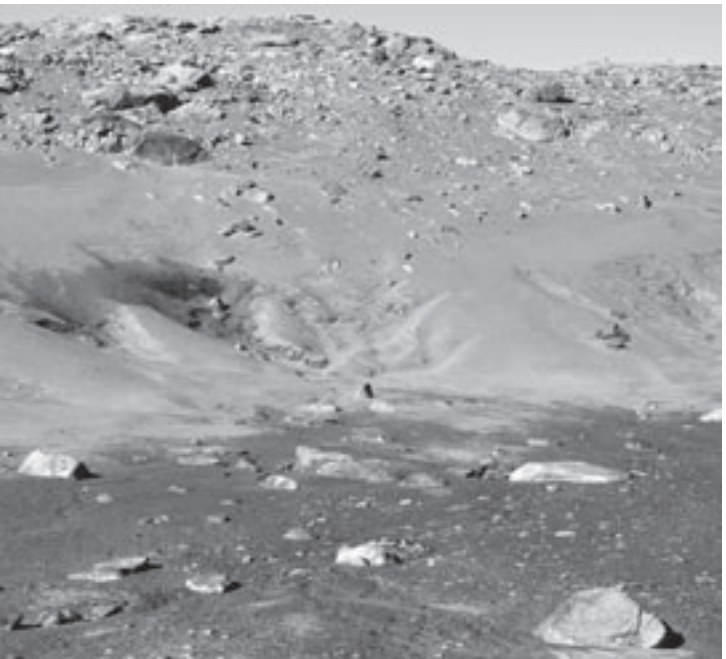
This entry in Sir Douglas Mawson's diary shows early Antarctic explorers and scientists saw parallels between Antarctica and space, many of which have been demonstrated as our exploration of space continues. The National Aeronautics and Space Administration's (NASA) Mars Exploration Rovers, *Spirit* and *Opportunity*, have transmitted pictures of the surface of Mars that show characteristics of many Antarctic localities. It would have astonished Mawson to know that 90 years later, Antarctic medical practice and human biological research would assist NASA in its planning for expeditions to the Moon and on to Mars.

The hostile, dangerous and unfamiliar Antarctic environment, with its isolation, cold, and changing light regimens, is arguably the most extreme on Earth. Small, confined groups who winter for up to a year, have to travel great distances to reach their stations, are totally self-sustaining and require complex maintenance operations. There are many analogues for space, such as undersea, mountains, caves and deserts. However, Antarctica provides an excellent high fidelity, physically isolated, non-simulated analogue for groups travelling on long-duration space missions, even though it does not replicate the space-specific effects of altered gravity and radiation.

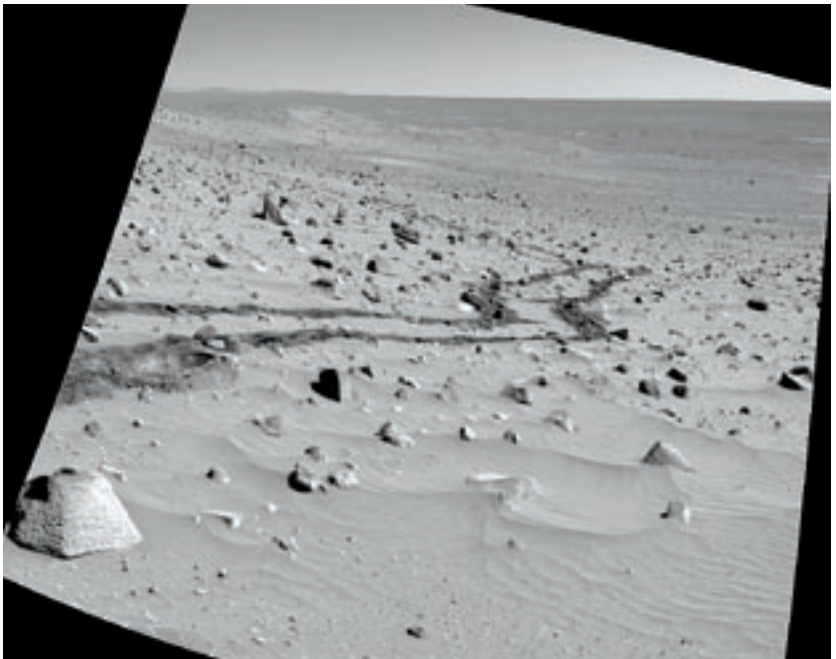
This is especially true in the area of polar medicine as practiced by the Australian Antarctic programme for over 50 years. Such practice had its beginnings on Mawson's Australasian Antarctic Expedition (1911–14) where McLean, the chief medical officer and bacteriologist, combined medicine and research. This gained him the first doctorate for Antarctic immunology and bacteriology.

