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Australian Government
Department of the Environment and Heritage
Australian Antarctic Division

Australian ANTARCTIC MAGAZINE

a window on CLIMATE CHANGE

9 Spring 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.

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FRONT COVER: JAMES DRAGESIC
BACK COVER: Although well adapted to their environment, life can still be tough for emperor penguin chicks. FREDERIQUE OLIVIER
INSIDE COVER: Sunset FREDERIQUE OLIVIER

Sharing the winter with emperor penguins has been the most amazing experience in my brief Antarctic career. Emperors are unique in that they manage to raise their chicks in the harshest winter weather. In the space of 10 weeks, in temperatures that humans can barely cope with, these tenacious and dedicated parents oversee the development of their tiny, fragile, hatchlings into these cute and charismatic little characters. Emperors fulfill an extreme challenge and teach us to remain humble in the face of Antarctica's wild and unforgiving environment.

—Frederique Olivier

FREEZE FRAME

A field scientist by trade, Frederique (Fred) Olivier has dedicated the last six summers to conducting a variety of science projects down south, or guiding tourist expeditions. Spending last winter at Mawson, she assisted in the filming of emperor penguins for a BBC Natural History series, which gave her the opportunity to invest herself full time in another passion...photography.

WADE FAIRLEY

A window on climate change

Sørsdal glacier near Davis.

After the introduction of two new CASA 212-400 aircraft to Antarctica last year, the Australian Antarctic Division (AAD) is this year gearing up to deliver an inter-continental air service between Hobart and Casey in 2007.

The Australian Government has given the AAD an extra $46.3 million over four years to establish the Australia–Antarctica Airlink. Preparations are underway to secure a suitable aircraft and to build the ice runway and supporting infrastructure at Wilkins Aerodrome near Casey station. The inter- and intra-continental aircraft, in combination with our ships, will provide modern logistics to support Australia's Antarctic scientists in their work, and to open up new research opportunities in unexplored areas of the Australian Antarctic Territory and the Southern Ocean.

A major thrust of our research aims to understand the role of Antarctica and the Southern Ocean in regional and global climate processes; how these climate processes arise; the impacts of climate change; and how ecosystems, communities and species will respond. In this issue of the *Australian Antarctic Magazine* we look at some of this research.

To set the scene, glaciologist Tas van Ommen, steers a path through the greenhouse jungle, describing the difficulties faced by researchers trying to separate human-induced climate change from natural climate variation. He also discusses the work yet to be done; work that is continuing through Australia's Antarctic programme and some of which is described in subsequent articles. This work includes monitoring the effects of sea ice reduction, understanding the responses of plants and animals to a changing environment, and improving climate models.

This issue also brings you up to date with the latest results from projects in our Southern Ocean Ecosystems Programme. Since our Heard Island expedition in 2003-04 (*Australian Antarctic Magazine* 7), Toby Jarvis has been analysing hydroacoustic data for clues to what makes up Heard Island's marine ecosystem. Colin Southwell has also finalised a survey of crabeater seals in east Antarctica - his results have implications for the sustainable harvest of krill in the Southern Ocean.

It has been a busy year for those in the AAD involved with the Antarctic environment, Antarctic tourism and whales. At this year's Antarctic Treaty Consultative Meeting, for example, Treaty Parties adopted rules governing liability for 'environmental emergencies' (such as oil spills), concluding 12 years of complex negotiations. The Treaty Parties also passed the first site-specific guidelines for tourism on the Antarctic Peninsula, to manage tourism and to protect sensitive plants and wildlife. These guidelines will also help protect the tourist experience in this rapidly growing industry. Last but not least, members of Australia's Antarctic programme, participating in this year's meeting of the International Whaling Commission, were pleased to see the moratorium on commercial whaling retained.

Finally, on page 26, I am pleased to present our new Environmental Policy, which was finalised in April. As part of the Australian Government's Department of the Environment and Heritage, and as an environmentally responsible member of the Australian and Tasmanian communities, the AAD extends its environmental ethics to all its activities – at 'home' and in Antarctica – through its Environmental Policy.

Tony Press

—AJ PRESS
Director, AAD

FEATURE

Climate change: cold, hard facts on a hot topic

ADRIAN PATE

Sea smoke

Climate change is a hot topic in these times. Almost daily we are presented with claims and counter claims in a torrent of information of variable reliability. From some quarters we hear each and every extreme weather event cited as evidence of climate change, while others suggest that nothing is amiss, or that any changes to climate will be benign or beneficial. Rather like the extreme weather, extreme opinions can mask the underlying story, making it difficult to understand what is really occurring.

Modern climate science is global and multidisciplinary, and covers such a diversity of fields that maintaining a deep understanding across its breadth can be a challenge, even for professional scientists. The good news is that even without specialist training, the broad scientific issues are not so hard to appreciate and the main arguments can be readily understood.

What follows is an overview of some of the basics of climate change, with an emphasis on Antarctic issues. The Antarctic and Southern Ocean regions are key components of the global climate system, and regular readers of this magazine will be aware that climate research is a major component of Australia's Antarctic science programme.

The fundamental issue in climate change is of course the greenhouse effect: the well-known fact that the atmosphere traps some of the heat that would otherwise radiate away from our planet into space. This effect is not at all contentious – without it, the average temperature of the planet would be about 33 degrees cooler than its actual value of about 14°C. But this is the *natural* greenhouse effect. The real issue is the degree to which human activity is strengthening the greenhouse effect.

We know that our use of fossil fuels and changes in land use have added large quantities of carbon dioxide (CO_2) and methane to the atmosphere, and that concentrations have reached levels not seen for several hundred thousand years or longer. In fact, Australian Antarctic research has provided the clearest proof of this change in atmospheric composition, which is revealed in the analysis of bubbles of past atmosphere trapped in Antarctic ice (see figure).

We also know that the CO_2 and other emissions have a powerful greenhouse impact. The effect has been likened to piling extra blankets on the planet. As long ago as 1896, a Swedish Nobel Prize winning chemist, Svante Arrhenius, raised the idea that fossil fuel emissions would have this effect, although interestingly, he drastically underestimated the 20th century growth in emissions, suggesting that it would take perhaps 3000 years for atmospheric CO_2 to double in concentration. In fact, depending on various social and economic assumptions, doubling is likely to occur mid to late this century.

Since Arrhenius first raised the issue, the real problem has been determining the strength of this human contribution to the greenhouse effect. In the real-world climate, warming as a result of increased greenhouse gases leads to a range of other climatic changes – some that tend to reinforce and accelerate warming and others that tend to counteract warming. For example, in a warmer climate, retreat of ice and snow cover leaves a darker surface, which absorbs more heat and drives further warming. Conversely, a warmer atmosphere carries more moisture that may cause increased clouds in some areas, which reflect sunlight before it reaches the Earth's surface, reducing surface warming. The net result quickly becomes too complicated for manual calculation and requires the use of computer models that use known physics to quantify the processes.

Identifying all the processes that need to be modelled and getting accurate mathematical representations is a central activity in modern climate studies. Observations of current and past climate behaviour help to refine understanding of climate processes and allow us to test and improve the climate models.

While there is a wide variety of modern climate models, all confirm the net warming effect of human greenhouse emissions, despite the fact that the various models adopt quite different approaches to their internal representation of the climate system. The models indicate warming over the course of the 21st century in the range of 1.4 to 5.8 degrees; about half this range comes from the uncertainties in the models themselves and the remaining half is from uncertainty in projected emissions.

A major part of testing models is to see how they reproduce, or 'hindcast', past changes, including the closely monitored changes during the 20th century. The best of these 20th century hindcasts closely reproduce the observed rate of warming and total global average increase of 0.6 degrees. Tellingly though, they can only do so if known human emissions of greenhouse gases are included as drivers, providing strong evidence that not only are the models capturing major climatic behaviour well, but that the emissions are indeed the cause of warming.

Climate observations are important in building and testing models. Observations also show us just how climate changes are being manifest. The task of detecting human-induced changes is difficult however, because the climate system has natural variability. We know that the climate has changed in the past - very dramatically over timescales of hundreds of thousands of years. Even over short timescales, the climate shows natural variations which can be substantial, especially over limited regions. The result is that it can be difficult to determine if an observed change is just part of the natural behaviour.

So how *do* we know that the 0.6 degree warming in the last 100 years is significant? Aside from the modelling evidence, the answer comes from looking at past climate indicators from tree rings, ice cores, corals, ocean sediments and other sources. Several different studies have produced reconstructions of global climate over past centuries, some extending back some 2000 years. The evidence is strong that today's global climate is warmer than at any time in this period. Glaciers are in retreat, arctic sea ice is declining and there are changes, particularly at the margins of Antarctica and Greenland, that all suggest a warming outside what could be explained by natural variability.

Some have argued that climate changes were much more drastic in the past but, to the best of our knowledge, the climate has never been much warmer than present; that is, unless you look so far back that the whole geology, chemistry and biology of the planet was radically different. In more recent periods, over the past several hundred thousand years, temperatures in the warm intervals between ice ages may have reached a degree or two warmer than present. However, for ice age cycles, we know that temperature changes arise from slow variations in the Earth's orbit, which are not the cause of present warming. What's more, these ice age changes are much slower than current warming and happened in an environment with only about 280 ppm (parts per million) CO_2 and not the approximately 380 ppm we see today.

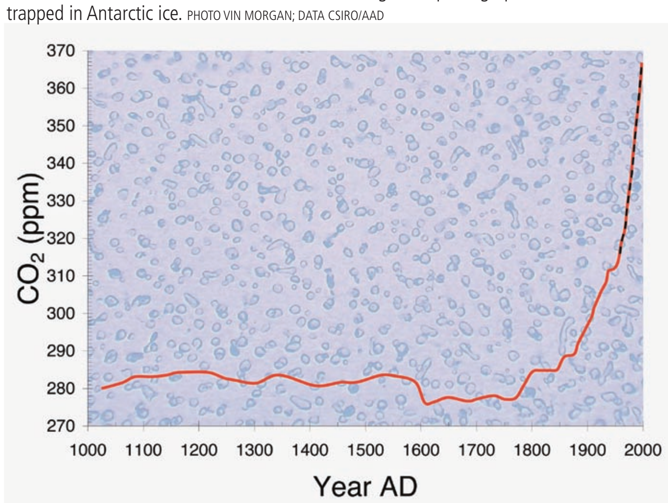
The evidence for human-driven climate change is now well established and the tasks ahead are both political and scientific. As we look for ways to respond, we are ever more reliant on our understanding of the climate system in all its complexity. The question of 'what to expect?' is a pressing one that demands continued scientific effort. Models are improving, but are generally limited in their ability to predict changes at continental and regional scales. We know that the climate changes will not be felt uniformly across the planet. Better understanding of the detailed workings of climate will be needed to reduce uncertainties.

In this century we will continue to see loss of temperate glaciers, increases in sea level in the range of 10 to 80 cm, average warming of about 1.4 to 5.8°C, and significant changes to the ice margins of Greenland and Antarctica. Popular reports of complete loss of ice in either Greenland or large portions of Antarctica, with metres of sea level rise, are inconceivable in less than centuries to millennia. The Antarctic interior is so cold that even the strongest projected warming will not lead to complete melting. But this is cold comfort, for even more realistic climate changes will have major impacts.

There is much to be done in Antarctic and Southern Ocean climate research. The systems of high southerly latitudes interact with the global climate system in powerful ways. The annual cycle of sea ice formation generates cold salty water masses (so-called Antarctic bottom water) that have major impacts on global ocean circulation. Monitoring these ocean water masses and understanding changes is just one aspect of ongoing research.

The response of sea ice formation to a warmer climate is likely to have large impacts on ocean circulation and the whole Southern Ocean ecosystem. Integrated research on the combined physical and biological components of this system is a major aspect of research at the Antarctic Climate and Ecosystems Cooperative Research Centre. The Antarctic ice sheet itself is a major target of study. Even small changes in the size of this ice sheet will have significant consequences for sea level, and changes are already being seen as warming alters the balance between water accumulation as snow, and water loss by iceberg calving and melting.

Atmospheric CO_2 concentrations over the past 1000 years from Law Dome ice cores. The ice core measurements overlap with direct atmospheric measurements at South Pole, available since 1958 (black dashed line). The background photograph shows bubbles trapped in Antarctic ice. PHOTO VIN MORGAN; DATA CSIRO/AAD



The Antarctic is a region where the climate records from observations are both short and sparsely distributed. To address this limitation, the ice sheet and ocean floor will continue to be probed for information about past climate, by drilling ice cores and ocean sediment cores. Antarctic ice core records are providing new information on climate changes on the continent, the surrounding sea ice and Southern Ocean, and even Southern Australia.

Given this concentrated, multi-faceted effort and the clear imperative for understanding the climate changes we face in the future, Australian Antarctic science is set to continue its record of major contributions to international climate research.

—TAS van OMMEN
Antarctic Climate and Ecosystems Cooperative Research Centre and Ice, Oceans, Atmosphere and Climate Programme, AAD

FURTHER READING:
Barrie Pittock. Climate Change: Turning up the heat. CSIRO Publishing, 2005.
Spencer Weart. The Discovery of Global Warming. Harvard University Press, 2003.
Also online at <http://www.aip.org/history/climate/>
RealClimate Website: <http://www.realclimate.org/>

ADRIAN PATE

A new international programme for Antarctic climate research

The Antarctica and the Global Climate System programme will focus research attention on the Antarctic climate and its interaction with the global climate.

A new scientific programme called 'Antarctica and the Global Climate System' (AGCS), will focus research attention on the Antarctic climate and its interaction with the global climate.

The programme is one of five flagship activities of the Scientific Committee on Antarctic Research, and 12 nations, including Australia, have submitted plans to address issues covering four main themes.

The first theme will look at climatic change across Antarctica and the Southern Ocean and try to better describe and understand climate variability over decadal time spans. The work will largely rely on observational data and computer modelling. Research will investigate, for example: changes in the El Niño Southern Oscillation that might relate to Antarctica and the Southern Ocean; shifts seen in many post-1970s climate indicators; and recent trends in atmospheric pressure and winds around Antarctica (connected with a phenomenon known as the Southern Annular Mode).

The second theme aims to use ice cores to better reconstruct the climate since the peak of the last ice age, and particularly over the last 10 000 years (the Holocene Period). A key activity, and one in which Australia has played a significant role, is the calibration and understanding of the relationships between typical climate parameters (such as temperature) and the dozens of properties that are measured from ice cores.

The third AGCS theme aims to separate the Antarctic climate response to natural and human influences. To do this, researchers will develop climate models and run simulations to evaluate Antarctic and Southern Ocean climate responses under different scenarios of natural variation and human activities. Australian researchers will focus on the response of the ice sheet to warming and its consequent impact on sea level. This work will involve enhancing climate models, by adding interactions between the ocean and ice shelves, which are currently not included.

The fourth theme of the programme looks at how Antarctic climate processes influence the global climate. We know, for example, that the formation of deep, salty, cold ocean water around Antarctica has a global impact. Computer model simulations and direct oceanographic observations will help us study these processes.

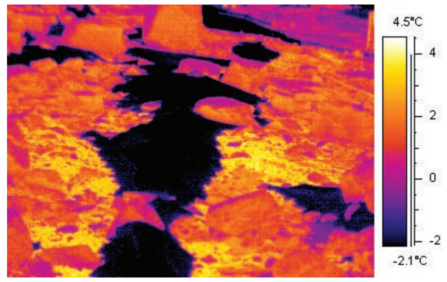
The AGCS programme runs from 2005-2010. It will include a number of international activities throughout the International Polar Year (2007-2009) and will provide a valuable forum for the development of Antarctic climate science into the future.

—TAS van OMMEN
Antarctic Climate and Ecosystems Cooperative Research Centre and Ice, Oceans, Atmosphere and Climate Programme, AAD

MARCUS SCHORTEMEYER

Warm gravel gathers more moss

MARCUS SCHORTEMEYER



Above right: The false-colour thermal image of moss growing at Mawson (original image at top) shows that snow has the lowest temperature – about -2.1°C – followed by rocks and boulders and then gravel beds. Moss turfs clinging to the gravel are even warmer, at a steamy 3-4°C.

Above left: Professor Marilyn Ball and PhD student Danielle Medek, from the Australian National University, record a thermal image of a moss turf at Casey.

Unlike most plants, some mosses are well adapted to the extreme cold, dry climate of Antarctica. They can survive long periods in a frozen or dried-out state. However, they need access to liquid water to grow. When air temperatures are near freezing point, it is therefore important to know if mosses and their immediate environment are colder or warmer than air, and whether they can access melt-water from ice or snow.

To identify the conditions that allow mosses to grow, and to predict how they may respond to possible climate cooling or warming, we need to know the actual temperatures at which mosses function. These temperatures may differ markedly from those recorded by weather stations.

At Mawson and Casey in early 2005, we used thermal imaging – using an infra-red camera – to assess and record surface temperatures in the Antarctic landscape. We found that loose gravel was usually warmer (up to two degrees) than solid rock surfaces (which have a larger thermal mass and take longer to warm up in the sunlight). Moss cushions and turfs, in turn, were up to two degrees warmer than gravel. Thus, gravel not only provides an easier substrate for mosses to cling to and take up nutrients, but also gives moss cushions a thermal advantage.

