



Australian ANTARCTIC

MAGAZINE

Spring 2001



SIGNALS FROM THE SOUTH BUILDING THE BIGGER PICTURE WITH REMOTE TECHNOLOGY

Australian ANTARCTIC

MAGAZINE



The Australian Antarctic Division (AAD), an agency of Environment Australia,

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 **Australian National Antarctic Research Expeditions (ANARE)**, maintaining four permanent Australian research stations, and conducting scientific research programs both on land and in the Southern Ocean.

Australia's four 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 system
- To undertake scientific work of practical, economic and national significance

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

Australian Antarctic Magazine is produced twice yearly. Editorial enquiries, including requests to reproduce material or contributions should be addressed to:

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ISSN 1445-1735 (print version)

Australian Antarctic Magazine can be viewed at Antarctica Online: <http://www.aad.gov.au/information/magazine>.

	From the Director	1	
FEATURE	New tools for Australia's Antarctic research	2	
	Antarctica: satellites give the big picture	3	
	Those massive icebergs: where are they now?	5	
	Better tools for better forecasting	5	
	Antarctic volcanic ash: a potential threat?	6	
	Looking forward from the past	7	
	Technology the Antarctic way	8	
	The machine that goes ping!	10	
	More than just counting: the pack-ice seal census	12	
	How we support our marine scientists	13	
	Weighing penguins from a distance	14	
	New techniques for counting penguins	15	
	Molecules and microchips: tools to unravel the secret lives of marine predators	16	
	A bottom-up approach to remote sensing	17	
	Going automatic... Australia's ASP observatories	18	
	Network technology aids in operating the LIDAR	19	
	SCIENCE	Australia continues as telecommunications innovator	21
Remote housekeeping at the press of some buttons		22	
Safer, greener power supplies for Macquarie huts		23	
Blizzard winds to power Australian Antarctic station		24	
Tide gauges that withstand stormy seas and Antarctic ice		25	
A moveable feast: explore the AAD's interactive maps		25	
Antarctic visions: making the most of digital imaging		26	
The season ahead: science on a grand scale		28	
Australian Antarctic shipping program 2001-02		29	
Proposals sought on Antarctic air transport system		29	
Heard Island uncovered: 2000-2001 summer ANARE		30	
Big Ben: the fire beneath the ice		31	
Our subantarctic glaciers: why are they retreating?		33	
Fertile ground for science: terrestrial studies in Antarctica		35	
ENVIRONMENT & HERITAGE		St Petersburg meeting reflects maturing of Protocol	36
		Research into the clean-up of tips at Casey and Wilkes	37
		Marine reserve proposed for Heard Island	39
	Heard Island treasure hunt	40	
INTERNATIONAL	Antarctic Treaty Parties meet in Russia	41	
	Treaty meeting looks at tourism	42	
	Casey and the Antarctic Treaty negotiations	43	
	Assessing influence within the Antarctic Treaty System	44	
	Another one that didn't get away!	45	
	A history of the Patagonian toothfish fishery	46	
	CCAMLR meetings address critical issues	47	
NINETY YEARS AGO		48	
RETIREMENTS		49	
IN BRIEF		50	
WEATHER RECORDS		52	
FREEZE FRAME		inside back cover	

Cover—Australia's Antarctic Program has employed innovative new technologies to revolutionise the collection and transmission of data in the most inaccessible parts of our planet. Computer-enhanced aerial image maps such as this one from the AAD's Australian Antarctic Data Centre, along with similar satellite imagery, are proving increasingly valuable as research tools. The map features Béchervaise Island near Mawson, Antarctica, where Australian engineers and scientists have deployed an ingenious remote-controlled system that tells us about Adélie penguins' movement and eating patterns without requiring any physical contact or presence by field-workers.

From the Director

2001, THE CENTENARY YEAR FOR Australian Federation and the Australian Public Service, is also a great year for Antarctic anniversaries. Ninety years ago Sir Douglas Mawson and his party – the most successful Antarctic scientific expedition of the ‘heroic’ era – departed Hobart for the ice. It’s 40 years since Australia, in recognition of its leading part in bringing key parties together in the original Treaty negotiations, was given the honour of hosting the first Antarctic Treaty meeting in Canberra. Twenty years ago the Australian Antarctic Division completed its move to Hobart. The same city, in the same year, saw the establishment of new headquarters for the Commission for the Conservation of Antarctic Marine Living Resources. And a decade ago this year, the Madrid Protocol was adopted by the nations of the Antarctic Treaty.

Anniversaries can be useful. They’re an opportunity to take stock, to draw on the knowledge and experience from our past for building better programs for the future. It’s fitting that in this anniversary year we in the Australian Antarctic Division pause for a moment to consider our place in the scheme of things and what we need to do to make our Antarctic program more effective, more relevant and more beneficial to Australia and the world.

One of our key goals is to support the Antarctic Treaty system, under which umbrella nations have worked cooperatively in Antarctica in the peaceful pursuit of knowledge for over four decades. This year, in the 24th Antarctic Treaty Consultative Meeting in the Russian city of St Petersburg, Treaty nations took a big step forward in agreeing to set up a permanent secretariat for the Treaty in Buenos Aires, Argentina, ending 40 years of ‘temporary’ arrangements. In this as in many other Treaty discussions over the years, Australia has had a big part in the decision-making process. Our active and constructive participation in Treaty forums have cemented our reputation as a strong supporter of the Treaty system and a leading player in its processes.

At a time when international structures are under stress, the Antarctic Treaty system stands proud. Besides the Treaty itself, the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) and the Protocol on Environmental Protection to the Antarctic

Treaty (the Madrid Protocol) are ambitious in their conception, their scope and their enormous geographical coverage. Yet they stand today as uniquely successful international agreements on cooperation and environmental conservation.

The continued success of these agreements depends on the continued willingness of participating nations to do the hard work in the field and the laboratory. Underlying Australia’s active role in the Treaty system is an ambitious research program demanding the highest commitment of its people.

This summer we will ship about 500 people into and out of the Antarctic. This is a major investment in people’s time and other resources that over the past couple of years has prompted us to look more seriously at a future air transport system to reduce transit time. It has placed further demands on our legendary inventiveness and innovation to find ways

At a time when international structures are under stress, the Antarctic Treaty system stands proud.

of gathering our field data at a distance, using remote sensing and automation. In this second issue of Australian Antarctic Magazine, we look at where this process is taking us.

Our research effort in 2001-2002 will take us on a major marine science cruise, part of an international climate variation study of water composition and quality, currents and ocean productivity. We will be drilling through the Amery Ice Shelf and retrieving moored buoys at the ice shelf face to find out more about how this major drainage basin works. We will be looking at sea ice thickness and other parameters such as pigment colour using a new microwave satellite reception system on the research vessel *Aurora Australis*. We will continue a long-term study of natural variability in penguin



PHOTO BY WAYNE PAPPS

survival as a tool for assessing the effects of krill and fin-fish fisheries. And we will be further fine-tuning the new ‘Lidar’ middle atmosphere laser probe at Davis, Antarctica, to gather data about the coldest part of the Earth’s atmosphere.

Our activities span over 10 million square kilometres or more of East Antarctica and the Southern Ocean. Not only across the globe, but up and down: our Lidar probes 90 km into the atmosphere and our ocean-probing instruments collect data from 6 kilometres below the sea surface – truly a huge slice of Planet Earth.

This is science on a grand scale, and Australians have long supported our significant endeavours in Antarctica. This is something we can be proud of. Providing Australia and the world with valuable insights into the state of our planet demands that we maintain high standards of scientific research and interpretation. This is the credibility test that Australia, as a leading Antarctic nation, must continue to meet. We are confident we can do it.