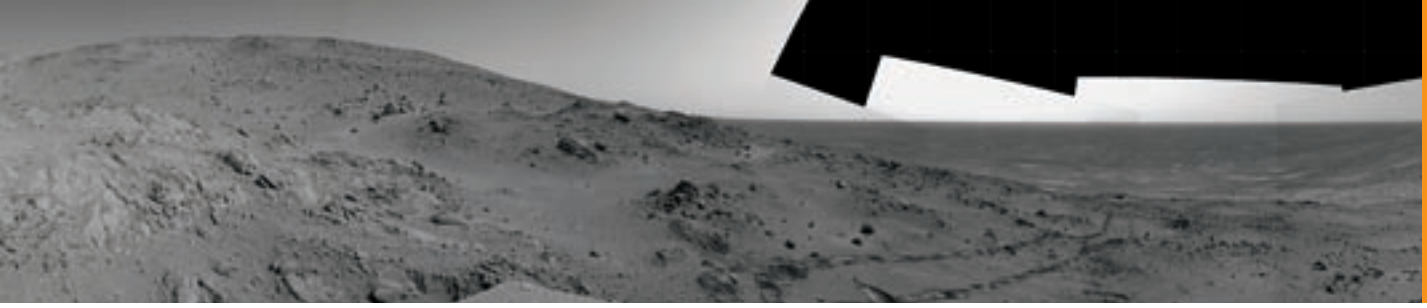
Antarctica or Mars? Sir Douglas Mawson drew parallels between Antarctica and the red planet in 1912. Today, researchers are applying the lessons learnt in the cold and isolated Antarctic environment to preparations for space missions. Photographs 1 and 3 were taken at Antarctica's Marine Plain, between Crooked Fjord and Ellis Fjord in the Vestfold Hills (near Davis Station). In photograph 2 NASA's Mars Exploration Rover *Spirit* looks back on its tracks across a rock-strewn landscape reminiscent of the Vestfold Hills. The image in photograph 4 was captured by the *Sojourner* rover during NASA's Mars Pathfinder mission

1 DENNIS CRAWFORD



2 NASA/JPL





NASA/JPL

NASA's Mars Exploration Rover *Spirit* used its navigation camera to take the images combined into this 360° view of the rover's surroundings, with the summit of 'Husband Hill' at the centre.

Australian Antarctic programme epidemiology shows that even with intensive pre-departure medical screening there is no certainty that staff in Antarctica will be free of all medical problems. An example of this is the occurrence of appendicitis on expeditions which led to a policy of pre-departure prophylactic appendectomy for all wintering doctors. Such evidence-based practice will assist NASA in making decisions on policy and the level of medical services, equipment and pharmaceuticals required.

Much of the preventive, clinical and emergency medicine in space will be similar to that faced by the sole Antarctic medical practitioner, although the space physician will have additional space-specific problems. Both scenarios have a scarcity of resources and trained personnel, isolation and confinement. The evolution and use of telemedicine in the Australian Antarctic programme provides significant lessons for its use in space. Conversely, equipment designed for space ultimately ends up in extreme Earth environments; just as intensive care monitoring owes its genesis to telemetry designed for the space programme.

Since 1992, collaborative research between the AAD and NASA has generated some interesting findings in a number of areas, all of which have relevance to long-duration space expeditions. For example, although Antarctic expeditioners exhibit altered immunity and herpesvirus reactivation, they have not contracted any known disease states, and are able to produce antibodies to antigens previously unknown to them, allowing the necessary immune response when needed.