In a related experiment we looked at the effect of water on different moss species after cold, dry periods. Small dehydrated samples of moss cushions of two local species at Mawson – the Antarctic endemic *Coscinodon lawianus* and the cosmopolitan *Bryum pseudotriquetrum* – were brought back to Canberra and re-wetted at cool temperatures. At the end of the Antarctic summer it takes *Bryum* one to two days to regain its capacity for photosynthesis after rehydration. In contrast, *Coscinodon* achieves the same in two hours. Thus, changes to the frequency of freezing and thawing, or drying and re-wetting cycles, as a result of climate change, could determine which species does better in Mawson's harsh environment.

In the next phase of the project we aim to determine how often water is available to Antarctic mosses, how long these 'moist' periods last, and how these 'windows of opportunity' are used by the plants for growth.

—MARCUS SCHORTEMEYER
Australian National University

Southern Ocean Atlas

CRAIG MACAULAY

Contributor to the Southern Ocean Atlas, John Church, from CSIRO and the Antarctic Climate and Ecosystems Cooperative Research Centre, presents a copy of the atlas to Professor Michael Stoddart, Chief Scientist of the Australian Antarctic Division (AAD). The atlas will be keenly reviewed during the AAD's marine science voyage (BROKE-West) in January 2006.

When the *Aurora Australis* departed Hobart on her first voyage of the season in October, she took a 'road map' to the inhospitable Southern Ocean. The 225-page Southern Ocean Atlas is the first of four atlases in a series that also covers the Pacific, Atlantic and Indian oceans. The atlases were produced as part of the World Ocean Circulation Experiment (1990-2002) that aimed to establish the role of the oceans in the Earth's climate and to obtain a baseline dataset against which future change could be assessed. About 30 nations, including Australia, participated in the programme, using ships to make physical and chemical observations and employing moored and drifting instrumentation. Satellites were used for global observations. Funding of Australia's commitment to the programme was made through CSIRO, the Bureau of Meteorology, the Antarctic Climate and Ecosystems Cooperative Research Centre, the Australian Antarctic Division and the Federal Government's science and environment agencies. Printing and international scientific distribution of the series has been partially funded by energy explorer BP. For details see <http://www.woce.org/atlas_webpage/>.

Going with the floe

The Western Weddell Sea is rarely visited by Australian scientists. But in the summer of 2004-05, sea ice scientist Dr Anthony Worby and his field assistant Carl Hoffman, worked on a multi-national, multi-disciplinary, drifting ice station in the region. The Ice Station Polarstern *(ISPOL) study was organised by the Alfred Wegener Institute for Polar and Marine Research in Germany and involved glaciologists, biologists, oceanographers and meteorologists from 12 nations. ISPOL and similar studies in the future will provide international scientific programmes with information about changes in sea ice over time and its effect on the global climate.*

The Western Weddell Sea is one of the few regions around Antarctica where the sea ice does not melt completely over summer. For 37 days between November 2004 and January 2005, the German icebreaker *Polarstern* was moored to an ice floe that drifted with the winds and currents. This drifting laboratory provided scientists with round-the-clock access to adjacent ice floes, where experiments were set up to observe changes in the physical and biological properties of the sea ice during the early summer melt season.

The ice station was set up in the same region where Shackleton's ship *Endurance* was crushed in heavy sea ice in 1915. Having experienced the particularly harsh ice conditions that can occur in this region first hand, it is not hard to see why the wooden-hulled ship suffered such a terrible fate. Even with four powerful engines and a strengthened double-steel hull, the *Polarstern* struggled at times to break through the sea ice, which in some areas was ridged up to 10 m thick.

While the large-scale ocean circulation in this region is well understood, a great deal is yet to be learned about the impact of forces such as wind, waves, currents and tides on the drift and deformation of the sea ice. This is important because the sea ice has a significant effect on ocean-atmosphere interactions in the polar regions and is an important component of the global climate system. To learn more about the sea ice drift, we used helicopters to deploy a series of drifting sea ice buoys over a region of approximately 70 x 70 km. Each buoy reported its position hourly using the satellite Global Positioning System (GPS) and some carried air temperature and pressure sensors. The GPS technology enabled us to track the drifting buoys from the ship and to revisit them throughout the experiment. The buoys were deployed on ice floes of about 1.5-3 m thick, which is enough to safely land a helicopter on, despite the water below being more than 2000 m deep.

On clear weather days we took aerial photographs over the buoy locations so that we could monitor changes in sea ice conditions related to the drift and deformation of the sea ice. The photographs were taken with a high resolution digital camera that was mounted in an enclosed casing on the skid of the helicopter. The photographs were processed with computer software designed to identify different ice types and floe sizes. The mosaic of images (below) shows the ice station on 1 January 2005, with the ship clearly visible moored to an ice floe.

Analysis of the data has already shown how cyclical changes in wind speed and direction influences the drift of the ice, and how the onset of summer conditions changes the surface characteristics of the floes. The aerial photographs show the development of surface melt ponds as well as a reduction in average floe size and an increase in the area of open water between the floes. When combined with oceanographic and surface measurements, these data give us insights into the processes that dominate ice decay and breakup. This information is used to improve the way that sea ice is characterised in global climate models, which are the primary tools used to investigate possible climate change scenarios and to predict future climate.

Two of the drifting buoys were left on the ice at the end of the voyage. They have provided data right through 2005 and are expected to continue into 2006. One of these buoys drifted northeast in the Weddell Gyre (an ocean current), while the other drifted west through Drake Passage and south along the western side of the Antarctic Peninsula. These buoys were originally deployed approximately 70 km apart, and are now more than 800 km apart, providing new insights into the large-scale sea ice drift in the region.

—ANTHONY WORBY
Antarctic Climate and Ecosystems Cooperative Research Centre and Ice, Oceans, Atmosphere and Climate Programme, AAD

Anthony Worby deploys a buoy on a sea ice floe to gather information about sea ice drift.

The Ice Station *Polarstern*.

Below: This sequence of aerial photographs shows the sea ice conditions in the region of the ice station. The *Polarstern* was moored to an ice floe that drifted approximately 100 km northward during the 37-day experiment.

Lightweight ice core drilling rigs, such as this, can be deployed by aircraft and allow short, remote field programmes to retrieve cores to several hundred metres depth.

Solving an ice age mystery with a million year old ice core

International moves are afoot to drill an ice core in Antarctica containing a 1 million year record of the Earth's climate. The project is one of four recommended by the International Partnerships in Ice Core Sciences – a recently formed group of ice core climate researchers from 12 nations, including Australia. A 1 million year record is significant because it would provide information such as climatic temperature and atmospheric greenhouse gas concentrations over a period of fundamental change that occurred in the ice age cycle some 900 000 years ago.

For about 2.5 million years, ice ages had come and gone in a regular 41 000 year cycle. But about 900 000 years ago, something in the Earth's climate system changed and the cycles mysteriously switched to an ice age every 100 000 years (see figure). These glacial cycles are linked to small variations in the Earth's orbit around the sun, which produce changes in the amount of solar radiation reaching the Earth. However, these changes in solar radiation are too small to directly produce the large temperature changes needed to move in and out of ice ages. Rather, a range of natural 'amplifying' phenomena (feedback mechanisms, thresholds and resonance) in the Earth's climate system must be driving the switch. We need to understand these amplifiers to better understand the climate system and make realistic predictions of future natural or human-induced changes.

Our knowledge of long-term climate variability comes from sources such as ice cores and ocean sediment cores that store data in layers that can be accessed by drilling. Sediment cores provide records that extend back millions of years but, so far, the oldest ice core is that drilled at Dome C during the European Project for Ice Coring in Antarctica (EPICA) – dating back 804 000 years.

Recent data from a sediment core suggests that the ice age cycle switch may have been due to a change in the carbon dioxide (CO_2) concentration in the atmosphere. Because CO_2 is a greenhouse gas that helps the atmosphere trap solar heat, a change in CO_2 will alter the global heat balance and so could alter the amount of heat necessary to trigger a jump into or out of an ice age. Ice cores contain samples of the atmosphere in bubbles, which can be analysed to determine atmospheric composition. Currently, CO_2 levels in the atmosphere are higher than they have been for at least 450 000 years. A long ice core record of atmospheric composition would therefore allow us to directly test the role of greenhouse gases in causing the mysterious ice age period switch.

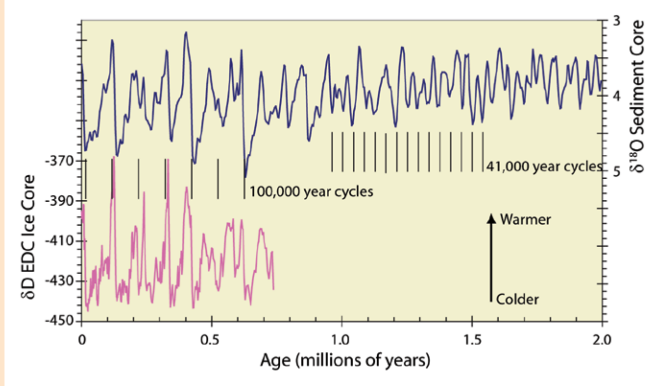
Drilling a 1.2 million year ice core is a large undertaking and would most likely be carried out by an international consortium. Drilling is likely to start around 2011, but before then we need to identify a suitable site (or sites – since two cores are necessary to confirm that the deepest part of the record is a true record of climate and not distorted by uneven ice flow over the bedrock hills). The Aurora Basin, 700 km inland of Casey station, has ice sheet properties that may be suitable (see box). In 2008-09, we propose to drill a 600 m pilot ice core over Aurora Basin to investigate ice sheet properties in the area. This pilot core will also provide a climate record midway between the inland Dome C site (where the 800 000 year core was drilled) and the coastal Law Dome site (where a 90 000 year core was retrieved by Australian Antarctic Division glaciologists between 1989 and 1993), allowing us to compare the different climate records.

The pilot core project proposal has already gained international interest, with the offer of a Danish ice core drill. At this stage, international participation depends on commitments of other national programmes and also on our ship and air transport options. Fortunately, Aurora Basin is within convenient reach of our new CASA 212-400 aircraft from Casey. The advent of the Australian-Antarctic Airlink will also greatly facilitate the project and encourage collaboration.

—VIN MORGAN
Antarctic Climate and Ecosystems Cooperative Research Centre and Ice, Oceans, Atmosphere and Climate Programme, AAD

Predicting the age of ice cores

The age of cores from an ice sheet depends primarily on the rate of snow accumulation and the ice thickness. For example, at Dome C the current accumulation rate is 2.7 cm of ice per year and the ice thickness is 3136 m. The bottom of the Dome C ice core obtained during EPICA is 804 000 years old. This age is greater than that obtained simply by dividing the depth by the surface accumulation, because the annual ice layers get thinner with depth, due to ice flow. There are areas of Antarctica where accumulation rates are even lower (resulting in thinner ice layers), and there are areas where the ice thickness is over 4000 m. One of these deep areas is Aurora Basin. Here, accumulation rates vary from about 10 cm at the coastal boundary to less than 2.5 cm at the inland edge. With a similar accumulation rate to the Dome C site, and with some 900 m more ice, we anticipate that an ice core recording 1–1.2 million years of climate history will be obtainable.



ICE AGE CYCLE This figure shows sediment core and ice core climate records over the last 2 million years. $\delta^{18}O$ is a change in the chemical signature of small organisms (foraminifera) in the sediment core, and is a proxy for the size of the Northern Hemisphere ice sheets during ice ages. δD is the ratio of hydrogen isotopes in the Dome C ice core and is a proxy for global temperature. Ice sheet size and temperature track each other with a 100 000 year cycle over the 800 000 years for which there is ice core data. The sediment core shows the change to 41 000 year cycles prior to 900 000 years ago.

SEDIMENT CORE DATA FROM: AC MIX *ET AL.*, IN *PROC. OCEAN DRILL. PROG. SCI. RESULTS* 138. NG PISIAS, L MAYER, T JANECEK, A PALMER-JULSON, TH VANANDEL, EDS. (OCEAN DRILLING PROGRAM, COLLEGE STATION, TX, 1995), PP. 371-412. DOME C DATA: <WWW.NCDC.NOAA.GOV/PALEO/ICECORE/ ANTARCTICA/DOMEC/DOMEC_EPICA_DATA.HTML>

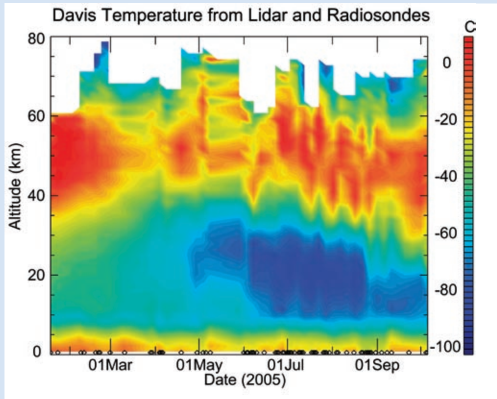
New telescope aids climate studies

A new telescope recently installed on the Davis LIDAR (Light Detection and Ranging), is enhancing the quality of climate-related data collected by the instrument. The new data will be used in the international Climate and Weather of the Sun-Earth System Programme to examine large-scale climate processes in the Antarctic atmosphere.

The LIDAR uses laser light to remotely sense atmospheric temperature as well as the properties of aerosols (fine solid particles and large molecules) from near the ground to about 100 km altitude. The new telescope allows us to collect more laser light that is scattered back from the atmosphere than before, extending the altitude range of the instrument and reducing the amount of time needed to attain more precise measurements.

One focus of the LIDAR research programme is on the temperature structure of the atmosphere. In the figure (right), temperatures obtained by the LIDAR above 25 km altitude are shown combined with measurements from balloons (radiosondes), flown by the Bureau of Meteorology. Part of the seasonal cycle in the lower atmosphere can be seen, with temperatures cooling to as low as -95°C during winter. At altitudes above 45 km, warm summer temperatures earlier in the year gave way to considerable variability, particularly in late winter and early spring. During July and August, the variability was associated with 'planetary-scale' waves which periodically influenced temperatures above Davis every 15 days or so. These waves are natural atmospheric oscillations that arise in the polar region due to climate processes occurring in the lower atmosphere.

It is becoming apparent that planetary-scale waves propagating in the stratosphere (10–50 km above the Earth) can influence weather patterns at the surface. This is important in developing long-range weather and climate forecasts, as planetary wave propagation at high latitudes is expected to be influenced by changes in atmospheric circulation associated with global warming and ozone depletion. Indeed, changing rainfall patterns in Australia have been linked with a shift in stratospheric circulation patterns over Antarctica.



Atmospheric temperatures (degrees Celcius) above Davis synthesised from LIDAR and balloon measurements. The LIDAR observation times are shown by diamonds above the date axis. Features during mid-May are smeared by a gap in the LIDAR observations due to instrument adjustments.

ANDREW KLEKOCIUK & ANDREW CUNNINGHAM

The LIDAR will continue this observing programme during 2006, when an additional telescope will be installed to further investigate stratospheric processes.

—ANDREW KLEKOCIUK, JOHN INNIS and ANDREW CUNNINGHAM
Ice, Oceans, Atmosphere and Climate Programme, AAD

FURTHER INFORMATION:
Climate and Weather of the Sun-Earth System Programme: <http://www.bu.edu/cawses/>
Stratosphere-troposphere coupling in the southern hemisphere: <http://www.nwra.com/resumes/baldwin/pubs/Thompson_Baldwin_Solomon_2005.pdf>
Stratospheric memory and extended range weather forecasts: <http://www.nwra.com/resumes/baldwin/pubs/Baldwin_etal_1Aug2003.pdf>
Climate change – An Australian guide to science and potential impacts: <http://www.greenhouse.gov.au/science/guide/>
Polar vortex linked to declining rainfall in Australia: <http://www.abc.net.au/catalyst/stories/s948858.htm>

Improved treatment of ice-ocean interactions enhances climate modelling

A new 'coupled' ocean-sea ice model will help researchers more accurately model how different components of the climate system interact, improving their ability to predict the effects of climate change.

One of the greatest challenges facing earth system science (see box) today involves understanding how the global climate system works, so that we can determine how it will respond to climate change and how to predict weather and climate on timescales from months to millennia.

The climate system has numerous components, including the atmosphere, ocean, cryosphere (ice and snow) and the biosphere (part of the Earth where living organisms reside). These components interact with each other at various levels. To advance our understanding of the global climate system, we need to understand the interactions and feedback mechanisms between all these components, by finding answers to questions such as:

- How will global warming affect sea ice and how will this affect the ocean circulation?
- What are the climate variabilities associated with seasonal, annual and decadal timescales, and how will that impact on life on Earth?
- What is the role of Antarctica within the global climate system, how does it interact with the Southern Ocean and how does it affect Australia?