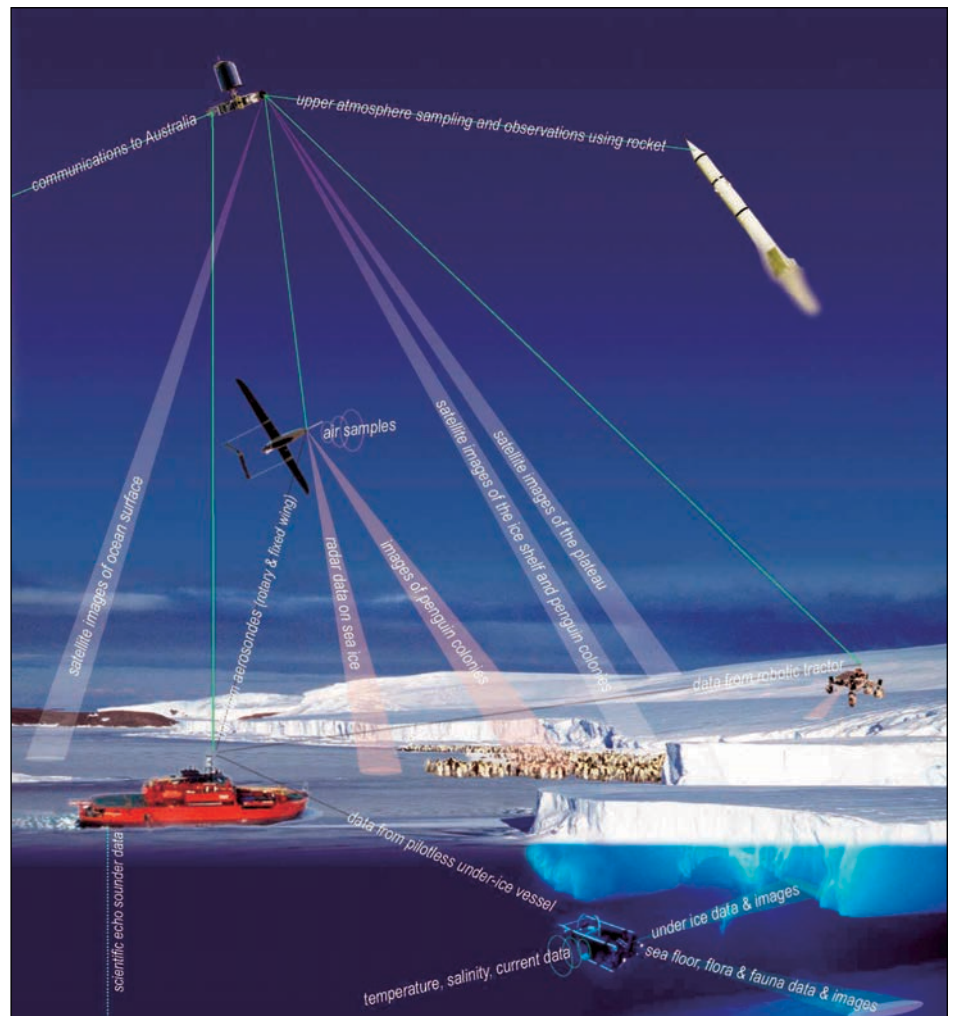
A handwritten signature in blue ink that reads 'Tony Press'.

New tools for Australia's Antarctic research

IN THIS, THE SECOND EDITION of *Australian Antarctic Magazine*, we have chosen to take a look at the new tools with which science is actually done in the Antarctic. As the Director points out in the introduction, the swag of anniversaries we have been celebrating this year gives us a wonderful platform from which we can look forward and, as it were, reflect on the future.

Scientific research has come a long way from the first experiments made by Sir Edmond Halley aboard the *Paramore* in 1699. In his day scientific knowledge was sketchy and instrument design was, by present day standards, poor. It was a scientist of great courage who set off in a small wooden boat to measure magnetic fields and other physical phenomena but many did so with astonishing accuracy. Some of Halley's magnetic variation data obtained 400 years ago has been considered reliable enough for inclusion in a recent study of geomagnetic variation.

But science in the Antarctic is no different from science anywhere else. Advances in technology can be quickly applied, provided some care is given to instrument design and construction. Computers and radio telecommunications have revolutionised how data may be collected and stored, or transmitted directly to a scientist's lap-top, many thousands of kilometres away. As the collection of articles in this edition shows, the Australian scientific program is heavily based on new and emerging technologies. As costs of on-site data collection increase, and the scientific questions that need to be asked become ever more complex, we can confidently expect to see dramatic increases in our use of remote sensing, of collecting information about the world about us through remote instrumentation. But I am not advocating a person-free Antarctic science program! The future for the science program rests on us being able to do the things we are currently doing at lesser cost, to free up resources (and the scarcest of these is human brain power) for entirely new developments. Close your eyes and imagine the Australian scientific program in the



A glimpse of the future?

Antarctic, 10 to 15 years hence.

Our ice-breaking research vessel slows down as it approaches the ice edge. Technicians and engineers wheel a pilotless helicopter from a small hangar and adjust its payload of cameras, radar arrays and atmospheric sampling vessels. Lifting off the deck, its three-metre rotor span gives it great controllability and within a few minutes it is photographing a colony of emperor penguins from 1000 metres altitude. Rising to 3000 metres it collects radar data on ice thickness and roughness. Its GPS system enables scientists later to compare the ice conditions at one precise location over several years. Finally it collects samples of air at a number of predetermined altitudes before returning to the mother ship, where its samples and films are unloaded. The program's technicians then launch a pilotless submarine vessel that is able to travel far under the sea-ice shelf, recording temperature, salinity, and current, while its upward-looking cameras scan the undersurface of the ice for a record of recent melting

PAULINE DE VOS

and refreezing. After being sent to the ocean floor its downward-looking cameras capture images of the sea floor, and its flora and fauna.

Too fanciful? A bit. Futuristic? Certainly. Today we have the technology to make enormous strides in the understanding of the Antarctic environment. As Nick Gales points out in his article, we are entering a new era of obtaining crucial data about the lives of marine mammals using new biotechnological and electronic tools. Tim Pauly's discourse on hydroacoustics, and Peter Yates's description on communications technology give a flavour of how we can now do things that were inconceivable just a few short years ago. Neal Young extols the future of satellite technology, already widely used in much of our program. With the advent of new types of sensors there is no telling what we will be able to study in a decade's time.

Our scientific research program in Antarctica has reached a certain level of maturity. But good science

never really grows up. With sophisticated and automated equipment delivering data to our desks every day we can devote more time and energy to the new, exciting things that lie around the corner. We are fortunate at the Australian Antarctic Division, and in the research institutions with which we work, to have access to the world's most inventive brains, and to the support of people for whom it is true that the impossible can be done immediately but miracles might take a moment longer! The articles in this magazine can do no more than give a taste of the state-of-the-art but, alas, they do not adequately expose the human ingenuity and sheer hard work that has gone into making the instruments work in the harshest of all environments. I share the Director's confidence in our ability to take the Australian scientific program in the Antarctic to new and exciting places. Oh, that Sir Edmond could come South with us now!

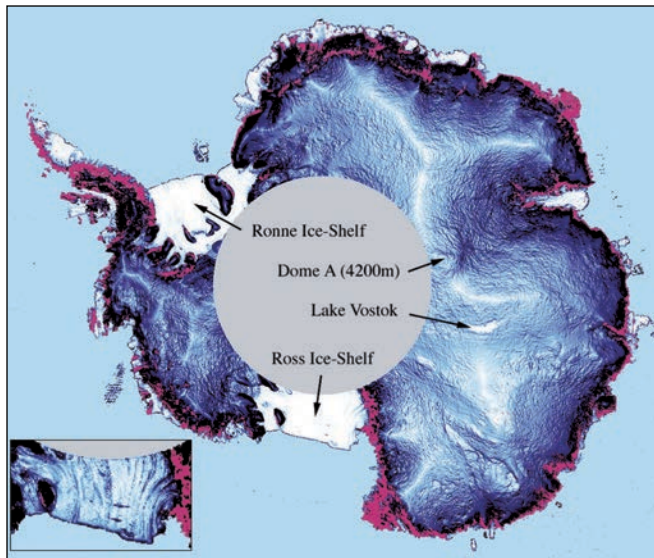
Professor Michael Stoddart, ANARE Chief Scientist, AAD