Studies on psychology and behavioural health in both station and field groups, reinforce the need to study individuals, and not aggregate data at the group level. Psychological issues, including problems in team interaction, do not affect all members of groups equally. Individual personality factors, the unique combinations of these in each group, and local events, were the primary cause of changes observed, with the degree and length of isolation being important. Most of the staff cope well most of the time and the risk of a major psychiatric problem is low. But if it does occur it is of great consequence, due to the demands on the team to achieve a successful outcome when resources and pharmaceuticals are limited.

One current study is looking at sun deprivation in Antarctica and whether this causes irreversible bone loss (page 29). The aim of the study is to determine if markers of bone turnover increase in expeditioners. As the microgravity of space induces bone atrophy, evidence of bone changes from sun deprivation may be an important additional factor on space missions of several years duration.

A solid foundation has been established between NASA and the AAD for further research, testing of equipment and procedures, and medicine in extreme environments. This will be important to expeditioners wintering in Antarctica or travelling to Mars in the decades to come; the Antarctic analogue for Mars as envisioned by Sir Douglas Mawson.

—DES LUGG
Medicine of Extreme Environments, NASA HQ, Washington DC, USA

3 DENNIS CRAWFORD

4 NASA/JPL

Doctoring in Antarctica: then and now

Dr John Birss recently returned from Davis Station, where he attended to the medical needs of wintering expeditioners – 26 years after his first Antarctic experience at Mawson.

JOHN BIRSS

Happy customers – the real patient, Davis Station Leader Bob Jones, is flanked by sympathisers, Steve Morrow (left) and David van Duyl.

My first trip to Antarctica was to Mawson Station in 1978 – back in the dog days. It was very different back then – very basic. We lived in converted freezer boxes that were heated inside. It was mostly all-male crews, although a female doctor had been appointed at Macquarie Island in 1976. But I was stationed with 28 men for 12 months.

When I applied for the job in 1978, the big question was whether I was capable of opening a belly. Could I do an appendix if I had to? Had I been managing general practice and casualty work? We didn't have as extensive a training programme as we have now and certainly no dental skills. If someone had a sore tooth, we'd put the pliers on it and take it out. Now we spend two weeks at the dental hospital in Melbourne learning how to do root canals, fillings, scaling and polishing. It's one of the more interesting aspects of the job for me now.

Communication was the difficult thing back in '78. We used to use telex or a single satellite phone that you had to book time on. If the weather was bad we couldn't communicate with Australia. Communications were out on the day I was faced with a case of acute appendicitis. Normally we'd get a surgeon to check whether we really needed to go ahead with an operation, but I had to tell them 36 hours after the event.

I remember the sweat was pouring off me. Even in those days, if you tried to do what we did in Antarctica, in Australia, you'd be hauled before the medical board for doing the wrong thing. You must never do both the anaesthetic and the operation on the same patient. But there's no-one else in Antarctica to help you. I had to anaesthetise the patient and then hand him over to people who had trained as anaesthesia assistants, but had never worked with a real patient. Then I had to scrub and make sure that the chef, who was assisting me, was also scrubbing and dressing properly. Then I had to show him which instruments to give me because he didn't know their names.

I had an excellent book which had step-by-step photographs of an appendectomy. So I had my assistant across the table turning the pages for me while I did the operation. It helped me work out the alignment of muscles so that I made the correct incision.

Our medical assistants have much better training now and communications have really improved. Last year I was faced with a nasty fracture dislocation. I'd never seen one before, but I was able to speak to a number of orthopaedic surgeons in Australia and send them X-rays of the injury for advice.

As a result of my experience at Mawson I decided to refresh my surgical skills for the 2004 trip. I worked with two surgeons intermittently and assisted them in operations. I ended up proficient at doing appendix, hernias, open abdominals, laparoscopic gall bladders, caesarean sections and a fair bit of general surgery. It was good to have had that experience at Mawson because I had a better idea of the skills I might need second time round.

— JOHN BIRSS
MBChB, Grad.Dip.Prof.Mgt, FACRRM

CHRIS SAMMUTT

Dr John Birss (second from left) and nursing and anaesthetic assistants (Peter Murphy, Mark Watson, David van Duyl and Matthew MacDonnell) simulate abdominal surgery on a volunteer at Davis Station, during training.