To answer these questions we need a numerical model in which physical processes and their interactions are explicitly simulated. As a first step in this direction, the Australian ocean community has developed the Australian Climate Ocean Model (AusCOM). Model results from the Southern Hemisphere will be used to improve climate predictability by understanding which Southern Ocean processes and feedback mechanisms contribute to climate variability. They will also be used to assess how changes in the Antarctic impact on the global climate and vice versa.

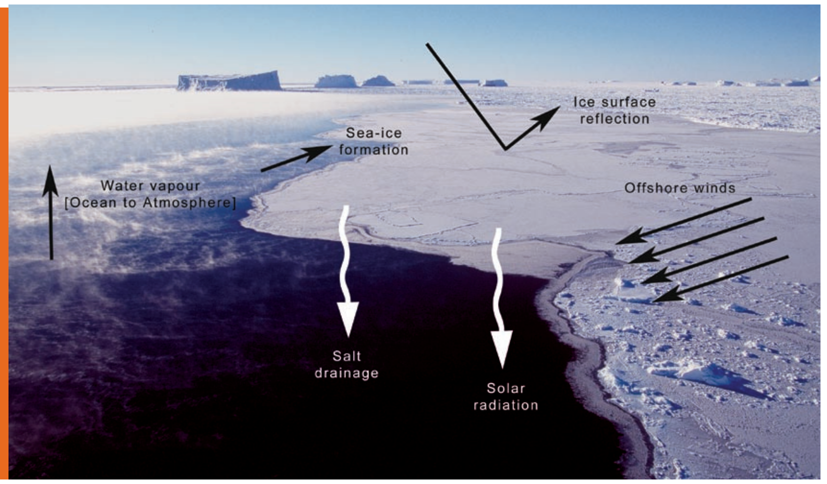
The AusCOM model is a 'coupled' ocean-sea ice model – an ocean model connected with a sea ice model. This coupling allows two of the main components of the climate system to directly interact. Information from changes in sea ice characteristics, for example, will feed into the ocean model, which then reacts in certain ways and feeds this reactive information back into the sea ice model. This provides a more accurate simulation of the climate system than using stand-alone models in isolation.

AusCOM is a collaborative effort involving scientists from the Tasmanian Partnership of Advanced Computing (TPAC), the Australian Antarctic Division (AAD), the Bureau of Meteorology Research Centre, CSIRO Marine and Atmospheric Research and several universities. Some of the model components were contributed by overseas colleagues, including the Geophysical Fluid Dynamics Laboratory (USA) and the European Centre for Advanced Training in Scientific Computation (France). The sea ice model was developed by the AAD and TPAC and will be integrated into the overall model. It is anticipated that the coupled model will be available to researchers in 2006.

—PETRA HEIL
Antarctic Climate and Ecosystems Cooperative Research Centre and Ice, Oceans, Atmosphere and Climate Programme, AAD

FURTHER READING:
Griffies SM. Fundamentals of ocean climate models. Princeton University Press, 2004.
Griffies SM, Pacanowski RC, Schmidt M, and Balaji V. Tracer conservation with an explicit free surface method for z-coordinate ocean models. *Mon Weather Rev* 2001;129: 1081-1098.
Roberts JL, Heil P, Murray RJ, Holloway DS, and Bindoff NL. Pole relocation for an orthogonal grid: an analytic method. *Ocean Modelling* in press.

Earth system science aims to understand how the Earth is changing and the consequences for life, with a focus on enabling prediction and thus, allowing room to mitigate undesirable consequences. Earth system science is multidisciplinary, and investigates the processes and interactions among the atmosphere, hydrosphere, cryosphere, biosphere and geosphere, from a global to local point-of-view and across the time scales (minutes to eons) in which these spheres interact. It requires knowledge of physical, chemical and biological processes, and uses mathematics to describe these processes within each sphere and the interactions between the spheres. These descriptions are combined with observations from instruments on the ground, in the atmosphere, at sea, or from space, to construct models through which complex interactions of the spheres are studied. It is through the understanding of these processes that accurate, predictive models are developed. MODIFIED FROM HTTP://EDUCATION.GSFC.NASA.GOV/ESSSPROJECT/ESS_DEFINITION.HTML



Production in sea ice could fall

New research suggests that climate change-induced sea ice reduction in Antarctica will shift the balance of 'primary production' – photosynthesis by seaweeds, phytoplankton and microalgae – from the sea ice to the sea floor, with consequences all the way up the food chain.

In the Antarctic marine ecosystem, sea ice controls light penetration, scours intertidal zones and ploughs through sediments. Thus, a reduction in sea ice cover as a result of global warming could lead to major alterations to the ecosystem as it adapts to changed seasonal light conditions, reduced abrasion and higher water temperatures.

Through the Institute of Antarctic and Southern Ocean Studies we have been investigating primary production at several coastal Antarctic sites with different annual sea ice distributions. The work is attempting to quantify the effects of sea ice reduction on coastal marine primary production. This is critical to our ability to understand and sustainably manage the coastal marine ecosystem and the resultant changes in animal populations that could occur.

In most temperate and tropical, coastal, aquatic ecosystems, primary production is dominated by two different plant communities – phytoplankton in the water column and seaweeds, sea grasses and benthic (bottom dwelling) micro-algae growing on the sea floor. Development of these sea floor communities is dependent on the amount of phytoplankton in the water column, as this can absorb much of the light available for photosynthesis.

In Antarctica, sea ice severely limits production in the benthic and phytoplankton communities for much of the year. Dense micro-algal mats develop on the underside of the sea ice over winter and spring, absorbing virtually all the available light and limiting both phytoplankton and benthic algal growth (there are no Antarctic sea grasses).

When the ice disappears or thins in late spring and summer, phytoplankton and benthic algal blooms occur. A reduction in sea ice through global warming could be expected to lead to an increase in benthic and phytoplankton production, providing more food for krill and fish.

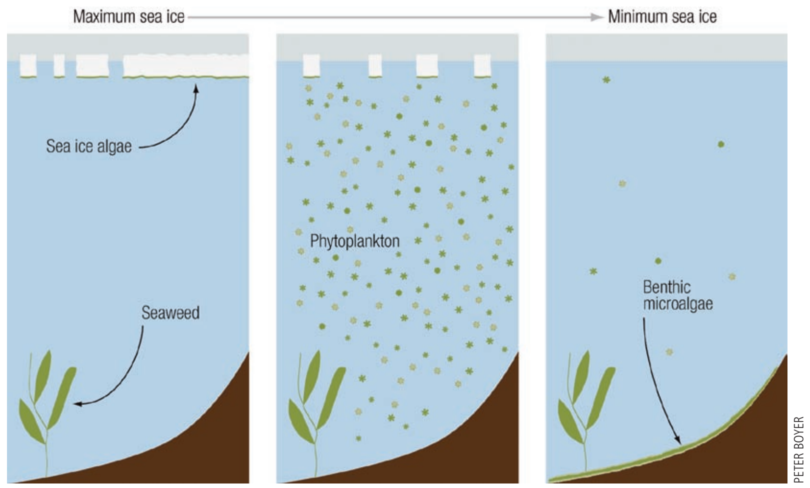
However, melting sea ice also stratifies the water column creating the necessary conditions for the development of large phytoplankton blooms. Accordingly, the absence of sea ice, or a very significant reduction in its extent, could limit the size of these important blooms. If so, we could see a cascading effect all the way up the food chain. The question then is: what is the net effect on primary production of sea ice change?

At Casey we have been measuring photosynthesis and primary production in the sea ice, the water column and on the sea floor, at sites covered by and free of sea ice. Field work commenced in the 2004-05 field season and will continue in 2005-06. *In situ*, custom designed micro-electrode and fibre-optic fluorescent probes are being used to make measurements.

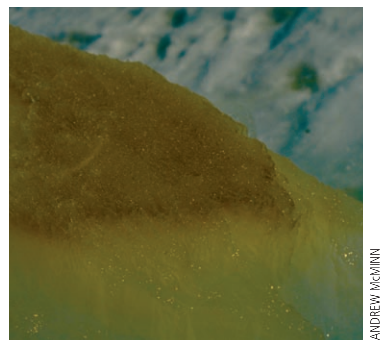
The results show that the contribution to primary production from sea ice algae in areas with less ice was lower than in areas with more ice. The net contribution from phytoplankton was approximately the same in both high ice and low ice areas but the contribution of benthic algae was considerably higher in areas with prolonged open water. It is predicted that in future years there will be an increasing proportion of annual production on the sea floor and this will favour benthic communities over 'pelagic' (open ocean) communities.

Further field seasons are planned to determine how much of the observed change has to do with inter-annual variability and how much is due to long term climate change. The work will also investigate how the changes in primary production are likely to affect other animals and plants.

—ANDREW McMINN
IASOS, University of Tasmania



In areas of high sea ice cover, primary production (photosynthesis) is dominated by sea ice algae. As sea ice thins and declines, phytoplankton in the water column take over, followed by benthic (sea floor) plant species.



The brown layer in the sea ice is dominated by the diatom species *Entomeneis kjellmannii.*

WADE FAIRLEY

"Many snowy petrels follow in the wake of the ship, but they are silent companions, never uttering a song or a cry of delight or fear, always gliding lightly in the air and dropping easily into the water to seek the pelagic fish, which is their food."

—FREDERICK COOK (1900)
Through the first Antarctic night 1898-1899.

Predicting snow petrel nesting habitats in East Antarctica

WADE FAIRLEY

To find the nesting sites of these small, secretive snow petrels, Frederique used her extensive knowledge of their habitat preferences. She recorded nest sites on a Global Positioning System unit (shown below) provided by the Australian Antarctic Data Centre, which allowed her to visualize their location on a digital map of the survey region. This information was used to test models that predict nest sites based on habitat.

Snow petrels spend their entire life in Antarctica. They forage in the pack ice and breed on islands and rocky, ice-free areas of the Antarctic continent, where nest cavities are available. Sea ice conditions, which are likely to be affected by climate change, influence their survival and reproductive success. But climate change may also affect local continental weather, potentially changing the characteristics of breeding habitats (through altered snow accumulation), which will in turn impact on the breeding success of the birds.

To better understand this potential problem, we need to monitor snow petrel populations and their nesting habitats. However, estimates of local breeding populations are rare as systematic large-scale surveys are labour intensive and logistically difficult.

Some answers may be found in the project I have been undertaking over the past three years. The project analyses regional snow petrel nesting distribution using habitat selection models. Commonly used in temperate areas, habitat selection models are potentially useful for studying the ecological relationships between organisms and their environment in the Antarctic ecosystem. They are based on a variety of spatial statistical models, which determine the probability that an organism is present given certain environmental conditions. When combined with the recent advances in Geographic Information Systems, such models can complement the traditional ground surveys for the production of species distribution maps.

The first phase of the modelling project was the collection of spatial data on the distribution of snow petrel nests. During a summer of scrambling in the Windmill Islands near Casey in 2002-03, I mapped the distribution of snow petrel nests in 200 sites of about four hectares each. The locations of 4036 snow petrel nests were recorded using a Global Positioning System, along with descriptions of the local habitat (topography, orientation, slope and cover of various rocky substrates). The habitat was identified around each nest, providing information from which nesting preferences were interpreted.

Of the environmental predictors that explain snow petrel distribution, nest orientation is the most important. The level of wind exposure of the nests is crucial during incubation time, where successful hatching depends on each parent being able to live on its energy reserves until their mate returns to relieve them. Paradoxically, I found that nests at Casey were predominantly located on hills exposed to the prevailing winds. However, by doing so, snow petrels avoid areas where snow accumulates (generally located downwind), reducing snow blockage in the nests early in the breeding season and later snow melt which can trap the eggs in ice.

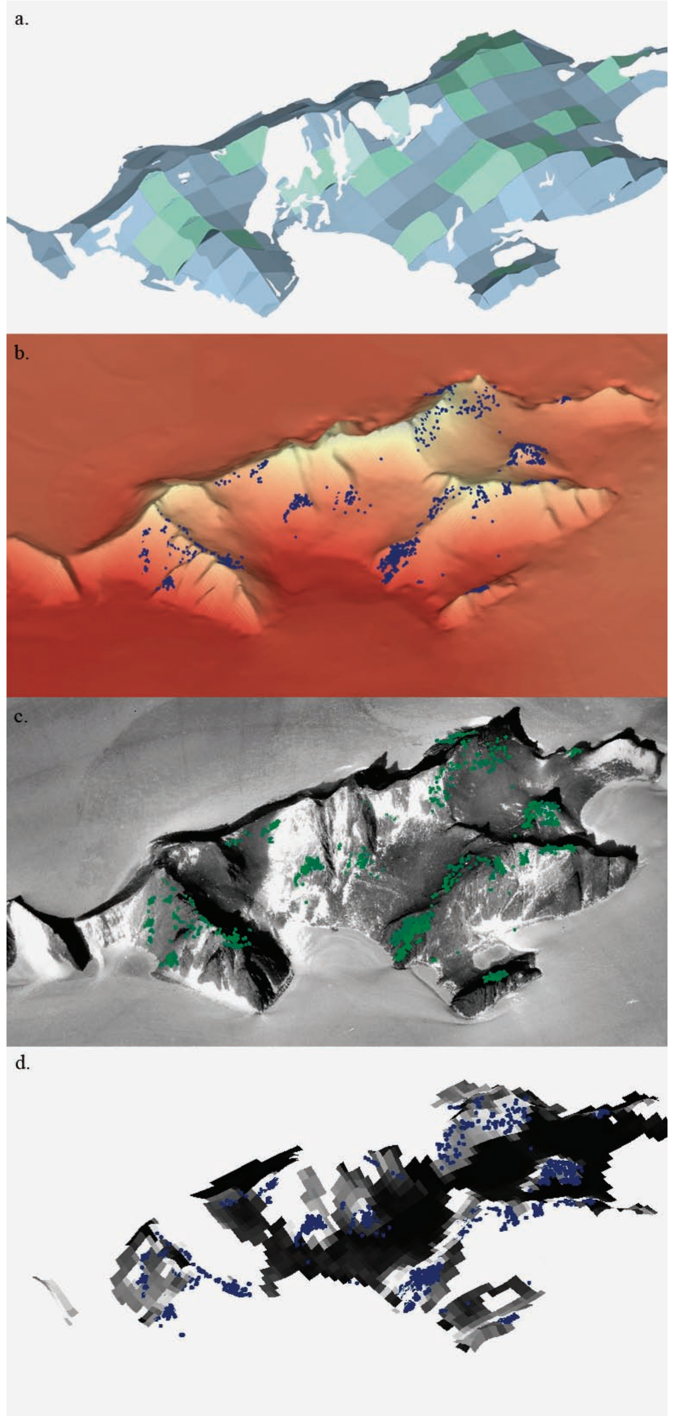
Amongst Antarctic nesting birds, the snow petrel has one of the shortest brooding times. Its chick stays in the nest with only intermittent parental visits from three days onwards until fledging. For this reason snow petrel nests need to be as concealed as possible to minimize exposure of the chick to weather and predators. This determines the choice of specific rock types for nesting. At Casey, snow petrels mostly nest at high concentrations in scree slopes, but in a dispersed manner in flat boulder fields, where habitat availability limited densities. By excluding areas where models predicted snow petrel nests to be absent, I could estimate that the number of snow petrel pairs that reside in the Casey region to be as many as 17 000.

The second but most important phase of the modelling project involved testing the robustness of the habitat selection models by checking if the same environmental factors affect snow petrel distribution elsewhere. Field validation was undertaken at Mawson in 2004-05. Mawson provides two types of nesting environments for snow petrels; coastal nesting habitats relatively similar to the Windmill Islands, although lower in elevation, and inland mountain ranges carved by the ice-sheet (the Framnes Mountains), with a completely different geomorphology. This diversity made it an excellent location to investigate the level of variability in the species' ecological niche, and allowed assessment of the models for the purpose of estimating populations at a large scale in East Antarctica. In two months of endless scrambling, Wade Fairley and I located a total of 1050 snow petrel nests in Holme Bay, around Mawson station, and 6500 in the Framnes Mountains.

Large concentrations (up to a thousand nests) were found over a few hectares in the Framnes Mountains, despite a much harsher climate. The age of nests, which can be estimated from the amount of calcified spit built up at the nest entrance, suggested a much more ancient colonisation than in the coastal islands. The shortage of habitat in Holme Bay may explain why snow petrels find refuge inland. General weather and wind conditions also explained differences in habitat selection between Casey and Mawson and were reflected in the model results. But it was with relief that I found overall similar nesting preferences for the snow petrels residing at Mawson. Distribution maps created with the Casey models predicted more than 70% of the nests located in the field. The models worked!

Habitat selection models are likely to be applicable in other unsurveyed areas of East Antarctica and to other species. I am now testing the models with the Wilson's storm petrel. Spatial models have many useful applications in the conservation and management of Antarctic and subantarctic seabird species – in protected areas and areas of human activity, and in flight path maps and the installation of automatic weather stations. Modelling the relationships between species distribution and their environment may also provide valuable monitoring information to predict the effects of habitats altered by climate change.