Antarctica: satellites give the big picture

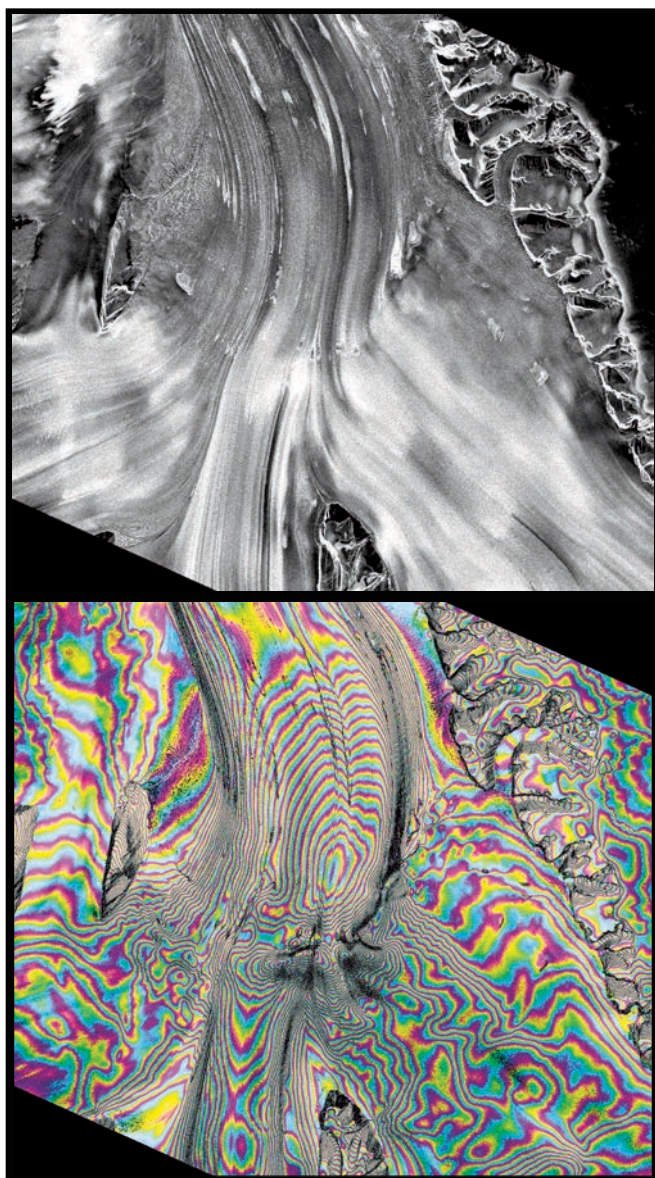
SATELLITES OFFER A GREAT ADVANTAGE OVER OTHER MEANS of observing the Antarctic region, its ice sheet, exposed land, sea ice cover, and ocean. They offer a unique ability to view very large remote areas, on a repetitive basis over long periods of time and almost at will. In this way they provide the "big picture" in both space and time for field programs that operate over limited areas or within short time frames.

Fixed installations such as Automatic Weather Stations provide long time series of observations at a number of discrete points. Field surveys by tractor traverse over the ice sheet, by aircraft, or by ship, collect data along discrete lines or over a network. The distance or area covered is limited by the duration of the field activity of weeks to months. A satellite can gather information for the whole study area in a matter of moments with a single image, or even for the whole region over a relatively short time.

Remote sensing by satellite uses measurements of radiation scattered or emitted from the surface to derive information about the surface, such as its shape, texture, temperature, movement and composition. Most satellite instruments carry no source of illumination, but depend on the sun for the source of radiation scattered from the surface. Other instruments measure the radiation emitted from the surface. A few instruments transmit their own signal and measure the radiation backscattered from the surface. These are various forms of "radar". Clouds, gases, and particles in the atmosphere also scatter, emit and absorb radiation. This affects what we see of the surface and complicates the interpretation of those measurements. Some instruments take advantage



The detail in the surface topography of the Antarctic ice sheet is revealed in this image built from millions of measurements of surface elevation acquired by a satellite radar altimeter. These data were collected, a narrow strip at a time, from about 5000 orbits of the satellite over a year. The image is computer generated as though it is illuminated from above and shaded to enhance the surface slope. The ridge lines that form the inner boundaries of the major ice drainage basins are clearly visible together with many other features related to the flow of the ice over the sub-glacial rock surface. The surface expression of Lake Vostok is visible in East Antarctica, and large white areas are the major ice shelves. Even these exhibit subtle shading variations of flow features within the shelves, and large rifts running parallel to the front (inset from the Ross Ice Shelf). The red colour indicates points where there are no valid elevation data from this instrument. That occurs on rough terrain over mountains and along the steeper margins. (ERS RA data © ESA (European Space Agency) 1994-5.)



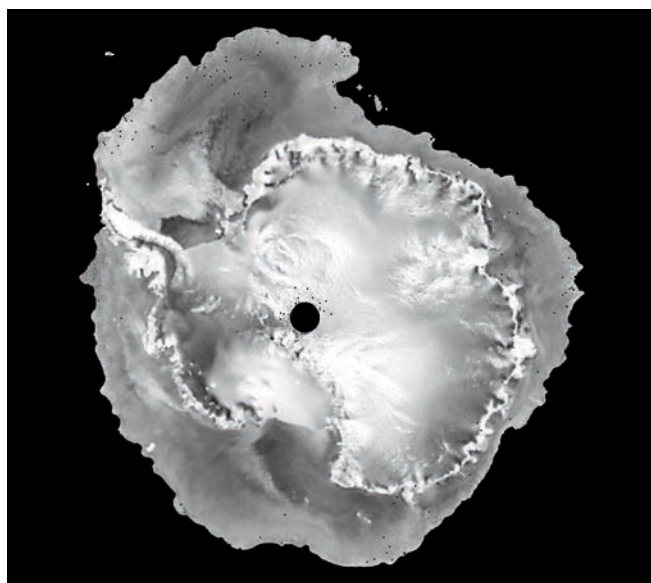
Two views of the same southern section of Amery Ice Shelf produced from Synthetic Aperture Radar (SAR) data. Top, is a standard image showing (right to left) the Lambert, Mellor and Fisher Glaciers merging west of Mawson Escarpment. The grounding zone, separating the glaciers from the floating ice shelf, is along a cup-shaped feature in mid-image. The 'fringes', superimposed in the bottom image, come from interferometric analysis of a pair of SAR images, and show a recent development in glaciology which can map both the topography of the surface and accurately measure the motion of the glaciers. SAR data © Canadian Space Agency, 1997.

of these effects to measure the composition of the atmosphere. They map the ozone hole, and measure other trace gases important to the greenhouse effect.

The variety of satellite systems now available allows the measurement of many different parameters. Some examples of these for the snow and ice cover are surface elevation, movement, temperature, roughness, sea ice extent and sea ice concentration, ice sheet extent, abundance and size of icebergs, and snow melt. Some

instruments measure parameters directly. For instance radar altimeters trace out a line vertically below the satellite measuring the elevation of the surface. By combining the observations from many orbits across the region, a map describing the shape and elevation of the surface is generated. A radiometer measuring the thermal infrared radiation emitted from the surface gives the surface temperature. It scans the surface in a series of lines across the orbit track and thus builds a temperature picture of the surface as the satellite moves along its orbit. The principles are simple but the practice is often difficult and much processing is required to arrive at the required product.

Imaging systems such as Landsat provide a wealth of information corresponding to the time the data is collected. There are many instruments that operate at different wavelengths and at different spatial resolutions from many kilometres down to metres. But darkness and frequent cloud cover limits the use of instruments operating at visible or infrared wavelengths. Satellites with Synthetic Aperture Radars (SAR), the new high-resolution imaging system, provide a powerful tool which can be used at anytime because they "see" through clouds. There is a compromise between resolution or detail and the area imaged at any time. Large areas are imaged by combining individual scenes from many orbits. From these images, the outer edge of the continental ice sheet



A midwinter view of the Antarctic region, uninterrupted by cloud and in the darkness of winter. This coarse resolution composite radar image was generated from data acquired by NASA's wind scatterometer on the Japanese ADEOS satellite in June 1997. Data were processed and accumulated from multiple orbits over five days. Major features of the continent are well defined. The expanse of sea ice and structure within the pack, as well as very large icebergs can also be seen. The motion of the pack ice and icebergs is derived using a time-series of these images. (NScat data provided by JPL / PO-DAAC)

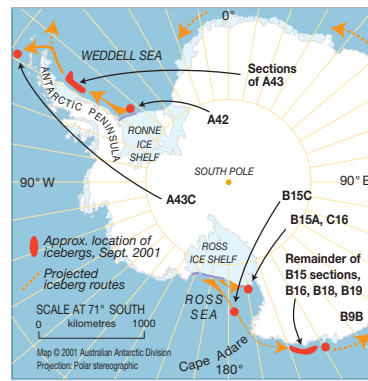
is mapped and thus its change in extent over time. The velocity of glaciers is measured by tracking, in pairs of images, the displacement of crevasse patterns and other features visible on the surface of glaciers. Similarly the motion of the pack ice is given by the movement of the ice floes. Other systems with a coarse resolution but wide imaging swath cover the whole region in a day. These are used to monitor the broad-scale motion of the pack ice, calving and drift of icebergs, and so on.