Ginger and Gadget in Antarctica

After much anticipation, the newly certified, ski-equipped CASA 212–400 aircraft ('Ginger' and 'Gadget') touched down in Antarctica on 29 December 2004. A warm reception awaited them at the French station, Dumont D'Urville, and at Casey the following day.

Unfortunately, the aircrafts' arrival had been delayed by the complex nature of certification, the fitting of skis and ferry tanks, the obligation to meet the operating requirements set by the Civil Aviation Safety Authority, and weather conditions that did not match those needed for the flight from Hobart to Casey. This delay had a significant impact upon a range of planned scientific activities that were relying on the aircraft, including the Amery Ice Shelf Ocean Research project and some deep field science.

The demanding 3400 km flight over the Southern Ocean was a notable achievement, however, and the AAD is grateful to its French counterparts for the use of their skiway, support crew, accommodation and weather observations. Bureau of Meteorology staff at Hobart and Casey also provided a high standard of service, with the route forecast proving to be extremely accurate; while the Casey expeditioners did a fantastic job preparing and keeping both primary and alternate skiways serviceable – not only for the flight, but for the lengthy period of the 'deployment window' prior to the flight.

After aircrew familiarisation and training, both aircraft transferred to Davis Station and deployed field parties to the Amery Ice Shelf, Prince Charles Mountains and Grove Mountains. These operations on unprepared blue ice and snow surfaces provided invaluable experience to the aircrew.

On 12 January this year Gadget sustained nose gear damage while landing in the field. The reason for the failure is not yet known and investigations are continuing. Repairs were completed at Davis thanks to a cooperative effort between Australia, New Zealand, France, Italy and the USA, enabling spare parts to be flown to Concordia on the Antarctic Plateau. The parts were collected by Ginger – a trip that required the aircraft to operate in temperatures around -35°C and at altitudes of 3230 m. Gadget was ferried back to Hobart at the end of the season, but was unable to play any further part in the flying programme from Davis. Despite this, Ginger's capabilities – in the sometimes brief windows of good weather – were maximised with the use of five pilots and three engineers. A total of 22 inter-station flights were flown during the season; the most notable being the 2780 km flight from Davis to Casey and back in one day.

The end-of-season north-bound ferry of both aircraft from Casey to Hobart on 3 March was conducted in excellent conditions and, in contrast to the south-bound ferry flight, occurred with very little delay. This was due predominantly to the tailwinds that commonly arise on this route and the flight was completed in approximately 10 hours.

The aircrafts' introduction to Antarctica has led to an overall improvement in the level of ground support and safety to both fixed and rotary wing operations provided by the AAD – particularly through the employment and training of dedicated aircraft ground support officers in skiway preparation and certification, loading of expeditioners and cargo, refuelling, weather observation, and expeditioner briefings. However, the venerable AS 350BA (Squirrel) helicopters, which have been operating for 19 years, will continue to provide essential support by maintaining the link between the Davis Plateau skiway and Davis Station, and by providing additional search and rescue coverage.

It was disappointing that the initial delays in delivery of the planes to Antarctica, and the damage to Gadget's nose gear during field operations, resulted in so many detrimental impacts to the planned science programmes. However, the operational knowledge gained in the performance of ferry flights, intra-station transfer and deployment, and the support and retrieval of field parties, will be invaluable to the continued implementation of a safe, efficient and reliable air transport system in the future.

—ADRIAN PATE and CHARLTON CLARK
Operations Branch, AAD

Aircraft Ground Support Officer Sharon Labudda prepares to hook up another load of cargo from Ginger to the Squirrel helicopter, for transfer to Davis.

SKYTRADERS

Leading the charge to Antarctica

IAN PHILLIPS

Voyage leaders are critical to the success of scientific and/or re-supply voyages to Antarctica; ensuring complex logistical operations proceed safely and on time and developing contingency plans when conditions change. Together with a team of logistical experts both on and off the ship, sea ice physicist Vicki Lytle helped steer the Aurora Australis *through a tight six-week schedule of equipment deployment, krill fishing, sea-ice studies and the delivery and retrieval of people to and from Antarctica, during the AAD's first voyage south for the 2004–05 season.*

Everyone was aboard. The bosun looked my way and asked if they could pull up the gangway. I glanced behind me before I realized he was talking to the voyage leader…me! After a quick confirmation from the logistics manager, I nodded and the crew went to work. My first trip as voyage leader and so far things were going well.