—FREDERIQUE OLIVIER
IASOS, University of Tasmania



FREDERIQUE OLIVIER

Three-dimensional view of the location of snow petrel nests in the Rumdoodle area (Framnes Mountains) of Mawson. From top to bottom: (a) Survey sites (green); (b) GPS observations of snow petrel nests (blue points); (c) nest observations (green points); (d) the predicted location of nests (in blue) generated by the model, based on environmental parameters – probability of nest presence ranking from low (black) to high (white).

FREDERIQUE OLIVIER

Snow petrel nests are well concealed and usually surrounded by snow and an oily spit which accumulates at the top of the nest site and helps to scare predators.

SCIENCE

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Sounds of the 'silent world'

Remote acoustics is an effective way to study baleen whales, such as this humpback whale, living in inclement (for humans) environments such as the Southern Ocean. The technique will help scientists understand more about the populations and life histories of these animals.

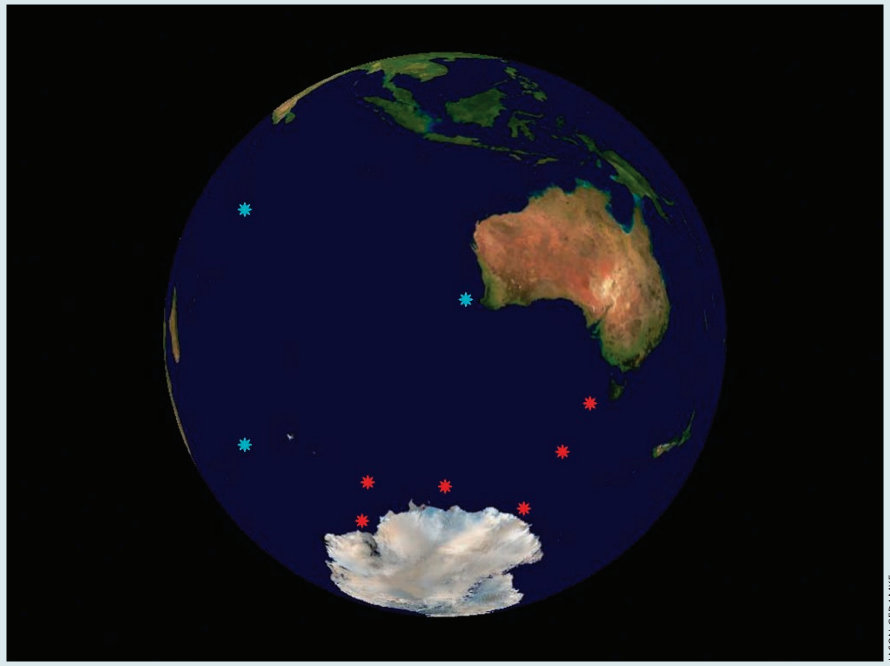
Jacques Cousteau once described the ocean as the 'silent world'. But in fact, the ocean is filled with a cacophony of noise from creatures, machines, wind, rain, earthquakes, explosions, and anything else that can produce an underwater sound. Water is so efficient at carrying sound energy that some of these sounds even travel around the globe.

Over millions of years, cetaceans (dolphins, porpoises and whales) have evolved to use the acoustic properties of their ocean environment. Toothed cetaceans produce sounds to essentially 'see' their environment through echolocation (listening to the characteristics of echoes), much like bats in the terrestrial environment. Many species of baleen whales sing, producing stereotypic sounds in regular patterns for hours on end. These songs can travel for hundreds of kilometres, allowing the whales to communicate with distant individuals. Humans can also take advantage of water's incredible ability to conduct sound, learning more about whale populations by eavesdropping on their species-specific songs from great distances away.

Remote acoustic study is a remarkably effective tool for studying baleen whales and has been used to track blue, fin, humpback, and bowhead whales in the Atlantic, Pacific, Arctic and Southern oceans. The technique allows researchers to be remote from their instruments (and the weather), and to record sound for a year or more. The simple presence or absence, and relative abundance of particular whale species' sounds, can be used to determine whale presence, seasonality and relative population density between locations and times of year.

The need to learn more about these animals was highlighted by recent manoeuvring within the International Whaling Commission to reintroduce commercial whaling. Even without commercial whaling, Southern Ocean baleen whales are facing increased pressure from so-called scientific whaling. In the face of these increasing pressures, it is important to understand as much as possible about the populations and life histories of these animals. There are still enormous gaps in our knowledge, but remote acoustic monitoring provides an excellent opportunity to fill some of these holes.

Last year we worked with the Scripps Institute of Oceanography to use a relatively new technology – autonomous acoustic recording packages – in Antarctica. These instruments are anchored to the ocean floor during the summer season, and left in place for a year to record all low frequency (i.e. most baleen whale) sounds. Once they're recovered, the hard drives can be replaced and the instrument immediately re-deployed, while the previous year's data can be analysed in the lab.

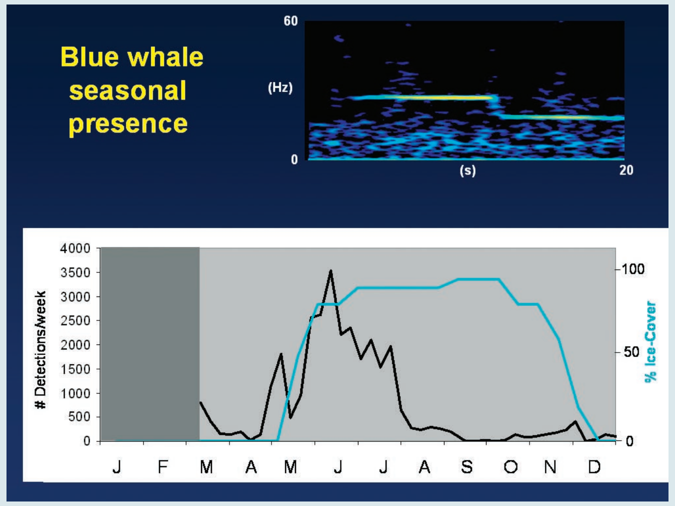


JASON GEDAMKE

The locations of past, present, and future Australian Antarctic Division acoustic instruments are represented by the red stars, while the blue stars show the locations of the nuclear monitoring project acoustic listening stations in the Indian Ocean. JASON GEDAMKE

The autonomous acoustic recording package consists of a hydrophone (underwater microphone) and two round floats that hold it off the sea floor. The main unit contains underwater pressure cases that house the acoustic recording electronics and batteries.

JASON GEDAMKE



The graph shows the number of blue whale vocalisations recorded at Casey station using an autonomous acoustic recording package. Whale numbers peaked at the start of winter and then declined as the sea ice thickened and winter set in. The spectrogram shows a typical Antarctic blue whale call, with two sequential 'tones' that are inaudible to the human ear. JASON GEDAMKE

While this program is in its early stages, its promise is demonstrated by the data recorded on an acoustic recording package that we recovered from the ocean floor off Casey station. It was deployed from February 2004 to April 2005 at a depth of 3000 m and obtained clear recordings of blue, fin, and humpback whales. Blue whales demonstrated a distinct seasonality in their presence off Casey in 2004. Somewhat surprisingly, there appear to be large numbers even when the area is covered by sea ice, though their numbers drop quite quickly once the ice consolidates. Fin whales had a very low level presence throughout the year, with their sounds relatively rare. The lower frequencies of humpback whale song could be heard in April and May, prior to their migration to winter breeding grounds off the west coast of Australia.

Interestingly, there were at least three other repetitive, stereotypic sounds whose source remains a mystery. We suspect they are produced by baleen whales. During the 2005-06 BROKE-West cruise (*Australian Antarctic Magazine* 8: 12), we hope to ground-truth our recordings by determining which species produce them.

We also picked up the sound of the magnitude 8.1 earthquake that struck off Macquarie Island last year, and the magnitude 9.0 Indonesian earthquake – over 7500 km away – that caused the disastrous Boxing Day tsunami.

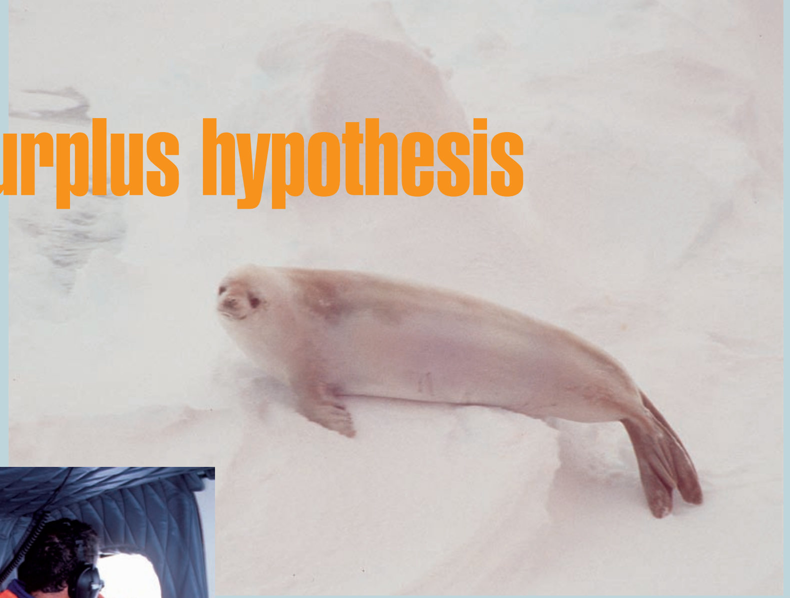
In the future, we will continue to deploy Scripps's acoustic recording packages in various locations off the Antarctic. We are also developing new acoustic recording devices with Curtin University in Western Australia. These will be attached to oceanographic moorings running south from Tasmania to the Antarctic. Ideally, if we can detect differences in the timing of the peak acoustic presence of whales, we will be able to assess north-south migratory patterns of various species.

Finally, we are planning to use an array of hydrophones established throughout the Indian Ocean by the nuclear monitoring project. The systems record the same low frequency sounds that blue and fin whales use, and will help determine their presence over very large scales.

Despite Cousteau's early assessment of the ocean as the silent world, sound's ability to travel great distances underwater provides a window that can be used to observe whale populations across entire ocean basins.

—JASON GEDAMKE
Southern Ocean Ecosystems Programme, AAD

Testing the krill surplus hypothesis



Exploitation of living resources in the Southern Ocean potentially has a profound impact on the ecosystem. Perhaps the greatest impact comes from the harvesting of large krill-consuming whales, whose populations declined dramatically during the 20th century as a result of whaling. Twenty-five years ago it was proposed that this reduction in whale populations led to a 'surplus' of un-eaten krill – up to 150 million tonnes per annum – which became available to other krill consumers. This proposal became known as the 'krill surplus hypothesis' and strongly influenced thinking on the krill-based ecosystem in the Southern Ocean.

COLIN SOUTHWELL

After the decline in whales due to whaling, the crabeater seal was thought to have benefited from an apparent 'surplus' of un-eaten krill. It was predicted that the circumpolar crabeater seal population would quadruple over the past 30 years. However, Australian Antarctic Division research testing this 'krill surplus hypothesis' provides little support for this prediction in the Australian Antarctic Territory.

Tim Booth (right) sighting crabeater seals during an aerial survey while Mark Underwood logs the sighting data.

One prediction of the krill surplus hypothesis has been that the excess krill has allowed other populations of krill consumers to increase. The crabeater seal, which eats krill rather than crabs, has been the subject of much speculation about current populations and change in populations over the past 50 years. Crabeater seals are restricted to the pack-ice surrounding Antarctica and have a circumpolar distribution.

The earliest surveys in the 1950s estimated the circumpolar crabeater seal population to be around 5 to 8 million animals. Later surveys in the 1970s produced estimates of around 12 million animals. This apparent increase in population size was taken as evidence in support of the krill surplus hypothesis. In the early 1980s it was predicted that crabeater seal populations would increase to 50 million animals by 2000 – a 10-fold increase over the last 50 years (and a four-fold increase over the past 30 years). If true, this would represent a fundamental change in the structure of the krill-based ecosystem.

This prediction has fuelled speculation about the dominance of the crabeater seal as a consumer of krill, over other animal groups such as birds, fish and squid, and led to claims that the crabeater seal is the most 'abundant large wild mammal on earth'. It has even been suggested that crabeater seal populations could hinder the recovery of exploited whale populations because the krill surplus is no longer available to the whales.

Until now it has not been possible to substantiate or refute the predictions of the krill surplus hypothesis because there have been no estimates of crabeater seal populations since the 1970s. A recent Antarctic Pack-Ice Seal program (APIS) aimed to address this situation.

APIS was an international, multi-platform survey of the regional and circumpolar abundance of pack-ice seals. Australia took a lead role by undertaking a major survey off east Antarctica in the summer of 1999-2000. This survey, which extended from 60°E to 150°E, straddled most of the coastline of the Australian Antarctic Territory and covered one quarter of the longitudinal extent of circumpolar pack-ice (*Australian Antarctic Magazine* 1: 7-8). The boundaries of the survey region coincided with surveys undertaken in the 1970s (when the crabeater population was estimated at 800 000), allowing a comparison of regional crabeater seal abundance in the same area and at the times (1970s and 2000) of the krill surplus hypothesis predictions.

Estimating the abundance of any animal over large, remote areas is always a challenging task, but there could be few more difficult surveys than for crabeater seals in the pack-ice. In the 1999-2000 summer, observers used the *Aurora Australis* and two Sikorsky S76 helicopters to count seals distributed across 1.5 million km^2 of pack-ice, in strips either side of survey tracks. As there was no guarantee that an observer would be able to count all seals on the ice in the strip, it was difficult to estimate the number of seals present but missed.

Another difficulty was estimating the number of seals in the water when the ship or aircraft passed by. This required capturing some seals and deploying dive recorders to record the time they spent hauled out and on the ice.

The next problem involved 'scaling up' counts from the survey strips to the entire survey region. Traditional scaling up methods require the survey tracks to be scattered at random through the pack-ice. However, this was not possible because the ship was limited in its movements through the ice and the helicopters were limited by weather.

After developing new methods of data collection and analysis to address these problems, the 'best estimate' for the survey region was around one million crabeater seals, although plausible estimates ranged from 700 000 to 1.4 million.

These logistical and estimation difficulties were also present in the 1970s survey, but many of the technical advances that could be applied in the 1999-2000 survey were not available 30 years ago. The 1970s estimate of around 800 000 crabeater seals may therefore be biased. Even if we allow for bias, there is no strong evidence in support of the four-fold increase from the 1970s to 2000 that is predicted by the krill surplus hypothesis.

And what of the predicted circumpolar population of 50 million crabeater seals in 2000? Testing this prediction must await the analysis of data collected by the other nations who participated in APIS. However, with only one million or so seals estimated to be in a zone covering one-quarter of the circumpolar region, it seems hard to imagine another 49 million in the remaining three-quarters!

After 25 years of discussion and speculation about the possible impact of a krill surplus, there is finally some evidence to examine whether the predictions can be substantiated. The results of the Australian APIS survey suggest that we may need to re-assess the krill surplus hypothesis and, more broadly, our understanding of the structure of the krill-based ecosystem in the Southern Ocean.

Improved modelling of the krill-based ecosystem is now a priority activity for scientists working within both the International Whaling Commission and the Convention for the Conservation of Antarctic Marine Resources. The results from the APIS surveys will be pivotal to these modelling efforts.

—COLIN SOUTHWELL
Southern Ocean Ecosystems Programme, AAD

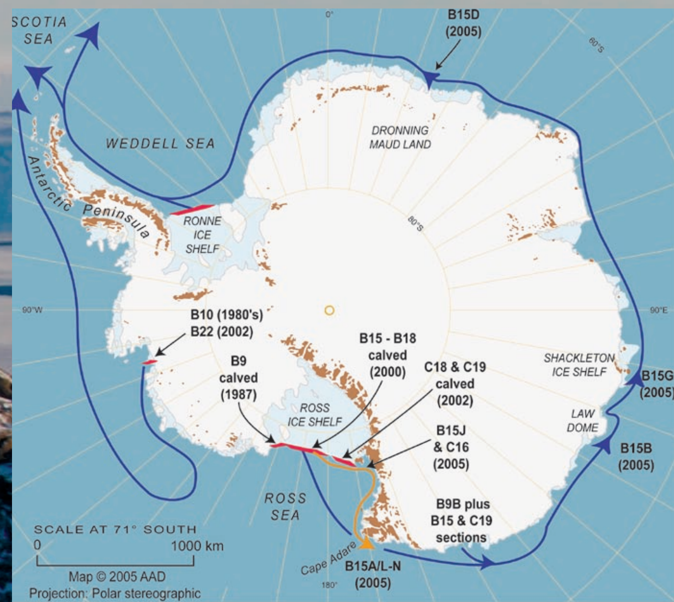
Massive icebergs on the move

Massive icebergs that calved during 2000-2002 are now spread around the Antarctic coastline. Of these, B22 remains within a few kilometres of its source – the Thwaites Glacier. Of the bergs that calved from Ronne Ice Shelf in March 2000 (A42 and A43), small sections of A43 remain in the Weddell Sea, while the others have drifted out into the South Atlantic and dissipated.