Many parameters cannot be measured directly but are derived by combining data for different wavelengths. Sea ice concentration is obtained from measurements of microwave radiation emitted from the surface of the sea ice and water. New instruments offer the prospect of more and better measurements of parameters needed for the study of the ice. But the satellites cannot provide everything and measurements from field programs are needed to extend our knowledge of what is seen from the satellites and to validate the information that is collected.

Neal Young, Continental Ice Sheet Program, Antarctic CRC & Glaciology Program, AAD. Images generated by Glenn Hyland, also Antarctic CRC & AAD.

Those massive icebergs: where are they now?

Australian Antarctic Magazine #1 described the massive icebergs that calved from the Ross and Ronne Ice Shelves in 2000. Those icebergs have been gradually moving along the paths indicated on the map below. The largest remaining section of B15 (B15A) moved west along the front of the Ross Ice Shelf and now spans the gap between Cape Crozier on the eastern end of Ross Island and Franklin Island, 160 km north. Another smaller, but still massive iceberg, C16, which calved from the western end of Ross Ice Shelf when B15A hit the shelf, is trapped between B15A and the northern point of Ross Island. They will certainly change the environment for Cape Crozier's emperor penguins. The rest of the 2000 icebergs have moved out of the Ross Sea and are now spread along the coast between longitudes 152°E and 160°E. The largest, B15B, broke into several sections as it was moving towards Cape Adare. Most of these icebergs are likely to become trapped behind another massive iceberg, B9B, which calved



from Ross Ice Shelf in 1987 and is still grounded northeast of Mertz Glacier Tongue around 147°E. In the Weddell Sea, the icebergs A42 and A43, from Ronne Ice Shelf, have moved west along the shelf and north along the east coast of the Antarctic Peninsula. A43 has broken into several sections, now about halfway along the coast of the peninsula. A42 is still in the southern part of the Weddell Sea. *Neal Young, AAD*

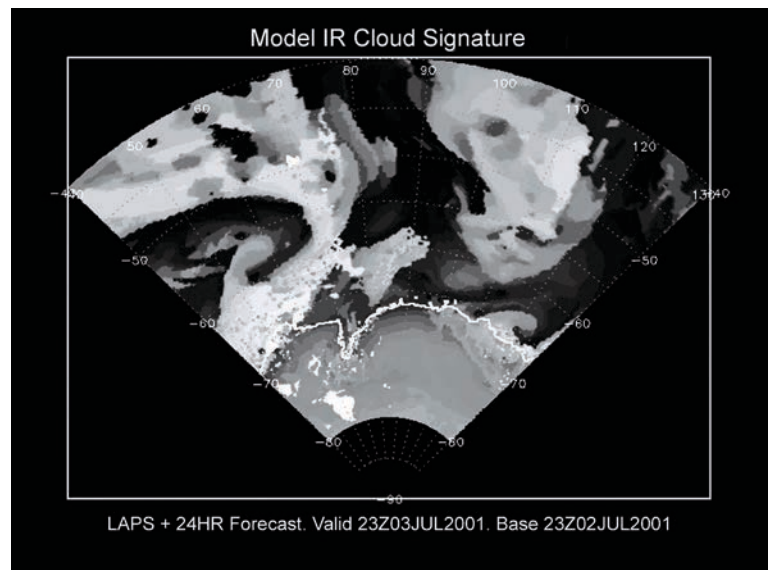
Better tools for better forecasting

ACCESS TO HIGH RESOLUTION SATELLITE IMAGERY AND a wealth of information from increasingly sophisticated atmospheric numerical models have brought a significant improvement to our understanding of Antarctic meteorology over the past 10 years. However, communications limitations at Antarctic stations have required some novel solutions.

Australia's Bureau of Meteorology routinely provides summer time meteorological support for operations out of Davis Station. Forecasting services cover station forecasts for both local and remote locations, support for shipping operations through Prydz Bay and aviation forecasting support for helicopter operations between Davis, Mawson and the Prince Charles Mountains.

Davis meteorologists have very restricted access to imagery and modelling datasets because they must share the station's low communication bandwidth with other users. The amount of meteorological data currently accessible to the Australian forecaster on a routine basis would simply swamp Antarctic stations' ANARESAT links, so until better bandwidth is available some innovative thinking is called for:

- While numerical model data is not sent to the station, the forecaster can interrogate it through the web and acquire snapshot images fairly quickly. The above figure shows a +24 hour numerical model forecast of infrared cloud cover signature over the Mawson-



Davis area. A low pressure system is clearly evident to the northwest of Mawson, as is low cloud pushing into the Lambert Basin and Prince Charles Mountains region.

- Bring tested over the coming summer season is a system allowing email interrogation of the numerical model data to return terminal area and route forecasts for locations to be visited by helicopters.

Neil Adams, Australian Bureau of Meteorology

Antarctic volcanic ash: a potential threat?

AIR-BORNE VOLCANIC ASH IS COMPOSED OF FINE pulverised rock and accompanied by a number of gases, which become converted into droplets of sulphuric acid and hydrochloric acid – a mixture potentially deadly to aircraft and their passengers. In 1982, for example, a British Airways airliner lost all its engines on encountering ash from an Indonesian volcano, losing more than half its cruising altitude before engines could be restarted and an emergency landing made in Jakarta.

The main problem is that the ash melts in the hot section of the engine and fuses into a glass-like coating on components further back in the engine, causing loss of thrust and possible flame out. The ash can also cause abrasion of engine and other parts and clogging of fuel and cooling systems.

Darwin Volcanic Ash Advisory Centre, one of nine centres around the world advising aircraft about location and movement of ash clouds, takes in Indonesia, Papua New Guinea and part of the Philippines, as well as the region to the South Pole between 75°E and 160°E (see Bureau of Meteorology web site at <http://www.bom.gov.au/info/vaac> for more information). The Darwin centre combines satellite detection techniques with volcanological ground reports, pilot reports, meteorological knowledge and numerical models to track and forecast movement of ash clouds.

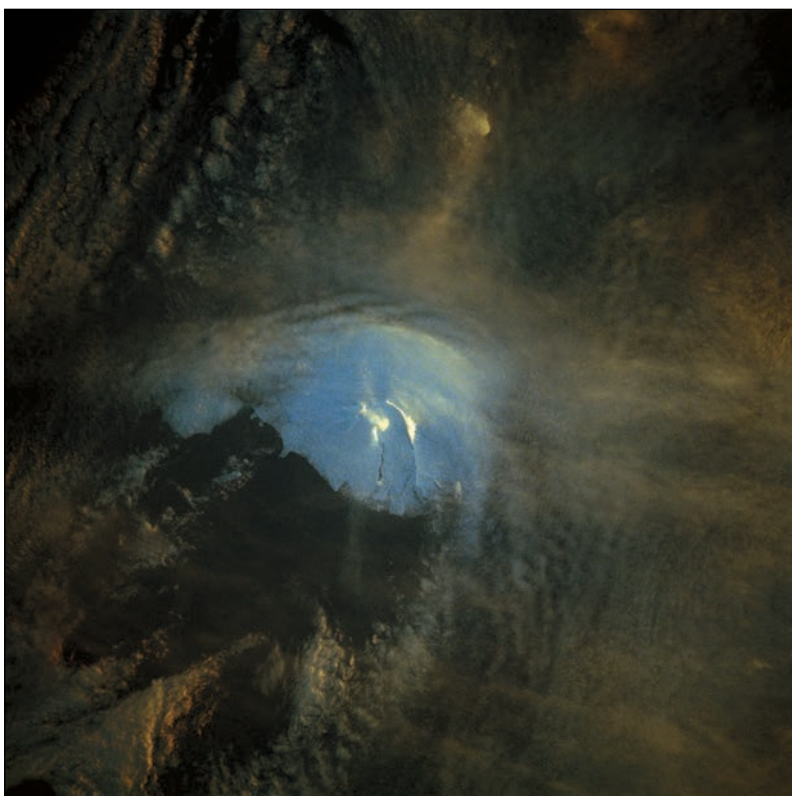


PHOTO COURTESY NASA

NASA Space Shuttle Photo ID: STS061A-49-47, 3rd November 1985. A faint plume extends towards the top of the image from the summit of 'Big Ben'. The McDonald Islands may be seen near bottom center of the image.