As the ritual of pulling up the gangway proceeded, I wracked my brain for something we had forgotten, or some snippet of information I needed. Nothing critical came to mind. I studied the expeditioners along the rail, trying to put names to faces. About 50:50. Not bad for me. Then I spotted one of my colleagues rushing through the crowd to get an envelope on board. This was routine, just like every other voyage I'd been on. Time to relax.

When I was deputy voyage leader last season, I wasn't sure what the voyage leader did. Today, I still struggle to create an exact list of the voyage leader duties. Before departure I had been briefed, given manuals, briefed, attended meetings, and briefed. I had asked a myriad of questions, studied manuals, reviewed manifests, created lists, revised lists and lost lists. In hindsight, I think a voyage leader is best described as a data resource. People would tell me things which I would file, filter and collate. Then I would pass the information on to other people who would in turn tell me more things. Like a big white board; and yes, things occasionally were erased before their time.

The biggest challenge of the voyage was organising the two visits to Casey Station. People and cargo were going both ways via three Squirrel helicopters on each visit, 10 days apart. The new CASA 212–400 aircraft were also flying from Hobart to Casey and we were delivering the aircraft spares and tools, as well as an engineer and pilot. Some people needed to go to Casey on the first visit and return to the ship on the second. We also needed to drop off people intending to stay at Casey, or flying on to Mawson and Davis in the new aircraft.

Everyone going into Casey had important work to do, but I needed to decide which order to fly people and cargo. Discussions with the project scientists, station leaders, operations manager and others started before we left Hobart, but priorities changed as the CASA aircraft schedules were modified. Everyone was hoping the sea ice conditions would allow us to sail close to Casey Station, but the ship ground to a halt some 100 miles distant.

This put us near the limit of permissible helicopter range, severely restricting loads in the helicopters. The first group off the ship – scientists destined for Law Dome – needed to get into the field in order to catch the return trip home. People and cargo departed the ship over the next six days during breaks in the weather, as the sea ice continued to push the ship west. As the weather closed in, however, the ship approached maximum flying range and I decided to stop the fly-off operations and start the sea ice work, hoping we would be able to get closer in 10 days. Unfortunately, this meant that several people who wanted to go to Casey had to wait on the ship for another two weeks.

Compared to the fly-off operations at Casey, the marine science work seemed straightforward; probably because I had been closely involved in similar operations from a science perspective several times in the past. The trials before the voyage had gone well and the people working from the trawl deck did a great job, especially with the new and heavier trawl gear. The sea ice biological programmes were also relatively straightforward. There were less than a dozen people getting on and off ice floes from the ship and using short helicopter flights; rather than the 80-plus people and tonnes of cargo flying to and from Casey.

You could say we had some good luck on the voyage. The sea ice conditions were just loose enough to allow us within flying range of Casey on both visits. The sea calmed down just when we wanted to trawl or work on the moorings. The krill arrived just when we were ready to give up. And the sea ice type was just right for the sea ice biology work. But it wasn't all luck. It was the really good people on board the ship, in Hobart, and from other institutions, who made the voyage a success. I will not try to thank everyone involved as I would surely forget someone, but they all helped make my first trip as voyage leader memorable.

—VICKI LYTLE
Ice, Oceans, Atmosphere and Climate Programme, AAD

VICKI LYTLE

Taking advantage of a chance to let their hair down are cargo supervisor Barbara Smith, voyage leader Vicki Lytle and deputy voyage leader Karin Beaumont.

Background image: Squirrel helicopters played a crucial role in delivering people and cargo to Casey Station after thick sea ice forced the *Aurora Australis* to remain some 100 miles distant.

Australia Day Awards

Two AAD project teams received Australia Day Achievement Awards this year; for successful air transport operations and planning the 2003–04 Heard Island expedition.

The work of the AAD **Air Transport Team** to introduce two CASA 212–400 aircraft ('Ginger' and 'Gadget') into Antarctica, has significantly advanced preparations for the potential introduction of intercontinental air transport between Australia and Antarctica. In presenting the award, AAD Director Dr Tony Press said the project team had shown great initiative in all their endeavours, and responded efficiently, with good humour and creativity to every request and direction received.