Iceberg B15 created a lot of interest when one of its progeny, B15A, drifted west across the front of Ross Ice Shelf, ultimately blocking the entrance to McMurdo Sound, affecting wildlife in the area and hindering shipping movements (see figure). During 2004 another two sections (B15J and B15K) broke off B15A, allowing its northern end to clear Franklin Island and swing into the northern part of McMurdo Sound. Here it became temporarily grounded, blocking movement of sea ice out of the sound. Some months later it began moving slowly north, giving a glancing blow to the outer end of the Drygalski Ice Tongue and then almost colliding with the Aviator Glacier Tongue. On October 28 2005, as B15A was exiting the Ross Sea round Cape Adare, it broke into several more sections. The list of progeny now extends to B15N.

Almost all of the massive icebergs coming from Ross Ice Shelf have drifted westwards out of the Ross Sea and onto the continental shelf east of the Mertz Glacier, where they have been either grounded or locked in by fast ice (sea ice that is joined to the coast, islands, or grounded icebergs) for some time. B9B, which calved in 1987 is still there. B15D is now off Dronning Maud Land, a half circumnavigation from its calving site. B15G followed, but then drifted into the coast near Casey station, where it became grounded for some weeks and made a prominent sight on Casey station's horizon. It is now adjacent to the Shackleton Ice Shelf. B15B, which is now the largest of the B15 progeny, as of November 2005, is passing just north of Law Dome.

—NEAL YOUNG
Antarctic Climate and Ecosystems Cooperative Research Centre and Ice, Oceans, Atmosphere and Climate Programme, AAD

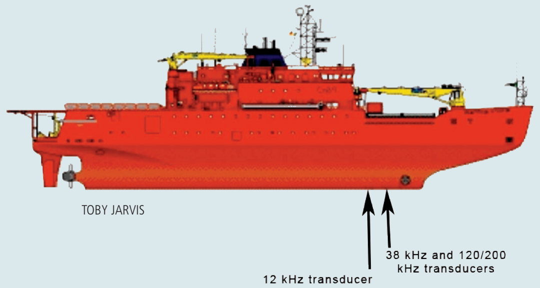


Movement of icebergs since calving.

CHRISTOPHER CLARKE

B15-G loitered on the horizon near Casey station in 2005. About 15-20% of the length of the iceberg is pictured here, behind the cliffs of Vanderford Glacier off Browning Peninsula, about 20 km south of Casey. The iceberg was calculated to comprise more than 220 cubic km of ice, enough for 15 thousand million, million ice cubes, or around 200 000 billion litres of fresh water.

The Heard Island *echo*system: eavesdropping on the food web



The subantarctic waters of the Heard Island and McDonald Islands (HIMI) region support a diverse range of living organisms, each of which plays a role in the complex web of interactions that make up the marine ecosystem. In the summer of 2003-04, we set out on the *Aurora Australis* to improve our understanding of this web using echosounder data collected as part of the larger 'Heard Island Predator-Prey Investigation and Ecosystem Study' – 'HIPPIES' for short (*Australian Antarctic Magazine* 7: 6-7).

A detailed understanding of the HIMI food web is important because Australia oversees commercial fisheries for Patagonian toothfish and mackerel icefish in the region. The overall aim is to manage fishing so that the impacts on the ecosystem are minimised.

We know that the marine ecosystem is fuelled ultimately by energy from the sun and nutrients in the water, and that this energy enters the food chain through microscopic phytoplankton drifting in the sunlit surface waters. We also know that this energy passes through a diverse range of drifting animals (zooplankton), which in turn are consumed by fish, seabirds and marine mammals. However, we know relatively little about where each type of organism is found, how many there are, and who eats whom and when.

Investigations of distribution and abundance of marine organisms have typically been made by towing nets through the water column and counting what is caught. There are two main problems with nets, however. Firstly, net catches don't necessarily reflect what is down there. Secondly, the area that can be surveyed this way is tiny. This is where echosounding comes in. By sending pulses of sound into the water and recording the timing and strength of the echoes that return, we can build up a better picture of distribution and abundance. This is because even the smallest organisms in the water column can give off a detectable echo if the frequency of the sound pulse is right and the equipment is sensitive enough. In short, you can literally hear where these things are.

The *Aurora Australis* is equipped with computer-controlled, state-of-the-art echosounders mounted in the hull (*Australian Antarctic Magazine* 2: 9-10). During HIPPIES, we sent pulses of sound ('pings') into the water column at frequencies of 12, 38, 120 and 200 kHz[1]. As the ship steamed along its defined transects, the 12 kHz sounder pinged roughly every six seconds, while the other sounders pinged roughly every second (about 8 million pings in total). Following each 12 kHz ping, the equipment recorded the echo strength in decibels every 75 cm as the sound wave travelled down into the depths. At 38, 120 and 200 kHz, the echoes were recorded every 20 cm down through the water column. We ended up with about 40 billion echo measurements, taking up 250 gigabytes of computer memory, that described the location of reflective objects throughout the water column wherever the ship went.

A primary analysis of this mountain of data is nearing completion. The first task has been to display images of the reflected sound on a computer (see the echogram pictured) in much the same way that a digital camera does for reflected light. Each echo measurement represents a pixel that is colour coded according to its decibel value and positioned according to its depth and location along the ship's track. The second task has been to use these images to help answer questions about how the ecosystem works. This is an altogether trickier proposition.

The data are first prepared and cleaned – by removing background noise, for example – for further analysis. The 'post-processed' data can then be analysed in a number of ways, depending on the questions being asked.

At this stage we are asking:

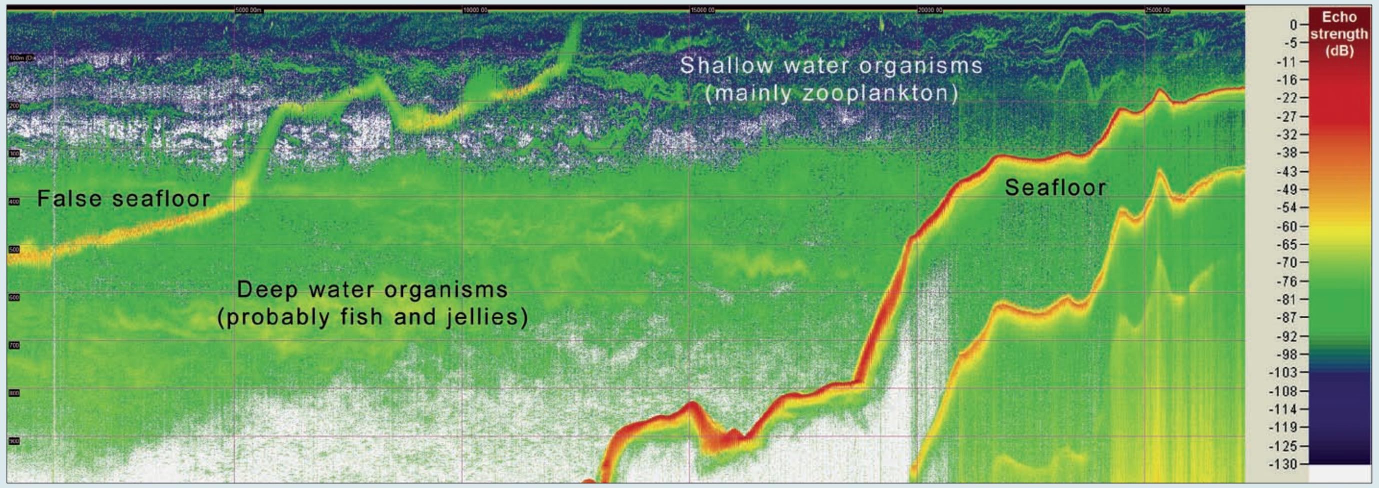
- Are there any noticeable zones in the HIMI marine region with different numbers and/or types of organisms and interactions?
- If so, what types of organism do we find in each zone, how abundant are they relative to each other, and how do they relate to each other and their environment?
- What do these findings tell us about how best to manage the commercial harvesting of Patagonian toothfish and mackerel icefish?

In terms of general numbers of organisms, we are simply calculating the total amount of echo energy in a given area using a technique known as 'echo-integration'. If we assume that this is due entirely to organisms in the water column, we can explore whether or not certain areas support more organisms than others.

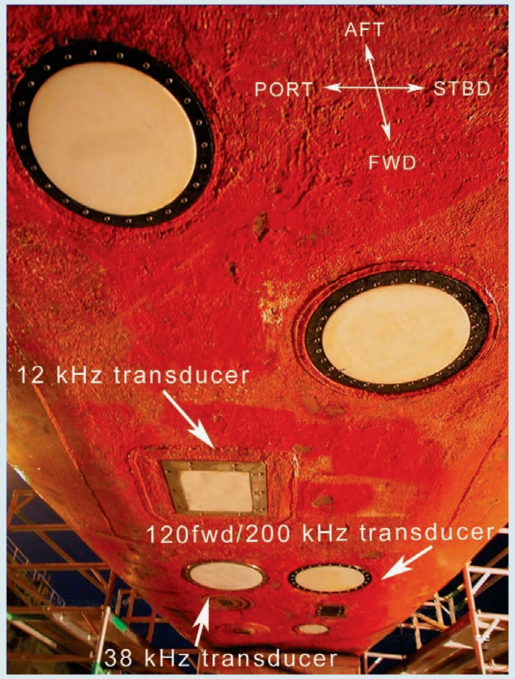
As for which types of organism are responsible for this echo energy, we need to partition the energy by species type (e.g. zooplankton, jellies, squid, fish) and then look again at their individual distributions. This requires detective work using a combination of approaches.

Firstly, we can get an idea of where each species type might be on the echograms by seeing what was caught in nearby trawls. This is called 'ground truthing'.

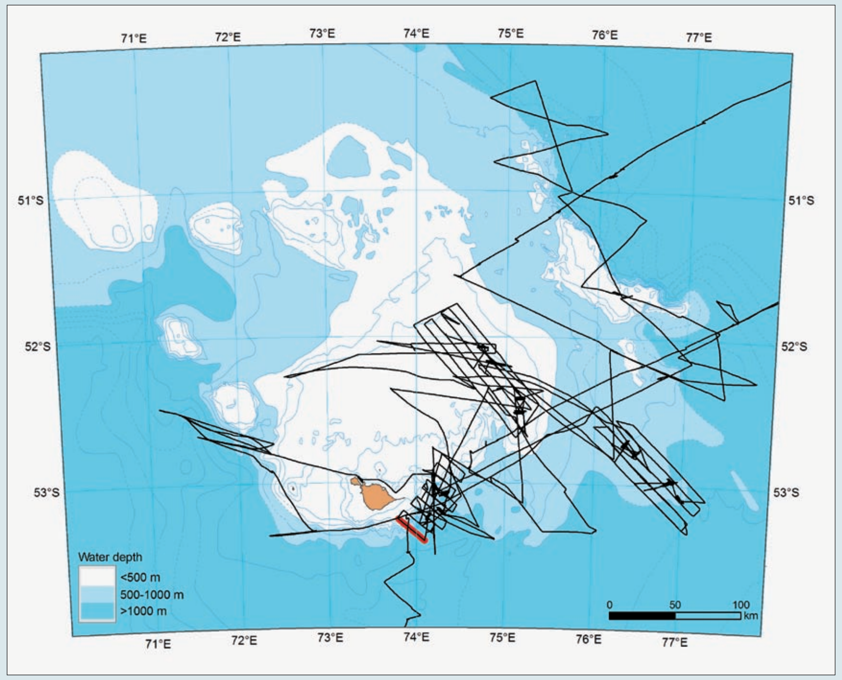
1 The hearing range for humans is about 0.05-16 kHz. For whales it is about 0.02-200 kHz.



An example echogram from the 38 kHz echosounder. The vertical height represents 1000 m through the water column. The horizontal width represents 27 km along the ship's track. Colours represent echo strength in decibels (dB), where red is the strongest echo and blue the weakest.



The echosounders on the RSV *Aurora Australis* are mounted in the hull and point downwards. During HIPPIES, data was collected from the sounders labelled '12', '38' and '120fwd/200'.



The ship's track during HIPPIES. The red transect shows the location of the example echogram.

Secondly, we can assign certain strengths of echo energy to certain species types, and filter the echograms based on this. For example, a fish with a gas-filled swim bladder will likely give a much stronger echo than a gelatinous jellyfish.

Thirdly, we can use the way objects reflect sound differently at different frequencies to filter the echograms. For example, a fish with a swimbladder typically gives a stronger echo at 38 kHz than at 120 kHz, while the opposite is true for many zooplankton.

Finally, we can use image-analysis techniques to encircle clusters of echoes on each echogram. By describing each of these clusters in terms of size, shape and depth, and grouping them using multivariate statistical techniques, we have a technique that is similar to ground-truthing but less subjective.

Through the course of these analyses we are gaining a better understanding of the biological structure of the HIMI marine region. Visual analysis of the echograms is revealing complex and extensive aggregations of organisms and highlighting interactions between different types of acoustic scatterers that vary depending on location and time of day. Echo-integration and energy-partitioning analyses are allowing us to quantify these observations in an ecologically meaningful way. As the first sets of results come in from each of the projects within the HIPPIES study, we can look forward to gaining new biological insights and a greater ability to simulate, and therefore mitigate, the potential impacts of commercial activities in the region.

—TOBY JARVIS
Southern Ocean Ecosystems Programme, AAD

Filming a frozen world for Planet Earth

A collaborative project between the Australian Antarctic Division and the renowned BBC Natural History Unit, led cameraman Wade Fairley and biologist Frederique Olivier on a journey through one of the toughest environments on Earth, documenting the breeding cycle of Antarctica's emperor penguins.

Emperor penguins endure the harshest weather conditions of any bird. They're the only animal breeding in Antarctica over the darkest, coldest months of winter, raising their chicks in temperatures as low as -60°C. As a result, emperor penguins are one of the most difficult birds to film because the camera crew must also endure the same freezing conditions. Discomforts aside, the rare privilege of observing and filming the birds' extraordinary breeding cycle is like witnessing an act of magic.

Our filming project, which was based at the Auster Rookery, about 50 km east of Mawson station, involved the BBC Natural History Unit and the production team behind the successful series *Life in the Freezer* and *The Blue Planet*. The material we filmed will be used in the *Frozen Worlds* episode of an 11-part series called *Planet Earth*, due for television, cinema and DVD release next year.

Ambitious wildlife films are a complicated and costly affair. Like all complex ventures, the best place to begin is with a detailed plan and a script, or a 'shopping list' as it's commonly called in the trade. The shopping list details a series of key shots and sequences to film in order to tell the story. In the field, however, the script often plays out differently because the only one not involved in its writing is the animal. Our aim was to capture the winter component of the birds' breeding cycle.

To do this, Frederique and I spent long hours in patient observation, sitting immobile or shivering, and watching carefully for the specific behavioural events that we wished to film. It's an odd job, waiting and observing. The work can be tedious, it's usually uncomfortable, but it's always rewarding. Even on the days when we couldn't capture what we set out to film (and there were many of these), there were always other surprises.

One of the major behavioural events we wanted to film was the extraordinary huddling of the emperor penguins, usually in the wildest winter conditions, to illustrate the behaviour and adaptation needed to survive. We wanted images in the worst weather that the birds have to endure. It's a fine line between a blizzard with enough visual drama to work on film, and so much real life drama that it becomes too hazardous to work.

The footage was hard won. There were many failures and discomforts, but highlights too, and I'm confident the results will prove to be some of the most moving footage I've had the privilege to shoot. All of the year's work was shot on film (being more robust and reliable for hard field work than video tape), but we won't see a single frame of our efforts until it's been through the lab back in Australia, long after the shoot is finished. There's no chance to return, so we try to get it right first time!

We couldn't help but feel for the birds, and particularly the chicks, when observing them during severe weather events. Their perfect physiological adaptation aside, it's a tough world and as much as the emperor penguin has been anthropomorphised and romanticised, the reality is sometimes shockingly different. Some of the events we filmed were confronting and at times difficult to witness. Two sequences that stick in my mind are chicks being violently fought over because there are inevitably more expectant breeders than successful eggs, and then later, groups of fat, healthy chicks being abandoned during a blizzard. As a cameraman, I'm drawn to the wonderful aesthetic of these beautiful birds. More than this though, as a documentary-maker, I feel it's also important to provide a broad and sometimes confronting realistic view.

Our access to the rookery and the long periods of time we worked there also provided an opportunity to gather scientific information. Frederique, an ornithologist, was able to carry out day-to-day observations on the huddle, and census work that will prove valuable to the long-term monitoring of the Auster Rookery.

Field life was a relatively simple affair and I feel privileged to have spent so much time in such a wild and remote place. Macey Island hut, a spartan but functional 1950s freighter hut, is six kilometres from the rookery and for most of the winter and spring we based ourselves there.

From Macey Hut, in candle-light, I tap this note out on my laptop - powered by a wind generator - while a blizzard rages outside and the vent overhead screams in the wind like a jet engine. The opportunity to live with emperor penguins is an honour both personally and professionally that will remain with us both. Thanks must go to the 2005 Mawson winter crew for their wonderful support, but most of all to the beautiful emperors at Auster Rookery.