Darwin's focus is inevitably on the volcanically active region to its north. But Heard Island, just to the west of Darwin's area of responsibility in an area officially unmonitored due to data sparsity, is of interest. And the Balleny Island group, southeast of Tasmania in New Zealand's area of responsibility, is a potential problem area for Antarctic tourist flights. Volcanic ash can circle the globe very quickly at these latitudes and there is little geostationary satellite data in the region, making it hard to identify and track volcanic plumes. But new communications technologies and increased international understanding are helping to address the problem.

An excellent paper about possible recent Balleny Islands activity at <http://www.volcano.si.edu/gvp/volcano/region19/> in which several international experts discuss this event, showed opinions divided on whether the data suggests volcanic activity, but there is agreement on the need for caution by aircraft operating in this area. Similarly, both Big Ben on Heard Island and the nearby McDonald Island are volcanically active, suggesting a need for aircraft flying overhead to be aware of the possible dangers.

*Steve Pendlebury and Andrew Tupper,
Australian Bureau of Meteorology*



PHOTO COURTESY NASA

NASA Space Shuttle Photo ID: STS066-89-14, 6th November 1994. Big Ben creates a whirl...vortices being shed by Big Ben.

Looking forward from the past

TECHNOLOGY AND REMOTE SENSING HAVE A long Antarctic pedigree built on years of accumulated experience. Scientists in the first wintering expeditions 100 years ago had only their own senses and a few instruments to observe what was happening around them. Their measurements of the earth's magnetic field sampled a phenomenon influenced by processes acting globally. These simple examples involve forms of remote sensing. But instruments able to collect or record data remotely were almost non-existent: data were collected only at the very few occupied sites and only sporadically. The spatial extent of the observations was as far as the expeditions could travel with their instruments across the sea or ice.

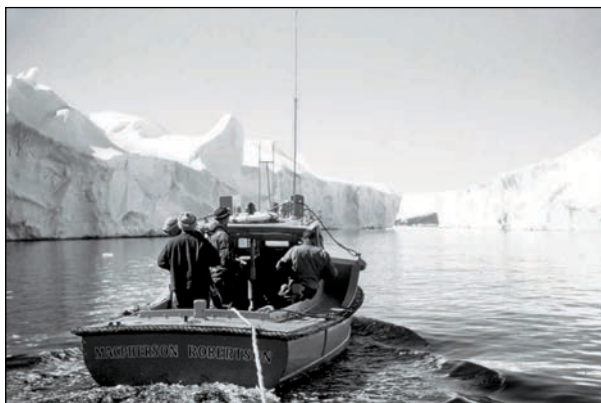
Around the middle of the century the scope and nature of activities started to change dramatically. Continuous occupation of stations and new equipment enabled longer-term, farther-reaching observations. Radiosondes on balloons and radar tracking yielded data on atmospheric winds, temperature, and humidity. Some instruments recorded observations of natural phenomena, either by pen chart-recorder, or on photosensitive paper. Most observations were made and analysed manually. Specially designed cameras recorded auroras. Such advances increased both the range of phenomena under study and frequency of observations.

The International Geophysical Year saw a concerted effort by many nations to study the Antarctic region, with emphasis on the earth sciences, notably geophysics, geology and meteorology. The many stations established on the continent, and the routes travelled greatly improved spatial sampling, but locations were still sparsely distributed. Support for systematic mapping of the coastal regions using aerial photography was a major effort, in addition to the huge task of extracting mapping information from the photographs.

Developments in electronics and communications including deployment of satellites have led to a continuing revolution in what is observed and how data are collected. The first new devices contained vacuum tubes; from the 1960s transistors and later integrated circuits brought much smaller, lower-powered

devices. Digital technology, programmable devices, and solid-state recording of data have opened up an enormous range of applications.

The first automatic weather stations, placed on Chick and Lewis Islands in 1962, transmitted data via high-frequency radio. Radio echo sounding of ice thickness (recorded on photographic film) was



Philip Law leads the 1958 party to establish the first automatic weather station in Antarctica PHILIP LAW

introduced in 1967. A prototype battery-solar-wind-powered remote geophysical observatory using transistor circuits and a magnetic tape data recorder was deployed on Law Dome in 1971. Instruments included a riometer, micropulsations recorder, three-component fluxgate magnetometer, an all-sky camera, clock, and wind speed/direction, temperature, and pressure sensors. The remote observatory was designed to operate unattended for a year, duplicating an array of auroral physics instruments typical of occupied stations. From its development evolved later automatic weather stations, the longest running of which, about 600 km behind Casey, is still providing data 17 years after deployment.

From 1965, on-board recorders on weather satellites provided wide-area images of Antarctica using a television-like sensor operating at visible or thermal infrared wavelengths. Designed for observing cloud distribution and pattern, they also enabled observation of sea ice distribution, and drift of a huge section of Amery Ice Shelf that calved in 1963-64. Within a few years ship-board receivers acquired these images directly to assist passage to the stations. But the early satellite systems provided only a simple image. Position was determined crudely with

reference to recognisable features. The first high-resolution images came from Landsat-1, launched in 1972.

Satellites soon provided new position determining capabilities. The US Navy's Navigation Satellite System, released for public use in the early 1970s, facilitated accurate positioning in the field independent of fixed features. The bulky geodetic survey equipment of early years became smaller, and computer power soon provided small units for weather-independent navigation. In the 1990s, the changeover to the US Defense Department's global positioning system (GPS) led to small hand-held positioning units. More recently these hand-held units have included a field data recording capability.

The same principles used in that first satellite navigation system were employed in a remote platform positioning and data collection system. Signals from the remote platform were recorded on the satellite for later relay to a user, along with information that allowed calculation of the platform's position. The ARGOS system, which evolved from this, is still used to collect data from such devices as automatic weather stations and sea ice buoys, although the platform's position tends now to be determined by an on-board GPS receiver. The combination of miniaturisation, GPS technology, very low power devices, solid-state recording and long-life lightweight batteries, together with the ARGOS data collection and relay services, provides the means for tracking and observing the behaviour of animals.

Innovation as well as adaptation of technology from other areas has made possible the impossible, the difficult tractable, and increased our ability to explore and learn about Antarctica many-fold. Animals can now be observed where people cannot go, large areas can be monitored regularly from satellite, and a new LIDAR system sounds the atmosphere from the surface out to its edge. Use of technology and automation is allowing effort to be re-directed away from the routine and applied to new areas of research. In less than a century the amount of data collected on Antarctica (and the ability to handle it) has increased by perhaps a billion-fold.

Neal Young, AAD

Technology the Antarctic way

AUSTRALIAN ANTARCTIC RESEARCH WORK OFTEN CALLS FOR special electronic and mechanical devices for collecting data and samples. Such equipment must be reliable and able to perform in very cold, harsh Antarctic and marine conditions, which makes it hard or impossible to obtain commercially.