GLENN JACOBSON

Dr Tony Press (left) and the Air Transport Team: Charlton Clark, Stuart Mcfadzean and Adrian Pate.

The **Heard and McDonald Island Marine Research Project Leadership Team** coordinated the ambitious expedition to Heard Island and surrounding seas in 2003–04. The project aimed to relate the feeding and foraging activities of large, predatory animals on Heard Island, to their food stocks in the Southern Ocean. The project also examined the effects of climate change on the island's glaciers and vegetation. Work at numerous locations on Heard Island and aboard the RV *Aurora Australis*, required a high level of support coordination.

'The success of the Heard Island expedition was due to meticulous planning by the Leadership Team, coupled with strong support from colleagues in Kingston, on Heard Island and aboard the *Aurora Australis*,' Dr Press said.

GLENN JACOBSON

Members of the Heard and McDonald Island Marine Research Project Team: Dana Bergstrom, Nick Gales and Andrew Constable.

Director's Award for Excellence

JOHN SMITH

John Smith attends the Portuguese fisherman.

Dr John Smith received this year's Director's Award for Excellence for his response to an International Maritime Distress call last December, while acting as ship's doctor on board the MV *Oceanic Viking*. AAD Director, Dr Tony Press said Dr Smith provided extraordinary lifesaving medical support to an unconscious fisherman during an eight-day emergency dash from the isolated Heard and McDonald Island fishery to Fremantle, Western Australia (page 26).

Dr Smith's actions were commended by the AAD Polar Medicine Unit, the medical specialists involved in Hobart, Melbourne and Perth, the Australian Customs Service and the Consul-General of Portugal.

Mawson's Huts recognised as a national treasure

Mawson's Huts – remnants of the 'Heroic Era' of Antarctic exploration – have been recognised for their historical, scientific and cultural significance by their inclusion on the National Heritage List.

Announcing the listing on Australia Day this year, Minister for the Environment and Heritage, Senator Ian Campbell, said the huts were a symbol of Australia's pioneering role in the exploration of Antarctica.

'In 1911, with the nation cheering him on, Douglas Mawson ventured as a hero into a largely unknown environment, confident that his exploration of the Antarctic continent would help make Australia richer in both scientific knowledge and in resources,' Senator Campbell said.

'He established the first base for scientific and geographical discovery in Antarctica by Australians, and from four simple huts in the fiercest environment on Earth, he set out to learn as much as he could about the land, the ocean, the weather, the rocks and the forces that carved out Antarctica.

DAVE KILLICK

One of Mawson's huts.

'The research and survey work he conducted, laid the foundations for what is our world renowned Antarctic research programme today.'

The AAD's submission to have the huts listed for protection under the *Environment Protection and Biodiversity Conservation Act* highlighted a range of heritage values. These included archaeological, scientific, technical, social and historical values. More information on Mawson's Huts can be found at <http://www.aad.gov.au/default.asp?casid=12151>. More information on the National Heritage List can be found at <http://www.deh.gov.au/heritage/national>.

Award for Antarctic engineers

AAD engineers have been recognised for their dedication and innovative approach to ensuring sustainable Antarctic operations.

Chief AAD engineer **Chris Paterson, and his team**, received the President's Prize at the Australian Engineering Excellence Awards in November 2004, for their efforts in developing a sustainable energy system at Mawson Station. The system includes two wind turbines to help power the station, and hydrogen generated using energy from the turbines, which is used for heating.

The President of Engineers Australia, Mr Doug Jones, said, 'This environmentally-sound, cost effective, sustainable energy system is the first serious attempt by any nation to use wind power generation in Antarctica on a large scale.

'When the system is fully developed, an Antarctic station will, for the first time, be able to use a renewable source to meet virtually all its energy needs.'

The award also acknowledges the AAD's proactive management of the satellite link between Kingston and the Antarctic stations, to make the most efficient use of bandwidth; and the work of the mechanical workshop in the refurbishment (recycling) of Hagglunds vehicles.

Mawson turbine construction.