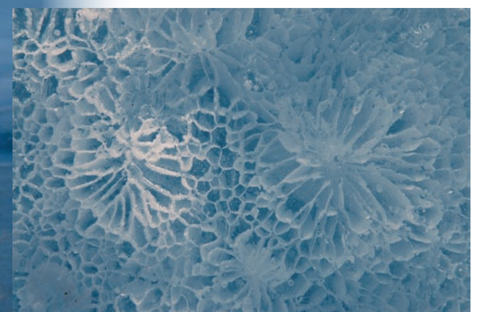
—WADE FAIRLEY
Freelance cameraman

FREDERIQUE OLIVIER

Filming an emperor penguin huddle requires patience, endurance and a good set of high altitude mountaineering clothing. Here Wade endures -25°C temperatures and 45 knot winds to capture the penguins in their element. His 35 mm camera, with lens attached, weighs about 50 kg, and each roll of film captures five minutes of footage. The cameras and lenses were modified for Antarctic conditions and tested to -40°C.

FREDERIQUE OLIVIER

Part of Wade's footage will help illustrate sea ice formation around Antarctica. Time-lapse photographs of the Antarctic landscape will be interposed with close up images of ice crystals (below), and satellite images (provided by NASA) of ice forming around the continent.



WADE FAIRLEY

Ice Flowers

How low can you go? New records for Antarctic weather

A new automatic weather station has been installed on the highest and possibly coldest point in Antarctica – Dome A – raising the chance of a new record low surface temperature being recorded.

According to glaciologist Dr Ian Allison, of the Australian Antarctic Division (AAD) and the Antarctic Climate and Ecosystems Cooperative Research Centre, the lowest temperature ever recorded was -89.2°C in July 1983, at the Russian station Vostok, inland of Australia's Casey station. As Dome A is nearly 600 m higher in elevation than Vostok, Dr Allison says there's a good chance an even lower temperature will be recorded.

The new weather station, which was designed by AAD scientists and installed by glaciologists from the Chinese Antarctic Research Expedition (CHINARE), will allow scientists to view the weather records immediately.

'Over the past 25 years we've installed automatic weather stations at more than 20 sites within the Australian Antarctic Territory,' Dr Allison says.

'These earlier stations provide information as a series of numbers which need to be decoded. But the weather station at Dome A contains new technology that enables it to do the decoding itself. So when we get the data back from satellites, we can see the temperature in degrees, pressure in hectapascals and wind speed in metres per second.'

The information from the weather stations is used for routine weather forecasting and in support of Antarctic shipping and air operations. The new weather station and some of the older ones also have additional sensors measuring snow temperature at different depths, atmospheric humidity, solar radiation and the height of the sensors above the snow surface. These data are used for climate research.

'We use information from the weather stations to study katabatic wind processes, surface energy exchange (the transfer of heat between the surface of the ice sheet and the atmosphere), how the rate of snowfall varies seasonally and from year to year, and to calibrate ice core records,' Dr Allison says.

Calibration involves comparing the air temperature measured by the weather stations, with the physical properties of recent snowfall – which occur as a result of climate conditions such as air temperature. This comparison provides a scale that can be used to deduce past climates and climate change from the snow that fell thousands of years ago and that is recovered in ice cores.

The new weather station installed at Dome A contains the latest technology for decoding temperature, pressure and wind speed.

CHINARE

Kayaking and other tourism activities are increasing in popularity in Antarctica. Wilhelmina Bay, Antarctic Peninsula, February 2005.

WARREN PAPWORTH

Antarctic tourism: more growth, new guidelines

Over 26 650 tourists visited Antarctica in the 2004-05 season, up 13 per cent from the previous year. This remarkable rate of growth keeps tourism firmly on the agenda of the annual Antarctic Treaty Consultative Meeting.

Treaty Parties are conscious that while the range of tourism activities is expanding – wildlife photography, heritage tours, zodiac cruising, hiking, climbing, diving, kayaking, skiing, camping and sailing – the geographic range of tourism, and therefore its potential environmental impacts, remains concentrated. The Antarctic Peninsula, off the tip of South America, accounted for over 99 per cent of all Antarctic tourists in 2004-05. Three-quarters of ship-borne tourists step ashore at some point in their cruise, and three-quarters of these landings occur at just 20 sites.

This year's Treaty meeting in Stockholm adopted the first site-specific guidelines for frequently visited sites on the Antarctic Peninsula. Consistent with Australia's policy on Antarctic tourism, launched in March 2004, Australia co-sponsored the guidelines which were proposed by the United Kingdom.

The guidelines cover Penguin Island, Aitcho Islands, Cuverville Island and Jougla Point on Wiencke Island. Each set describes the site, its wildlife and visitor pressures, and includes a map and a visitor code of conduct. The guidelines confine landings to ships with a maximum of 200 or 500 passengers, depending on the sensitivity of the site, suggest time limits of six or eight hours ashore during peak breeding times, and set a 50 m precautionary distance from nesting birds.

The Australian Antarctic Division (AAD) has alerted Australian tour operators to the guidelines and invited them to submit feedback on their experiences at these sites at the close of the 2005-06 season.

In 2004-05, an observer from the AAD (Warren Papworth) visited the Antarctic Peninsula to view tourism in action. He travelled aboard the RV *Akademik Sergey Vavilov*, operated by Peregrine Adventures. Both ship and tour operations were found to meet all environmental requirements.

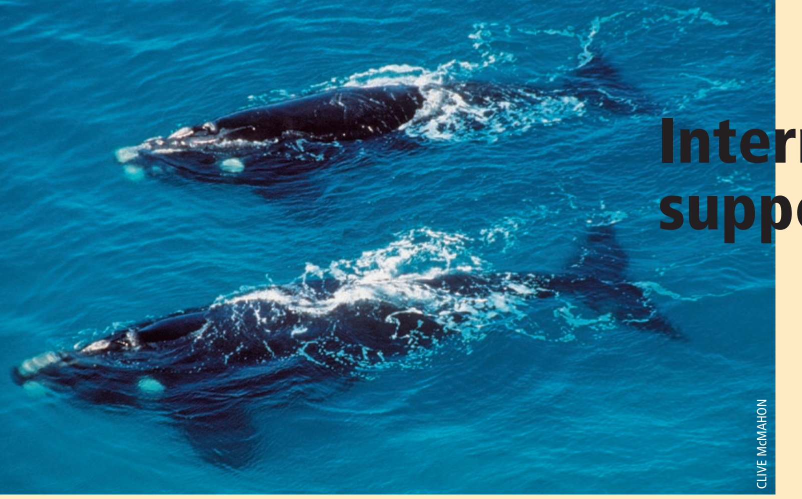
Other observations on this voyage and Antarctic tourism in general, were:

- Ship-based tourism provides excellent opportunities to educate visitors on environmental and safety issues. Passengers attend wide-ranging and informative lectures that guide their interactions with native flora and fauna.
- By keeping a high ratio of guides to tourists, operators minimise disturbance to sites. However, the cumulative impact of tourism activities is harder to assess. To better understand this, we may need more base-line data and more comprehensive monitoring programs.
- Tour operators seek to provide their customers with as broad a range of experiences as possible. The sites they visit have diverse natural features and environmental values. Some of these sites might be environmentally sensitive, such as when certain species of fauna are breeding or moulting, or there are particular floral assemblages. Site specific guidelines should help address the management of activities at such sites.

Beyond the Peninsula, the rest of the Antarctic continent, including the Ross Sea, received around 0.15 per cent of all tourists in 2004-05. No tourists visited the Australian Antarctic Territory last year, although two vessels are expected to visit Mawson's Huts and beyond in 2005-06.

For more information visit the website of the International Association of Antarctica Tour Operators: <http://www.iaato.org>.

—STEPHEN POWELL and WARREN PAPWORTH
Antarctic and International Policy, AAD



International majority supports whale protection

Southern right whales live only in the Southern Hemisphere, mainly between 20°S and 55°S. They mate and calve during the winter in the inshore waters of Chile, Argentina, Brazil, South Africa, southern Australia and some Southern Hemisphere islands, then migrate to waters nearer Antarctica to feed.

CLIVE McMAHON

This year's meeting of the International Whaling Commission (IWC) in Ulsan, Korea, saw delegates from the majority of voting States condemn a proposal to expand so-called scientific whaling in the Southern Ocean and vote to continue the moratorium on commercial whaling. The outcome was welcomed by Australian Antarctic programme scientists and policy staff, who are working to advance the Government's goal of permanently ending commercial whaling and scientific whaling.

The 57th IWC meeting (20-24 June) was attended by 59 voting member governments. Six new members have joined since the last meeting (Cameroon, the Czech Republic, Kiribati, Luxembourg, Nauru and the Slovak Republic). Australia's delegation was led by the Minister for the Environment and Heritage, Senator Ian Campbell, while Australian Antarctic Division (AAD) scientists and policy advisers played key roles in the meetings of the Plenary, Scientific Committee, Conservation Committee and various working groups.

Significant outcomes for Australia included:

- Japan's proposal to lift the moratorium on commercial whaling was rejected.
- More than half of the countries represented at the IWC's Scientific Committee meeting were critical of Japan's proposed expanded scientific whaling programme. The majority voted for a Resolution urging Japan to withdraw its proposal.
- The Southern Ocean Whale Sanctuary and the Indian Ocean Whale Sanctuary were retained and there was majority support for the proposed South Atlantic Whale Sanctuary (although insufficient votes for it to come into force). Strong support was also received for a South Pacific Whale Sanctuary, which Australia has been promoting for several years.
- The newly established Conservation Committee set its initial programme of work, which will include investigating the impact of ships on whales.
- A proposal to remove conservation-related items from the agenda of IWC annual meetings was defeated.
- A Resolution to hold a workshop in conjunction with the 58th IWC meeting, on whale-killing methods and associated welfare issues, was adopted.

The IWC will next meet in St Kitts and Nevis in the Caribbean in June 2006. Before then, AAD staff will participate in a working group on the Revised Management Scheme for commercial whaling and continue to highlight the major deficiencies of the proposal. The AAD will also host a workshop on a comprehensive assessment of Southern Hemisphere humpback whales to help determine the size of humpback populations.

—CATHY BRUCE
Antarctic and International Policy, AAD

Marine Reserve management plan in force

The Heard Island and McDonald Islands Marine Reserve Management Plan has been approved by Parliament and will now guide management of the reserve for the next seven years.

The plan details the way in which activities must be undertaken to protect the outstanding conservation values of the reserve. It also recognises the important contribution that scientific research in the reserve can make to issues such as the effects of global and regional climate change, and the sustainable management of the broader marine area surrounding the reserve. Copies of the plan can be downloaded from the Heard Island website: <http://www.heardisland.aq> or by emailing himi@aad.gov.au.

—*EWAN McIVOR*
Environmental Policy and Protection, AAD

The HIMI Marine Reserve Management Plan will protect the outstanding conservation values of the reserve.

EWAN McIVOR

The Liability Working Group, under the Chairmanship of Ambassador Don Mackay (New Zealand), nearing the end of negotiations on the liability annex in Stockholm, June 2005.

ANDREW JACKSON

Liability for environmental emergencies in Antarctica

Rules governing who is liable for preventing and dealing with oil spills, disease introductions and other 'environmental emergencies' in Antarctica were set at this year's 28th Antarctic Treaty Consultative Meeting in Stockholm, concluding 12 years of complex negotiations.

The adoption of a new Annex (Annex VI) to the Protocol on Environmental Protection to the Antarctic Treaty on 'liability arising from environmental emergencies' is the most significant addition to the Antarctic Treaty regime since the Protocol was adopted in 1991.

The Annex applies to environmental emergencies arising from scientific research, tourism and other activities in the Antarctic Treaty area, such as logistic (shipping and aircraft) support. The aim of the Annex is to stipulate – before anything goes wrong – who could be held responsible for cleaning up after an environmental emergency, and the legal avenues to respond to disaster. It also allows compensation to be claimed from the polluter if someone else has to clean up.

The Annex is the first step in establishing a comprehensive regime of liability for environmental damage in Antarctica; a requirement of Treaty Parties under Article 16 of the Madrid Protocol. Within the next five years Parties will have a time-frame for resuming negotiations to elaborate further rules and procedures.

Meanwhile, Treaty Parties will make the new rules effective within their own domestic laws. Australia, for instance, will require Australian operators to establish preventative measures and contingency plans and respond to any environmental emergencies arising from their activities.

The next Treaty meeting will be hosted by the Untied Kingdom in Edinburgh in June 2006.

For more information visit the Antarctic Treaty Secretariat's website <http://www.ats.org.ar>.

—STEPHEN POWELL
Antarctic and International Policy, AAD

Acting on illegal fishing

The marine living resources of the Southern Ocean are conserved and managed under an international agreement – the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR).

At CCAMLR's recent annual meeting in Hobart, members agreed on new actions to protect the Southern Ocean environment and help combat illegal, unregulated and unreported (IUU) fishing.

IUU fishing threatens fish stocks by overfishing, and damages the Southern Ocean ecosystem. One of the biggest impacts is on seabirds, as IUU vessels do not use the mitigation methods developed by CCAMLR that prevent the catching and killing of endangered albatrosses and petrels.

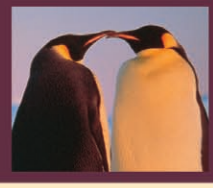
IUU fishing, previously a problem in Australia's waters around Heard and McDonald islands, has been largely been driven out of these waters by Australia's armed patrols. The patrols have, however, detected many IUU vessels in nearby parts of the CCAMLR area. Most of these vessels are flagged to countries that have not signed the Convention.

Actions agreed to by CCAMLR members to combat IUU fishing include:

- Developing a capacity-building program to help key countries strengthen their fisheries management and enforcement systems;
- Taking strong diplomatic action against countries engaging in IUU fishing or flagging IUU vessels;
- Working together to establish the rules for taking trade-related action against countries that are uncooperative or repeat offenders; and
- Stronger procedures for black-listing vessels engaged in IUU fishing. CCAMLR's IUU lists publicly expose offenders and help countries involved in Patagonian toothfish harvesting or trade to avoid dealing with IUU catches and operators.

CCAMLR members also embraced fresh ideas raised at a CCAMLR Symposium hosted by Australia and Chile in Valdivia, Chile, in April, which will help direct the organisation's work into and beyond 2006.

—PHILLIP TRACEY
Antarctic and International Policy, AAD



AUSTRALIAN ANTARCTIC DIVISION

Our Environmental Policy

WE SHARE OUR RESPONSIBILITY FOR ENVIRONMENTAL MANAGEMENT WITH ALL WHO WORK FOR US AND WITH US - IT IS OUR CULTURE

Tony Press

A J Press, Director
Australian Antarctic Division
29 April 2005

Australian Government
Department of the Environment and Heritage
Australian Antarctic Division

The Australian Antarctic Division (AAD) of the Commonwealth Department of the Environment and Heritage has lead responsibility for achieving Australia's Antarctic goals:

- 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 sytem; and
- to undertake scientific work of practical, economic and national significance.

To achieve these goals the AAD, from its Headquarters in Tasmania, administers the Australian Antarctic Territory and the Territory of Heard Island and McDonald Islands; develops domestic and international Antarctic policy; implements environmental protection measures; facilitates and conducts scientific research; and maintains research stations and field bases.

Environmental Policy

The AAD seeks to undertake its work in an environmentally responsible way. To this end, we will:

- comply with all applicable environmental laws and agreements, and require compliance with them by participants in activities supported by the AAD, by other Australian visitors to the Antarctic, and by our contractors and suppliers;
- promote compliance with the environmental obligations of the Antarctic Treaty System by other national operators, organisations and individuals in the Antarctic;
- ensure transparency in our environmental decision-making;
- implement measures to prevent or minimise pollution, waste and other human impacts in all environments in which we operate;
- conserve and protect our significant Antarctic heritage;
- provide environmental education and training for participants in activities supported by the AAD, other visitors to the Antarctic and the public;
- undertake and support research that contributes to protecting and understanding the Antarctic environment; and
- systematically manage our activities to achieve continual improvement in our environmental performance.

The AAD will communicate this policy to all persons working for or on behalf of the AAD, and will review and update this policy in two years.

OUR VISION: ANTARCTICA – VALUED, PROTECTED AND UNDERSTOOD

Photographer Kieran Lawton, Designer Vanessa Tucker. Australian Antarctic Division © Commonwealth of Australia, 2005

The next CEP meeting will be held in Edinburgh, Scotland, from 12-16 June 2006, and will consider draft management plans for Antarctic Specially Protected Areas at Haswell Island (Russian Federation) and Ardley Island (Chile), and Antarctic Specially Managed Areas at Admiralty Bay (Brazil), South Pole Station (United States), Port Martin (France) and the Larsemann Hills (Australia, China, Russia) – pictured.

EWAN McIVOR

International efforts deliver environmental rewards

A record 17 management plans were approved for Antarctic Specially Protected Areas or Antarctic Specially Managed Areas at the 8th Committee for Environmental Protection meeting (CEP) in Stockholm in June.