This is where the electronic and mechanical design and manufacturing skills of the Australian Antarctic Division's Science Technical Support Section come in. Their past and current contribution to our scientific tools of trade covers a wide spectrum of scientific activity:

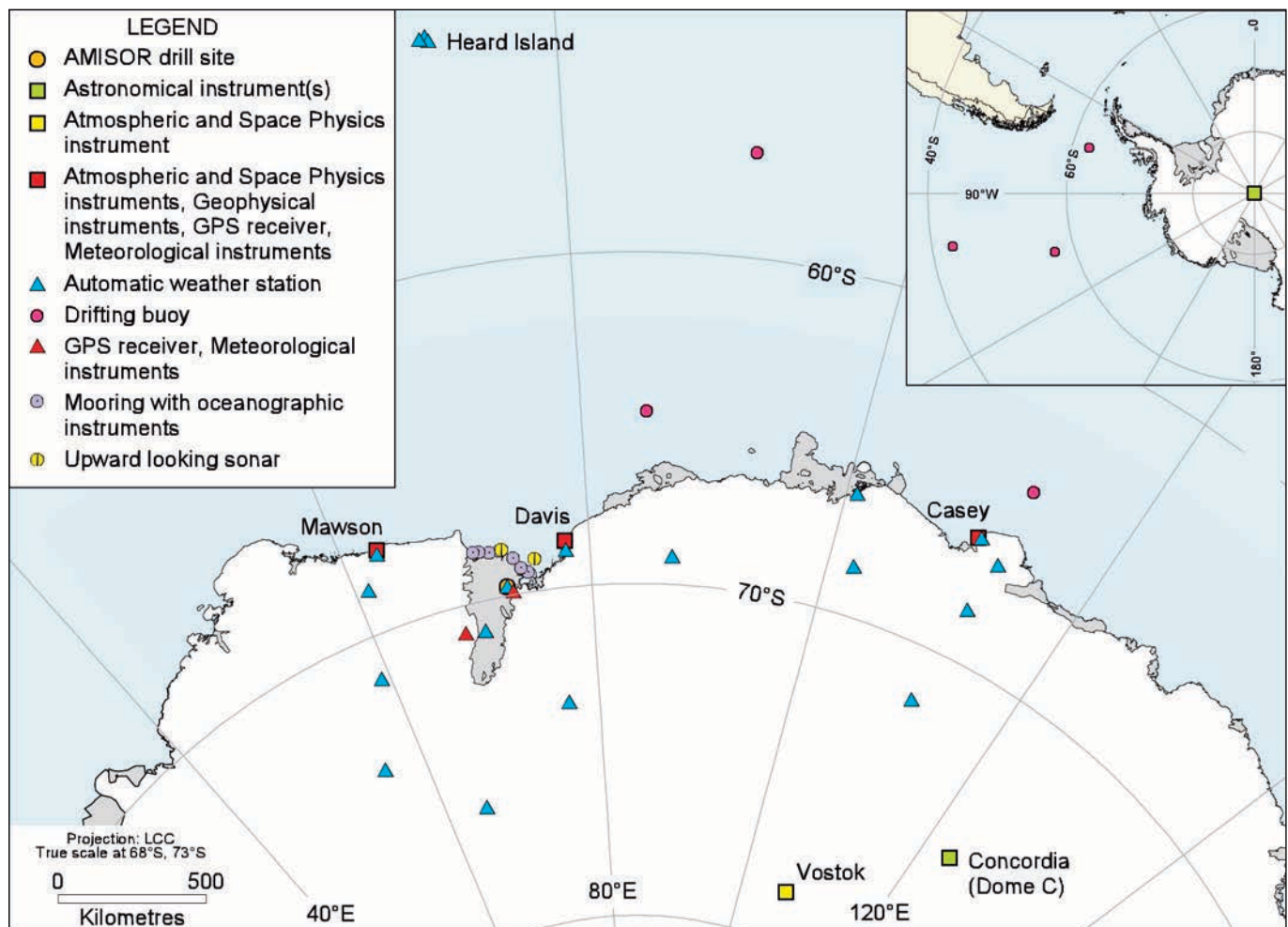
- a system to accurately record numbers and location of pack ice seals, operated from ships and helicopters;
- a hot water drill for making holes through ice shelves hundreds of metres thick to deploy instruments in the water below;
- novel nets to sample plastic fragments from ocean surface waters;
- data logging systems for research ships, including specialised display and analysis software;



MI E CRAVEN

High on the Antarctic plateau, ice radar equipment is used to measure the thickness of the ice sheet

- a system to monitor penguin feeding habits, which automatically detects and weighs penguins as they leave and return to their rookeries;
- control and logging systems for atmospheric studies, including cosmic ray research, all-sky imaging, and the Lidar project;



AUSTRALIAN ANTARCTIC DATA CENTRE

The locations of Australian Antarctic Program active remote sensing instruments on midwinter's day 2001. Note: 1. There are three automatic weather stations on Heard Island (Atlas Cove, The Spit, Brown Glacier). 2. Data were also being recorded by atmospheric and space physics instruments, geophysical instruments, a GPS receiver and meteorological instruments at Macquarie Island, and by atmospheric and space physics instruments at Bruny Island and Kingston, Tasmania. There are also cosmic ray physics instruments at Mawson Station.

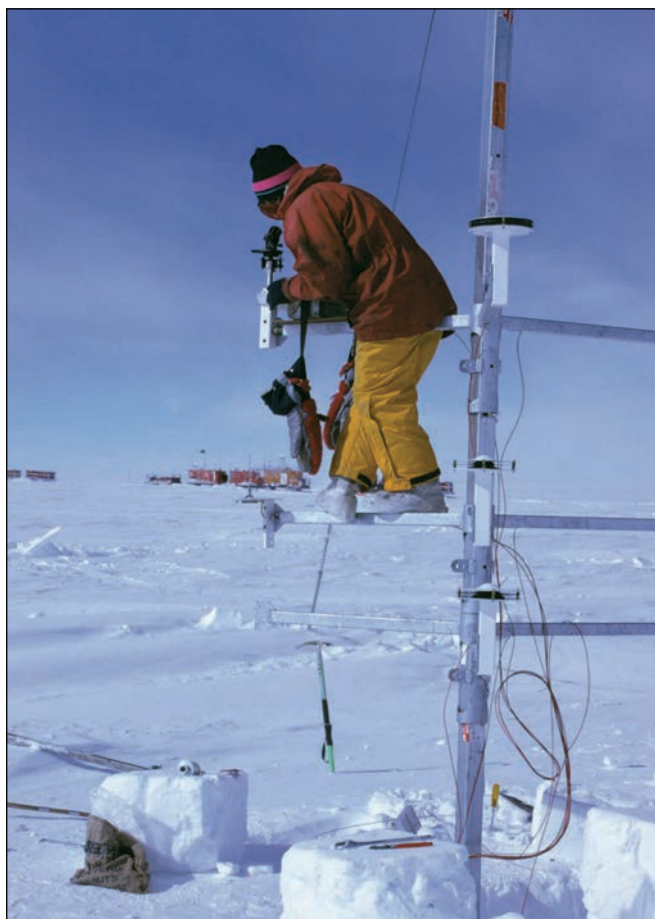
- equipment to sample oceanic phytoplankton throughout voyages;
- an electromechanical deep ice drill that collected 1.2 km of ice core from Law Dome, Antarctica;
- a digital ice radar system to measure ice up to 5 km deep;
- a gas anaesthetic machine able to operate in very cold conditions to safely anaesthetise seals in the field;
- an automated system to quickly and accurately measure fish collected by fishing vessels in Antarctic waters;
- towed sampling systems to allow the collection of ultra-pure, undisturbed water samples from *RSV Aurora Australis*;
- samplers to collect the sediment precipitating out of shallow water;
- easily portable laboratories for ship-board or Antarctic use;
- electronic tag readers to easily detect and identify individual seals or penguins in the field; and
- a system able to take photos of what penguins see when they are feeding.

Jon Reeve, Science Technical Support Manager, AAD



MIKE CRAVEN

Hot water drill: The hot water drill pumps hot water down the long hose, out through the head, and back up the hole to the surface where it is reheated and recycled. This allows holes to be drilled through hundreds of meters of ice shelf to access the sea below. Instruments have been installed through and in the hole made last year to help us understand melting and refreezing processes at the bottom of the ice shelves.