JOHN SMITH

Royal Society of Tasmania Award

AAD biologist, **Harvey Marchant**, was awarded the prestigious Royal Society of Tasmania medal in March for his prolific contribution to science and scientific publications over many years.

Among the many publications to which he has contributed are *Australian Antarctic Science: the first 50 years of ANARE,* published in 2002, and *Antarctic Marine Protists*, launched in March (page 11).

Harvey is renowned internationally for his research on the Antarctic plankton community and his contribution to the detailed taxonomy of the species. He has also played an active role in several international committees and working groups, including the SCAR (Scientific Committee on Antarctic Research) Group of Specialists on Southern Ocean Ecology and the Intergovernmental Panel on Climate Change.

GLENN JACOBSON

Harvey Marchant

Arts Fellows on-line

Want to learn more about seal wallows, mass spectrometers, katabatic winds, iceberg formations and the 'A' factor? Then log on to **Margo Foster**'s online diary on the ABC's Bush Telegraph website <http://www.abc.net.au/rural/telegraph/antarctica/default.htm>. Margo – one of the AAD's Arts Fellows – recently spent six weeks on board the *Aurora Australis*, braving heavy seas, fierce winds and curious wildlife. Along the way she recorded the sounds of ship life and the excitement of three brief stopovers at Mawson, Casey and Macquarie Island. Sounds include the 'song' of the ship stabilisers, the crunching of sea ice, whirring helicopters and wallowing seals. Margo will use the sounds of Antarctica for a series of specialised projects including a radio documentary and a soundscape for the Macquarie Island House at the Tasmanian Royal Botanical Gardens.

Also on board was teacher and childrens' author/illustrator, **Alison Lester**. Her Arts Fellow project involves drawing and painting Antarctic scenes and encouraging school children across Australia to draw images of Antarctica based on her emailed descriptions. The drawings will form part of a travelling exhibition of paintings called Kids' Antarctic Art. To read Alison's diary, see her photos and participate in her project visit <http://www.alisonlester.citymax.com/page/page/1781659.htm>.

BREAKING NEWS

Air link helps Antarctic research take flight

Australia has committed $46.3 million over four years to develop an Australia-Antarctic intercontinental air link.

Announcing the funding in the recent Federal Budget, the Minister for the Environment and Heritage, Senator Ian Campbell, said this was one of the biggest boosts to the Australian Antarctic programme since it began in the late 1940s.

The air link will operate between Hobart in Tasmania and a glacial ice runway to be constructed near Casey Station in the Australian Antarctic Territory. It is proposed to use a long range jet aircraft, which will also have the capability to help protect Australia's national interest through surveillance of our Southern Ocean fisheries.

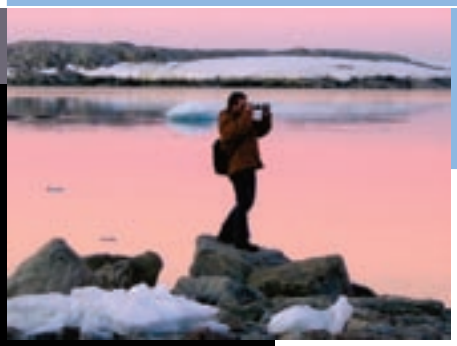
Feasibility studies, including runway construction trials, have already been completed. Trial flights are scheduled to start in 2006–07.

The more I stay here the more I love Antarctica.

Icebergs drift through the harbour in search of a place to rest; clouds form beautiful, organic patterns in the sky; unique rock formations make us question how they came to be; and the long days throughout summer bring glorious, deep colours and endless sunsets. Antarctic wildlife amazes me even more. Being able to catch it at the right moment is a challenge. This storm petrel and iceberg paves the way for photographic artwork and beauty. These images are what will stay with me when I return to Australia and remind me of my life in Antarctica.

—Christopher R. Clarke

BRAD BAILEY



FREEZE FRAME

Christopher R. Clarke is a communications technical officer and station photographer at Casey Station. This is his first year in Antarctica. He has previously worked in IT and as a freelance photographer. Antarctica's beauty, remoteness and wildlife have taken him there.

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Australian Government
Department of the Environment and Heritage
Australian Antarctic Division