These included Australia's revised specially protected area plans for Ardery and Odbert Islands near Casey station and Taylor Rookery and Rookery Islands near Mawson station, and a plan for a new specially protected area at Scullin and Murray Monoliths. This pair of spectacular near-vertical rock outcrops rises dramatically from the sea and supports the greatest concentration of breeding seabird colonies in East Antarctica, including the second largest colony of Antarctic petrels.

In past years the Committee – which meets during the first week of the Antarctic Treaty Consultative Meeting – has developed a series of guidelines to promote consistent application of appropriate environmental practices by national Antarctic operators. Guidelines adopted during this year's meeting included:

- Updated *Guidelines for Environmental Impact Assessment in Antarctica* to better address the potential cumulative impacts of proposed activities;
- Guidelines to provide for the listing, delisting and management of Antarctic species of high conservation status; and
- *Practical Guidelines for Developing and Designing Environmental Monitoring Programmes in Antarctica*, to be used in conjunction with standard monitoring techniques and methodologies.

The meeting considered a range of other issues including:

- Restrictions on the use of heavy fuel oil in vessels traversing Antarctic waters;
- Protecting the probable location of Roald Amundsen's tent near the South Pole;
- The environmental impacts of two new research stations – the United Kingdom's Halley VI Station on the Brundt Ice Shelf and Germany's Neumayer Station on the Ekström Ice Shelf; and
- The results of environmental inspection reports on the Antarctic Peninsula (page 29).

The CEP was established under the Protocol on Environmental Protection to the Antarctic Treaty (Madrid Protocol). It has 32 member countries and is chaired by Australian Antarctic Division Director, Tony Press.

More information about the CEP, including the documents considered in Stockholm and the final report, is available at: <http://www.cep.aq>.

—EWAN McIVOR
Environmental Policy and Protection Section, AAD

Exemplary environmental efforts recognised

Following two days of intense scrutiny of the Australian Antarctic Division's (AAD) operations in September, independent environmental auditors bestowed unconditional recertification on our Environmental Management System (EMS), to the new international standard, ISO 14001:2004.

Representatives from the NATA Certification Systems International examined all elements of the AAD's environmental management system, reviewing the new Environmental Policy and EMS Manual, our environmental training programmes and records, legal compliance, environmental impact assessment processes and document control procedures and our internal audits. They commended our EMS as the best they have seen in a government organisation.

Australia was the first Antarctic Treaty Party to have all its operations certified to an international standard for environmental management systems in 2002. It was recertified for a further three years on 23 September 2005.

—LESLIE FROST
EMS Manager, AAD

Antarctic Peninsula under the microscope

At the invitation of the United Kingdom, Australian Antarctic Division (AAD) Environmental Manager, Tom Maggs, participated in a joint inspection of facilities on the Antarctic Peninsula in February and March this year. The inspection was hosted by the United Kingdom Foreign and Commonwealth Office and included a representative of the British Antarctic Survey and the Peruvian Antarctic Institute.

Conducted under the provisions of Article VII of the Antarctic Treaty and Article 14 of the Environmental Protocol, the inspection covered 14 occupied stations, five unoccupied stations, one station under construction, five historic sites, and a tourist vessel. This represents the activities of 14 Antarctic Treaty Parties.

Inspections are a valuable means of ensuring compliance with the provisions of the Treaty and the Protocol. They also enable inspectors to develop a sense of 'best practice' in relation to environmental and operational issues and to compare the variety of solutions to similar problems, which can inform their own programmes and be shared with other Parties.

The inspection team noted that the nature of research programmes varied from world-class research to basic observations, with research facilities from the elaborate to the rudimentary. As there appeared to be little coordination of research between Parties active on the peninsula, the team suggested that the Scientific Committee on Antarctic Research undertake an audit of Antarctic science.

Although the team inspected or flew over five unoccupied stations, other stations in the region were undergoing major expansion, and one new station was under construction. Thus there is scope for greater regional cooperation and sharing of facilities.

At most stations the importance placed on protecting flora and fauna was apparent from the variety of posters describing the local environment and rules and guidelines to ensure its protection. Some stations had well developed environmental management systems in place or under development, and the attention paid to minimising and managing waste was consistently of a good standard. Many year-round stations had elaborate sewage treatment plants and incinerators, however there appeared to be little awareness of the risks of introducing non-indigenous organisms to the Antarctic environment.

Of particular concern was the state of facilities for fuel storage and handling at several stations, and the associated procedures for their use. In some cases, five separate fuel transfers were required to deliver fuel from the resupply vessel to the powerhouse, greatly increasing the risk of a significant spill. Some stations had no secondary containment (such as bunding or double-skinned tanks), and some tanks and associated valves and pipework were in a poor state of repair.

The final report by the inspection team – presented to the 28th Antarctic Treaty Consultative Meeting in Stockholm in June – highlighted the need and scope for better collaboration between Parties in the development and use of stations and resources. This is particularly so in areas such as King George Island, where the stations of many Parties are concentrated in Maxwell Bay and Admiralty Bay.

An Antarctic Specially Managed Area has already been developed to coordinate activities and minimise environmental impacts at Admiralty Bay. Parties active in Maxwell Bay have begun discussions about a specially managed area for the region. The Council of Managers of National Antarctic Programs has also agreed to undertake a survey of fuel storage and handling infrastructure across all Parties and report back to the 2006 Antarctic Treaty Consultative Meeting.

Australia is grateful to the United Kingdom for the opportunity to work closely together on such an extensive and important inspection.

—TOM MAGGS
Environmental Policy and Protection Section, AAD

The Inspection Team and members of the 2004 wintering party inspect the bulk fuel storage facility at Argentina's San Martin station on Barry Island.

TOM MAGGS

Members of the Inspection Team (in orange survival suits) with the 2004-05 summer team at the Bulgarian station St Kliment Ochridsti, on Livingston Island.

TOM MAGGS

Adventure on the high seas

Royal Australian Navy ex-Stoker, Neil (Tim) Tyler, was a crew member on the first Australian National Antarctic Research Expedition (ANARE) to Heard Island in 1947, when Australia's first scientific research station was constructed at Atlas Cove. Here he reminisces about the journey to claim Heard Island for Australia.

The HMALST 3501, later named HMAS *Labuan*, was built in Canada in 1943. The 2300 tonne naval vessel served in World War II before joining the Australian Navy. Her first ANARE voyage was to Heard Island, delivering Australia's first winter contingent on 11 December 1947. Far from comfortable, when heading into a sea she was described as being like a caterpillar in motion, rippling from bow to stern. The noise was deafening, with bulkheads buckling in and out with loud cracks, while the rivets creaked and groaned. On 16 December 1948 the ship was renamed HMAS *Labuan* and painted yellow for Antarctic service. She completed seven voyages with ANARE before being withdrawn from service after suffering severe damage when returning from Heard Island in 1951.

I was born at the seaside town of Rye, on the Mornington Peninsula, where I learnt about the sea. I left home when I was 14 to become a farm labourer in Gippsland and worked seven days a week from 5:30 am to 7:30 pm with time off on Sunday between milking. I believed then that men earned their living that way, so was satisfied with my lot. When I did leave it was because I could not take the cold Gippsland winters any more. It is ironic that within a few months I would be on my way to the Antarctic.

I enlisted in the Royal Australian Navy (RAN) for two years and was nearly three years at sea. This short time influenced much of my life thereafter. Even in my wedding photo I was standing at attention. After all this time I still march rather than walk, and pull my shoulders back when standing in a group.

After recruit training I was sent to Sydney to join HMALST 3501 (HMAS *Labuan*). I and the rest of the crew lived in Landing Ship Tank 3008 and crossed the gang plank each morning to work on our own vessel. Everything was new to me. Sydney was wonderful and Sunday anchored in the harbour was a delight.

I did not realise how different life on a ship could be until we sailed through Port Phillip Heads at the start of our journey to Fremantle. As we sailed down one of the huge rollers that race through the Heads, I found myself propelled across the quarter deck and straight into the Chief Stoker's arms. He said, 'I didn't know you cared', or words to that effect. Not a good start to my life at sea.

Our adventure began in 1947 when I was 18. Our captain (Lieutenant Commander Dixon RANR) came aboard and told us of our mission. We were to claim Heard Island for Australia and establish a research station there. The ship's complement was to be 112 crew and 14 scientists.

I was one of the few lucky people on board as I was never sea sick. However, as Upper Deck Stoker I was not spared other misfortunes that awaited us. I did not keep watches, but had to deal with all the material on the upper deck that was connected to the engine room. There were a lot of drums held with chains which I had to keep secure, and from time to time remove one and roll it down to the starboard waste for use in the engine room. I worked alone, while the seamen worked in teams. Their work was mostly on the dangerous fore deck and most of my time was spent on the quarter deck.

When we arrived in Atlas Cove the seamen lashed about 15 44-gallon drums to a cargo net and lowered it over the side, from where it was to be towed ashore. The sea was calm but the waves were rising and falling 15 or 20 feet up the side of the ship. When the sea rose the drums fell apart and on the way down they crashed together and scraped against the side of the ship.

The First Lieutenant was in charge and he turned to my mate and me and said, 'Right-o lads, down you go'. He wanted us to climb down the scaling net and fix the problem. Of course we could have been killed, so we hesitated. He then turned to the Petty Officer and said, 'Call the Master at Arms. I will charge these men with mutiny'.

Just inside the mess deck entrance there was a large notice called *Kings Rules and Admiralty Instructions*. This was a list of crimes and punishments that read something like this:

'**Desertion**: Death or such other punishment as is hear and after mentioned.

Cowardice: Death or such other punishment as is hear and after mentioned.

Sodomy: Death etc...'

And there it was, leaping off the page…'**Mutiny**: Death or such other punishment as is here and after mentioned'.

Fortunately, when we got below deck the Master at Arms said we would not hear any more about the incident. But I glanced at that notice every time I passed it for the next week.

When the ship beached at Atlas Cove, all off-duty men were told to report to the bow doors. When I got there I was given a pair of waders that came to about eight inches below my arm pits. A bulldozer had constructed a path from the ramp to the beach to unload stores and there was a line of men either side of the path passing light boxes hand-to-hand to people waiting on the beach. Suddenly the officer in charge said, 'Jump in there lad'. He was pointing to a space in the line. I did as I was told and quickly found the reason nobody stood there...it was a hole. I went up to the top of my waders in the water and had to be pulled out.

Later, I was sent ashore with a work party to recover metal objects from a pontoon which had sunk and was breaking up on the beach. For a few shillings worth of cleats and turnbuckles we had to paddle around in water up to our knees and take our mittens off to use the tools.

The Petty Officer saw something further down the beach and sent me to see what it was. I was nearly there when I glanced up at Big Ben. Something quite fascinating was happening. There was a fluffy collar around the top of the mountain which was growing larger and rolling downwards, looking like a smoke ring. Suddenly the Petty Officer yelled 'Run!'

As I ran I saw the rest of the party disappear into the hut [Admiralty Hut, built c1927] and then the storm hit me. The sleet, like hail and beach sand, was flying horizontally towards me and I had to cover my face with my mittens. It was a desperate moment, but a few yards from the station the sleet eased and I saw someone holding the door open for me. Eight of us made it to the hut while the rest climbed into the Walrus aircraft that was tied down on the beach. They must have spent a dreadful night. The plane was blown to bits by the storm the next day.

Just before heading home the Captain told us that the fuel oil was too thick to pump because of the cold. We would have to go to South Africa to pass through a warm current and free the fuel. But just as we were slapping each other on the back he spoke again. The problem had been solved.

It seems that a young seaman had suggested they lower a steam hose into the tank to warm the oil and then pump the condensate away before transferring the fuel to the boiler fuel tanks, which were heated. The young seaman became very unpopular after that.

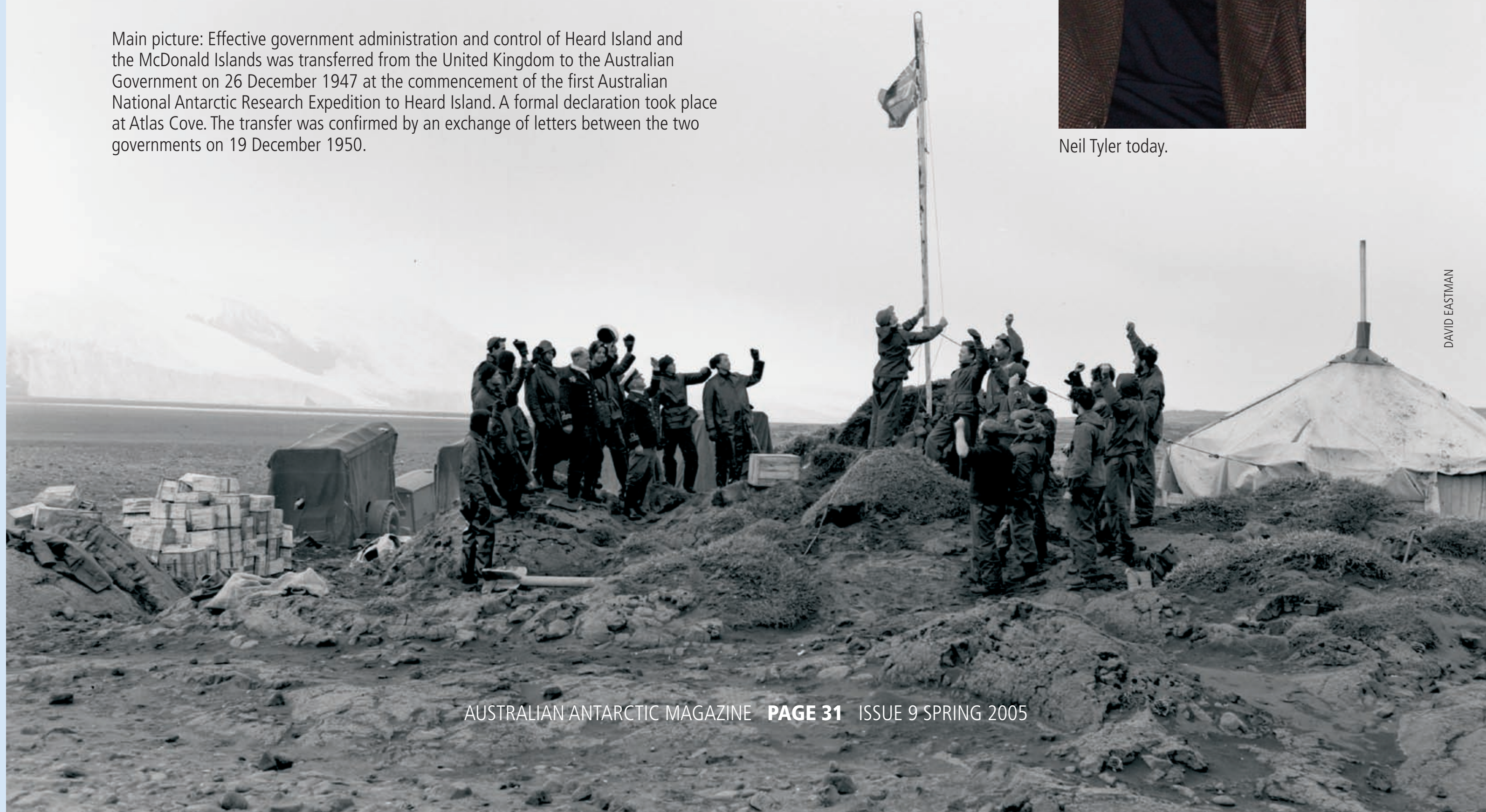
I had several more trips to Heard Island as well as Kerguelen and Macquarie islands, but that's another story.

For more information about Heard Island visit:
<http://www.heardisland.aq>
<http://www.aad.gov.au/default.asp?casid=6209>

—NEIL (TIM) TYLER
Ex-Stoker, RAN

'At 18 I thought I was a man, but as you can see I was a boy. I was very proud of myself in my uniform. Today our fine young men and women are allowed to go out in civilian clothing. This privilege came in the last months of my service. It is great to be able to do that, but it would be nice if certain days were put aside for them to wear their uniforms so that we could see them and be proud.'

Neil Tyler today.



Main picture: Effective government administration and control of Heard Island and the McDonald Islands was transferred from the United Kingdom to the Australian Government on 26 December 1947 at the commencement of the first Australian National Antarctic Research Expedition to Heard Island. A formal declaration took place at Atlas Cove. The transfer was confirmed by an exchange of letters between the two governments on 19 December 1950.

DAVID EASTMAN

A trade in Antarctica

Many expeditioners down south are experienced trades people who help keep Australia's Antarctic stations running like clockwork. Plumber, Patrick Brennan, and carpenter, Damian Love, describe their experiences practicing their trade in the Antarctic and subantarctic.

Patrick Brennan, Plumber, Davis 2005

I gained my qualifications as a licensed plumber, drainer and gasfitter in 1988 after completing the basic three-year trade course and an additional two-year advanced course. My apprenticeship involved work in industrial, commercial and domestic environments and included the installation of water and waste piping, gas systems and sprinkler and fire hydrant systems.

I ran my own business from 1990-2001, and tendered the Olympic Live sites throughout Sydney in 2000. In 2001 I became an inspector for Sydney Water - inspecting work done by plumbers and drainers to ensure it met the relevant codes and standards.