MIKE CRAVEN

Automatic weather stations: Many automatic weather stations installed in remote areas of Antarctica are still sending data by satellite more than a decade after being deployed. Within two years we hope to deploy one of these that will record an air temperature of about -90°C, the coldest temperature on earth!



VIN MORGAN

Ice drill: This ice drill has been used to take a continuous core of ice down to 1200 metres below the surface at Law Dome (inland from Casey Station). This enables us to understand how much the world's environment has changed over the centuries, since the ice was formed.



MIKE CRAVEN

Ice radar: The ice radar bounces radio waves down through the ice to measure its thickness. These systems have been deployed both on tractor trains and from aircraft.

The machine that goes ping!

FOR 20 YEARS THE AUSTRALIAN Antarctic Division has used hydroacoustics as a remote sensing tool for studying Antarctic krill, zooplankton, fish and even non-living phenomena such as ice crystals. It was a pioneer in using acoustics in the Southern Ocean – the Simrad EK400 and QD echo-integrator system installed on MV *Nella Dan* had serial number 1 – in some of the first Australian deep sea biological hydroacoustics research. In the 1990s the next generation Simrad EK500 digital split beam sounder aboard *RV Aurora Australis* had serial number 3.

With these systems Australia has contributed to multinational, multi-vessel krill biomass surveys (such as FIBEX – the First International BIOMASS EXperiment) and conducted the largest single vessel krill biomass survey, ‘BROKE’ (baseline research on oceanography, krill and the environment), a biological and oceanographic survey off the East Antarctic coast in 1996 (see *Australian Antarctic Magazine* # 1). The hydroacoustics data from such surveys is used for regional krill biomass estimates, which in turn are used to set precautionary catch limits on the krill fishery – the region’s largest fishery.

How does all this technology work? The systems operate a little like a spotlight or radar illuminating objects (‘scatterers’) in the water column beneath the vessel as parallel transects lines, each of constant bearing, are systematically sailed over a study region (Figure 1). Pulses of different sound frequencies (like different colours) are used simultaneously to give us more information about a particular type of scatterer or aggregation of scatterers. Higher frequencies of sound tend to give better resolution and stronger signals from smaller scatterers while lower frequencies enable us to see greater distances, as they lose energy at a much lower rate to molecular processes in seawater. With krill, our primary subject for observation, we use frequencies of 38, 120 and 200kHz. Combining

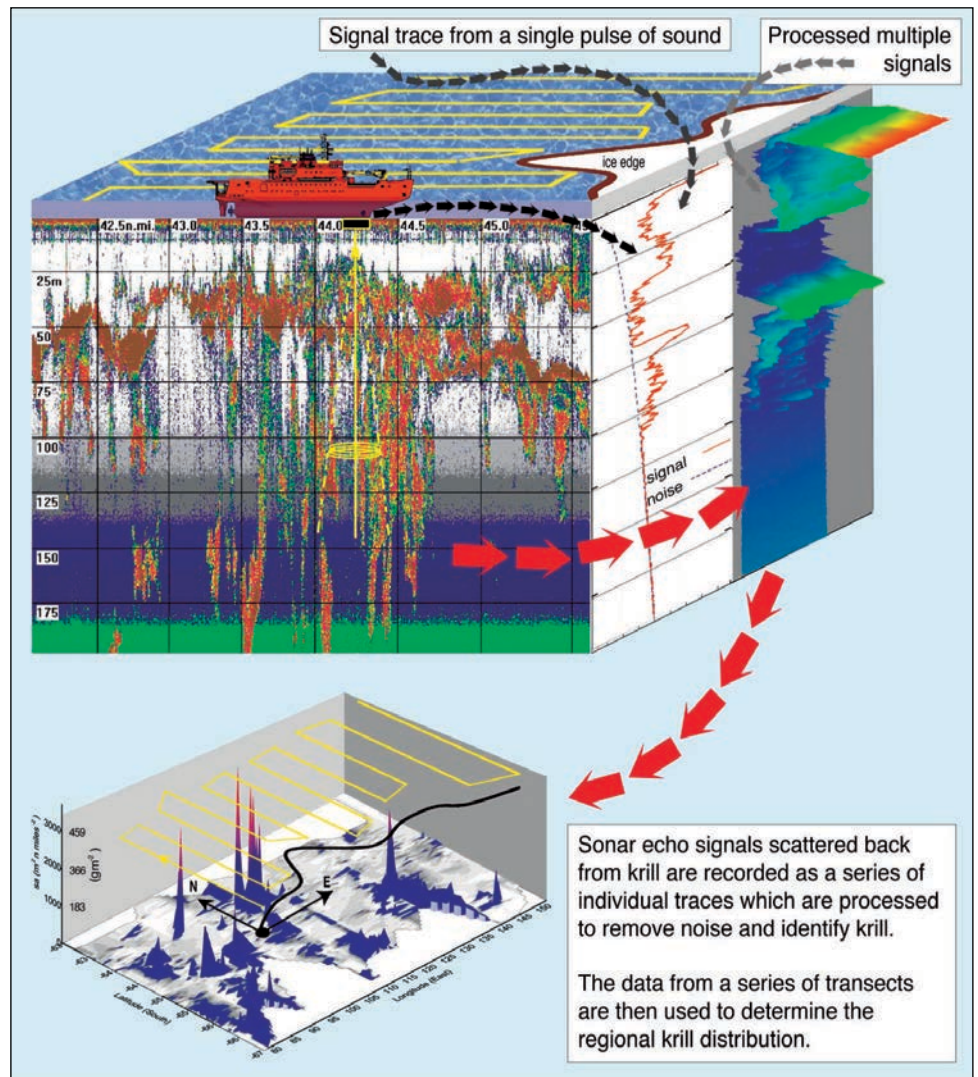


Figure 1. From backscattered sound off objects in the water column beneath RV Aurora Australis, research sonar systems form images of the objects based on a series of singles pulses (or pings). The ping data is corrected for transmission effects and noise – then vertically integrated and horizontally averaged for echogram cells. Such processed transect data are used to establish distribution patterns and form biomass estimates.

data from the different frequencies gives us insight in to the type of scatterer, krill, fish, other zooplankton or even ice crystals (Figure 2).

The primary form for viewing the acoustic backscattered data is the echogram (Figures 2 and 3), a two dimensional image of backscattered energy from beneath the vessel as a function of depth and time (or distance travelled). The form taken by aggregated scatterers in the echogram can also give us information about the identity of the scatterers. A dilute soup of mixed zooplankton species might have the form of a weak, continuous, fuzzy, scattering layer (Figure 3a). Antarctic krill (*Euphausia superba*) form many varied structures ranging from weak scattering layers through

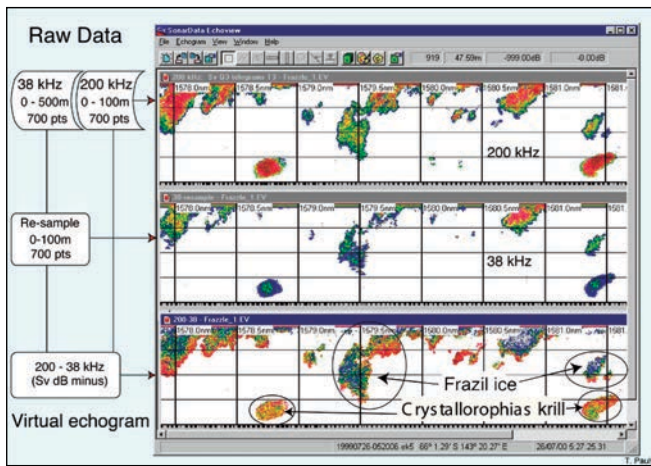


Figure 2. Different sound frequencies provide insight into the nature of scattering objects. Simultaneous echogram data of different frequencies can be combined in many different ways to form 'virtual echograms' which aid target identification.

to large dense complex structures (Figures 1 and 3c), whereas coastal cold water krill tends to form tight, dense, strong, scattering blobs (Figure 2).