In 2003 I applied to work in Antarctica. On a personal level, I wanted to experience a place that was largely untouched by humans, and to set foot where no other had stepped before. While trekking through the Vestfold Hills last summer I felt sure that I achieved this. On a professional level, the challenge of maintaining a complex system that included plumbing, heating and cooling, mechanical services, gas, refrigeration and maintenance, and anything else that fell under the blanket of 'base plumber', appealed to me. The need to work problems out systematically and adapt to different systems in a remote environment, often in extreme conditions, was something I had wanted to experience many years before applying for the position.

The basic skills of the trade remain the same no matter where you work. But in such a hostile climate the installation differs greatly – all external services are installed in an insulating sheath to protect them from extreme cold and strong winds. The weather also determines how long you spend outside on a task. We recently worked on the sewer outfall line in conditions of -25°C and 30 knots of wind. Days like these are extremely hard on the body and my hands suffered even with all the protective gear on. Two to three hours was all I could take before I had to go inside and warm up.

A large part of our time last summer was spent in the water production plant. This reverse osmosis system draws water from a small saline lake before it is filtered and treated for human consumption. The running and maintenance of this plant is time-consuming and demanding work, but necessary to keep it operating at a level that will provide enough water for winter, when production stops.

Apart from the regular plant room services and checks, we keep busy over winter with breakdowns and maintenance. We regularly monitor the indoor temperatures and adjust the mix of heated and fresh air to maintain a constant 17°C where possible.

I'm also the social co-coordinator on station and enjoyed helping to set up an Academy Awards night, a St Patrick's Day celebration, an indoor gaming night, and a spit roast and BBQ to celebrate the International Plumbers' Day on April 24.

My plumbing partner, Dave Nadin, and myself have managed to keep fit with three gym sessions a week. We also use the indoor climbing wall and play a fair bit of table-tennis, darts and snooker. In the evenings, I've been improving my hand writing by practicing calligraphy.

I would like to return one day. Antarctica has surpassed my expectations and left me mesmerised and speechless many times. The people I wintered with have become a surrogate family and are an amazing bunch whose company has greatly added to my experience. However, I would not subject my wife Lisa and our two young children to such separation again for a long time, as it has been hard on us all. When I return to Australia I intend to resume my previous role with Sydney Water.

Cutting the sewage line in order to clear a blockage.

DAVE NADIN

TIM PRICE

Damian's carpentry skills took him to Macquarie Island where he was privileged to observe its unique wildlife, including these curious king penguins.

Damian Love, Carpenter, Macquarie Island 2005

I've been interested in the Antarctic and subantarctic since I was a child growing up with the stories of my father's friend, who was involved with the Australian National Antarctic Research Expeditions. In 1985 my brother ventured south as a diesel mechanic and, while bidding bon voyage to the *Ice Bird* in Hobart, I decided I wanted to go to Antarctica too. So I began to steer my career in that direction.

I gained my qualification as a carpenter through a four-year carpentry and joinery apprenticeship at Box Hill College of Technical and Further Education. The training included concrete construction, steel work, form work, and domestic and commercial building and maintenance. I then undertook further studies in building and construction, safety, rigging, scaffolding, management and supervision, and gained various plant and equipment licences.

I've worked in many sectors of the building industry including housing, multi-storey and resort construction, and directed my own company, which specialises in property management and maintenance in Melbourne. In 1998 I achieved my goal when I spent a summer at Mawson and a winter at Casey. From 1999 to 2002 I spent two summers and a winter at Mawson, where I was involved in the wind turbine construction. I'm now working at Macquarie Island.

For a tradesman, working in Antarctica or the subantarctic provides a great opportunity to learn about the scientific work that Australia conducts and to contribute to the achievement of our country's scientific goals. The projects I have been involved in give me great satisfaction, especially when the results are published. These projects have included the Penguin Monitoring Programme at Béchervaise Island, the Amery Ice Shelf hot water drilling project, and the Prince Charles Mountains Expedition of Germany and Australia.

As a carpenter at Macquarie Island I'm involved in a range of activities, including replacing doors and furniture, repairing storm-damaged buildings, venturing out into the field to maintain field huts, and coordinating cargo and personnel at resupply. Indoor maintenance is a priority in the colder months and so my skills at plastering and painting are called upon.

We only get one resupply a year, so stock inventory is of the utmost importance. As there is no local hardware store from which to purchase additional stock, some improvisation may be required if the correct materials are not available. Because of the weather, work days need to be carefully planned. If the weather is clear then priorities may change in order to do outside work. If the weather is bad, or the conditions change quickly, outside work may need to be postponed and other jobs attended to.

I have a few other duties, the most interesting and important of these being fire chief and theatre nurse. As fire chief I'm responsible for fire management strategies on station. In such a remote location, it is important to be able to deal with any emergency response as it occurs, and this requires that I conduct routine checks and ongoing maintenance throughout the year. As a theatre nurse I assist the doctor with any medical problems that may occur. I am also on the boating team, search and rescue team, and during resupply I'm involved with cargo and logistics management.

I feel privileged to be living in this unique heritage area. From the station we can see elephant seals, hooker sea lions, fur seals, gentoo and king penguins and an abundance of other bird life. The chance to live and work with a group of people from varied backgrounds and experiences has also enabled me to learn more skills and work within a team environment.

Taken on North Head at the site of Douglas Mawson's wireless mast erected during the 1911-1914 expedition.

Art in Antarctica

CHRIS STANNARD

Left: Judith Parrott at her exhibition of *A Place in Bolivia* in 2004.

CRAIG COOPER

Anthony Eaton receives his Arts Fellow certificate from Senator the Hon. Ian Campbell.

Ted Mead

Four talented artists will be travelling south this season as part of the Australian Antarctic Division's (AAD) Australian Antarctic Arts Fellowship programme. The programme encourages Arts Fellows to communicate their experiences via their artistic media, so that others can appreciate and understand Antarctica's unique values and beauty and Australia's role in studying and protecting it.

The 2005-06 Arts Fellows are:

TED MEAD is an accomplished photographer whose work encompasses landscape, wildlife and macro photography. Ted will photograph the Antarctic landscape and wildlife to complete his photographic project *The Land of Extremes*, which already includes images from the arid outback and the wet tropics. The collection will be exhibited at Tasmania's Cradle Mountain Wilderness Gallery over the 2006-07 summer and in a travelling exhibition to be arranged through the national museum network.

PETER MORSE is a researcher and lecturer in Digital Media at the School of Creative Arts, University of Melbourne, and in Communication Studies at the University of Western Australia. He has a background in semiotics (study of signs and symbols), artistic practice and computer visualisation, and an ongoing interest in the intellectual history and practices of science and engineering. Peter will take stereoscopic (3D) images of Antarctica and create a database of images that will be combined with satellite, aerial and ground-survey data from the AAD Data Centre to create an interactive 3D virtual reality representation of Antarctica. This virtual environment, *Antarctica Virtua*, will be documented at <http://www.antarcticavirtua.net>. Peter will develop high-resolution content that will be displayed in the new stereoscopic projection system to be opened at the Tasmanian Museum and Art Gallery in 2006. This content will also be shown at several virtual reality centres around Australia and internationally.

ANTHONY EATON is an established author of books for children, teenagers and adults. Since 2000 he has published six books through the University of Queensland Press and aims to produce a new novel set in Antarctica. Anthony will research Antarctic life, its environment and history, to produce a book that will promote the interest of young adults in the issues and history surrounding Australia's involvement in Antarctica.

JUDITH PARROTT will document the life of a community in Antarctica, depicting the energy of a dedicated team of people, to produce an exhibition based on the five senses. The exhibition will include photographs, collages, data projection, a CD of sounds and interactive items for touch, taste and smell. It will be displayed at the Brisbane Powerhouse in 2006 and may become a travelling exhibition through Museum and Gallery Services Queensland. A braille diary will be produced from the exhibition material. Judith staged a similar exhibition featuring 'the Bolivian Indigenous community and their sense of place' at the Brisbane Powerhouse in 2004.

Below: This image was taken in front of the Vatnajokүll Glacier in Iceland using a portable 3D video-camera system that Peter Morse designed and built. When viewed with 3D (red and green) glasses the image appears as a 3D scene. Peter will produce similar still and video shots in Antarctica.

PETER MORSE

New Deputy Director for AAD

Virginia Mudie took up the position of Australian Antarctic Division (AAD) Deputy Director on 13 July 2005. Virginia was previously Group Manager, Corporate Support, in the Department of Family and Community Services in Canberra. She is an experienced senior executive with a varied career which spans working in the United Kingdom for the Australian Tourist Commission, private enterprise, the Chamber of Manufactures of NSW/Australia Business Limited and, since 1999, the Australian Government.

AAD

Midwinter chill-out for children

'Cool Science' was the theme of the AAD's first 'school discovery days' at its Kingston headquarters, during Tasmania's Midwinter Festival in June. Over three days, 480 grade 4-6 students from 12 schools in southern Tasmania, participated in demonstrations of Antarctic science and operations and the Antarctic Treaty.

On the science front, students became entangled in the Antarctic food web, tasted water from an ice core, sifted through rubbish washed up on the Antarctic coast and marvelled at the aurora and other atmospheric phenomena.

In Operations, four displays gave the students an insight into the clothing and field equipment needed to survive the extreme cold, communication technology used in the field and on station, and the vehicles needed to traverse ice and snow. The quad bikes, hagglunds, polar pyramid tent and radios were firm favourites.

Last but not least, the importance of the Antarctic Treaty in maintaining Antarctica as a place of peace and science was briefly discussed by childrens' author and illustrator Coral Tulloch. Coral visited Antarctica in 1999 as an AAD Arts Fellow. The children were then encouraged to draw pictures of Antarctica and write postcards to the AAD Director about their wish for Antarctica's future. The pictures will be incorporated into AAD Arts Fellow Alison Lester's travelling exhibition of childrens' art (*Australian Antarctic Magazine* 8: 36), while the postcards will be displayed at AAD headquarters.

GLENN JACOBSON

Tas van Ommen breaks the ice

Antarctic display at Parliament House

A volcanic eruption on the McDonald Islands in August this year provided a fiery backdrop to the opening of an exhibition, *Australia's Antarctic Programme, Connecting, Protecting*, at Parliament House in Canberra. The exhibition featured before and after satellite images of the McDonald Islands and photographs of Heard Island taken by AAD expeditioners during the 2003 Heard Island expedition (*Australian Antarctic Magazine* 7).

The exhibition also featured images of Antarctica's aviation history, to coincide with the announcement of Australian Government funding of $46.3 million for the Australian-Antarctic Airlink.

Antarctic Aircraft stamps

Four aircraft important in the Australian Antarctic Territory since the 1950s were commemorated in a set of Australia Post stamps on 6 September 2005. The four stamps, designed by Lynda Warner of Tasmania, feature:

- The Hughes 500 Helicopter debuted in the 1970s in support of a field party in the Prince Charles Mountains;
- The De Havilland DHC-2 Beaver was used for reconnaissance and photography from 1955-1966;
- The Pilatus PC-6 Porter was first chartered in the 1969-70 season; and
- The Douglas DC-3/Dakota C-47 was flown for 47 days before it was destroyed in a blizzard in December 1960.

For details of the stamps and other products see: <http://www.auspost.com.au/philatelic/stamps/stampshop_2.asp?category_id=457&product_type=8>.

Tasmanian Museum and Art Gallery opens Antarctic exhibition

Offshore whaling with the Aladdin and Jane, painted by William Duke in 1849, demonstrates Hobart's historic link to the Southern Ocean. The painting is part of the Tasmanian Museum and Art Gallery collection.

A new permanent exhibition exploring Antarctica and the Southern Ocean will open in early 2006 at the Tasmanian Museum and Art Gallery. *Islands to Ice: the Great Southern Ocean and Antarctica* will detail Antarctica's places, people, wildlife and other natural phenomena. The region's significant historical and present links with Hobart will also feature.

The exhibition will contain an array of original artefacts – objects, documents and film – with authoritative input from scientists, historians, artists and expeditioners.

'The exhibition will combine the humanities and science and use multi-media graphics. It will showcase objects and artefacts that form part of the state collection at the Tasmanian Museum and Art Gallery,' said Senior Curator of the Antarctic and the Southern Ocean project, David Pemberton.

The curatorial team spent months sourcing items to add to the Museum's collection, including from the AAD – where many people donated personal artefacts. The team are still eager for donations, particularly of dramatic images of the Southern Ocean. Donated items will be curated to international standards and incorporated into the Museum collection. They could also be used for various educational programs related to the exhibition.

A hotline has been set up for donations and information: email Antarctic.Exhibition@tmag.tas.gov.au or telephone: (+61 3) 6211 4166.

JEREMY SMITH

Casey station chef, Andrew Tink, is renowned for his contribution to station harmony and dedication to community duties.

Station Leaders 2005-06

Antarctic continent station leaders for 2005-06 have departed for Casey, Davis and Mawson. A station leader for Macquarie Island has also been selected and will begin work in March 2006. The new Antarctic station leaders are:

Marilyn Boydell – Casey: This season will mark Marilyn's third year as a station leader in Antarctica. She previously occupied the position at Casey in 2000 and Mawson in 2002. Marilyn began her Antarctic service after more than 20 years experience in the area of education, training and assessment. This included working with an aboriginal community in the north of Western Australia, teaching in the juvenile justice system, training and supporting adults with disabilities in the open workplace, and delivery of occupational health and safety programmes to specialist groups. She has also worked as an instructor in outdoor centres in the United Kingdom where she first discovered the joys of 'potholing'. Marilyn is also a keen bushwalker and an experienced trainer of Scuba diver instructors. She has dived all over the world and delivered training in areas as diverse as the Nullarbor caves, Irian Jaya and the Christmas Island.

John Rich – Davis: John has spent two winters as station leader at Macquarie Island (1990) and Casey (2002). He grew up in Canada, where he received his initial training as a geologist and worked extensively in northern and arctic Canada, before coming to Australia in 1979. John holds a Post Graduate Diploma in Environmental Impact Assessment and recently completed his PhD in wetland hydrology. In 2004-05, John worked in Namibia as an exploration geologist. He and his wife Kathryn live in Albany on the south coast of Western Australia and have two adult daughters. John's outside interests include bush walking, canoeing and aviation. His current 'very long term' project is the construction of a two-seater home-built aircraft.

Ivor Harris – Mawson: Ivor has worked for most of his career as a veterinarian, including large and small animal practice and TAFE teaching. For many years he specialised as a laboratory animal scientist and also developed a research interest in microbiology. In this role he has managed biomedical research support facilities in the Commonwealth Department of Health and the University of Queensland. He was in the Army reserve for 17 years and, since 1999, has been in the regular Army as Major, administrative/scientific officer at the Army Malaria Institute in Brisbane. In 2000-01 he was deployed to East Timor as coordinator of a major antimalarial drug trial. This season will be Ivor's second in Antarctica – he was the station leader at Casey in 2003.

Australian Antarctic Medals awarded

A Tasmanian biologist who helped eradicate cats from Macquarie Island and a Victorian chef with extensive Antarctic experience have been awarded the 2005 Australian Antarctic Medal. The awards to Geoffrey Copson and Andrew Tink were announced on 21 June by His Excellency the Governor-General, Major General Michael Jeffrey, AC CVO MC (Retd).

Geoffrey Copson is a wildlife management officer with the Tasmanian Department of Primary Industries, Water and Environment. He was responsible for the initiation, planning and implementation of the pest control program that has seen the eradication of cats and the New Zealand Weka bird from Macquarie Island.

Casey station chef **Andrew Tink** has spent long periods in Antarctica since 1997 – nine summers and four winters looking after the nutritional needs of expeditioners – with time at each of Australia's other stations, Davis, Mawson and Macquarie Island. While Mr Tink has served in a variety of roles, including search and rescue leader, deputy fire chief and hospital theatre nurse, he is best known for his culinary talents.

The Australian Minister for the Environment and Heritage, Senator Ian Campbell said the contributions of both men, above and beyond their day-to-day Antarctic service, made them deserving recipients of the 2005 Australian Antarctic Medal.

PM launches Australian-Antarctic Airlink

The Prime Minister officially launched the Australian–Antarctic Airlink in Hobart on 2 September 2005. To support the Airlink, the Australian Antarctic Division (AAD) will be funded by an additional $46.3 million over four years, as part of the Australian Government's $3.2 billion commitment to the environment and heritage.

The Airlink and the intra-continental CASA 212-400 aircraft – which commenced operations in 2004-05 – will deliver between 200 and 250 personnel and high priority equipment between Hobart, Casey, Davis, Mawson and other locations within Antarctica.

Inter-continental flights will operate over summer between Hobart and a snow capped blue ice runway near Casey station. Each flight will take 9-10 hours for a return trip and flights will run approximately every 7-10 days. Trial flights are scheduled to start in 2006-07.

Marilyn Boydell

John Rich

Ivor Harris

PETER LOVELL

PETER WHYTE

Left: Prime Minister John Howard cuts the official Airlink cake while AAD Director, Tony Press, looks on.