In an acoustic survey to estimate krill distribution and abundance, echosounders are calibrated using standard reference target spheres suspended within the acoustic beam beneath the vessel. Echogram data for each transect are classified into regions dominated by krill and regions dominated by other species. There are also regions of bad data resulting from noise (for example due to the vessel breaking ice), or reverberation from bubbles in rough seas. We use a combined knowledge of hydrography, multi-frequency analysis, form of the echogram and acoustically targeted scientific net trawls to identify the species. The classified echogram is then integrated over

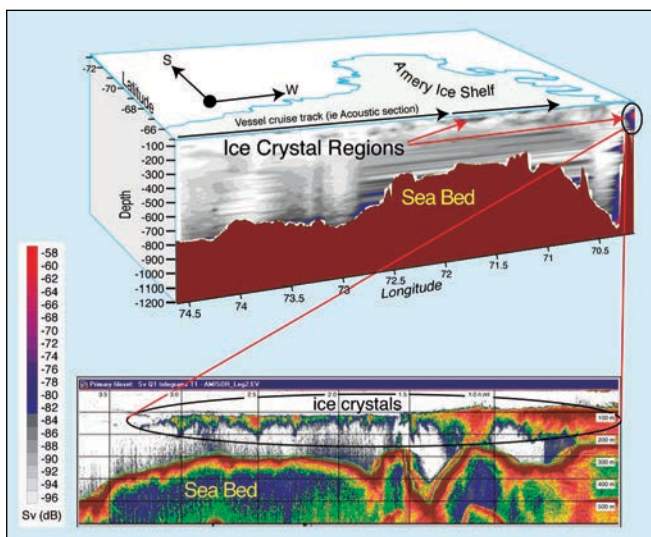


Figure 4. Acoustic data provides insight into other physical processes. Super-cooled water flowing outward and rising from beneath the Amery Ice Shelf forms plumes of ice-crystals which are visible in echograms. An oceanographic transect last summer studying the ice shelf's physical processes clearly identified the super cooled water by this means.

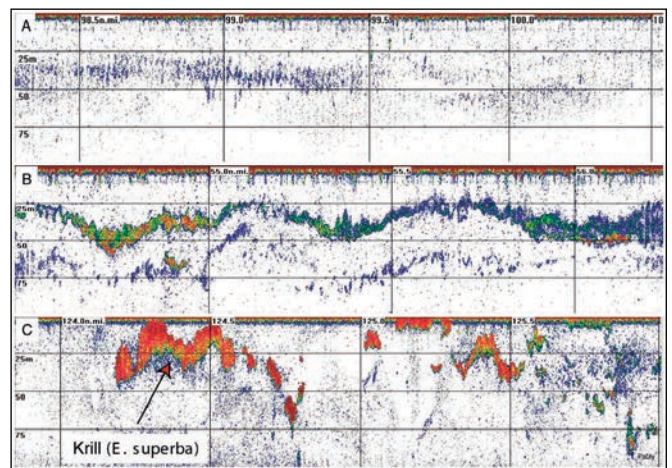


Figure 3. Echograms are the basic form for viewing backscattered data from echosounder sonar systems. Zooplankton backscatter can take a wide range of forms: a) very weak diffuse scattering layers often contain many different species, b) denser more continuous layers may be dominated by krill, and can also provide insight into physical processes such as internal waves or boundaries between different water masses, and c) very dense discrete aggregations of krill generally containing few other species.

the water column depth being investigated and averaged along the length of the transect to return a mean of the backscattered energy for both intervals along the transect and the whole transect. This information is then converted to mean krill densities. The lower diagram in Figure 1 shows this vertically integrated data as a snapshot of krill distribution for the large-scale BROKE survey.

Acoustic systems can also provide insight into oceanographic features. We have used them to identify plumes of ice crystals streaming out from beneath ice shelves such as the Amery Ice Shelf (Figure 4) and internal waves travelling along an interface of difference water masses of contrasting densities, such as the bottom of the surface mixed layer (Figure 3b).

The AAD has utilised a variety of other acoustic systems, including a Doppler current profiler, simple remote release devices on moored instruments, moored current meters, moored upward looking sonars for measuring sea ice cover, passive towed arrays for whale observations, multi-beam systems and seismic systems.

For future biological studies, scientific acoustic systems are likely to include multi-beam systems that will image close to a 180° arc of the waters directly beneath the vessel with a feathered beam taking in the waters to the sides of the vessel. This will produce a 3 D picture of the scattering objects in the water column. Current new technologies also include scientific scanning sonars able to look ahead of the vessel. Other nations have also successfully used moored sonar systems and autonomous underwater vehicles carrying sonar systems, such as the United Kingdom's Autosub-2.

Tim Pauly, AAD and J.D. Penrose, JASA

More than just counting: the pack-ice seal census

ESTIMATING THE NUMBER OF ANIMALS IN A POPULATION is a tricky business. Unlike a human census where most subjects make themselves available for counting, animals may be overlooked even though visible, or they may be present but hidden by obstacles. The science in an animal census is not in the counting but in estimating how many weren't counted.

Such problems made a recent survey of seals in the pack-ice off East Antarctica one of the most difficult animal population studies ever undertaken. To address them, researchers utilised recent advancements in survey methodology and technology.

The survey aimed to estimate the number of crabeater, leopard and Ross seals in the pack-ice between 60°E and 150°E, a vast area covering over a million square kilometres. To do this we used Sikorsky S76 helicopters flying at 80 knots on north-south tracks to count seals hauled out on the ice in 1200 m wide strips (600 m each side of the aircraft). It was impossible to cover the entire area so the strips represented only a sample, but provided the strips are representative then extrapolating to the entire area is straightforward.

Looking down from an aircraft would seem an ideal position for counting seals, but not so. Ridges and hummocks in the pack-ice can hide more distant seals from the observer, and the more uneven the ice, the more animals missed. A method that addresses this common animal survey problem is called distance sampling, where the distance between sighted animals and the flight path is measured. Typically fewer animals are sighted as distance from the flight path increases. Provided we can be certain that all animals are seen within a specified distance of the flight path, we can use the relative frequency of sightings at that 'certain' distance to correct for animals missed at other distances.

Distance sampling was developed for ground surveys where seeing an animal on the survey track could be considered a certainty. Counting from the air gives no certainty of seeing an animal, even close to the aircraft, because there is not time to search all the strip thoroughly. It is possible to slow down in a helicopter, but then there would not be enough time to gather a representative sample of the million square kilometres. Instead we maintained sufficient speed to sample enough area, and developed methods to estimate how many seals were missed in the zone of best visibility.

To do this we adapted another procedure for estimating animal numbers, called mark-recapture, by which a sample of animals is caught, given an identifying feature (usually a tag) and released. Some time later another independent sample of animals is caught and the proportion of tagged animals (recaptures) in the sample used to estimate the total number of animals in the population.

So how do we mark animals from a fast-moving helicopter? The 'tag' can be simply a unique identifier for a particular seal. We have two observers (front and back)



COLIN SOUTHWELL

Scientists undertaking seal surveys from the bridge of Aurora Australis. The 'gun' is used to measure the distance of the seal from the ship as it passes abeam. An electronic inclinometer is attached to the gun, so that when the seal is sighted through the telescopic sight, the angle of declination from the horizontal is measured and stored in a computer. With the known height of the bridge above the water, the angle can be converted to a distance from the ship.

on each side of the helicopter, searching the same area independently. On sighting an animal, the front observer 'tags' it by recording unique features identifying it from other sightings, such as the exact time the seal passes abeam of the aircraft, the seal's distance from the flight path, its species and group size.

In combination, these features can form a unique identifier for each sighting. If the back observer sees the same animal independently of the front observer, as indicated by the tag identity, it is considered 'recaptured'. From then on the sums are similar to a normal mark-recapture exercise.

If each observer records both the exact time, distance, species and groups size for each sighting, we have the potential to use both distance sampling and the adaptation of mark-recapture in combination to estimate all the animals that were present but not sighted in the survey strip, regardless of distance from the flight path. But before the survey began there was no easy way of recording these data conventionally in the short time available to record data for each sighting.

We put the problem to Australian Antarctic Division engineers, who designed an electronic data logging system in which a laptop computer logs data from several sources. Altitude and position are logged at 10-second intervals using a radar altimeter and GPS unit. Each observer has a sighting 'gun' and a keypad to record data for each sighting.

As the seal passes abeam of the helicopter, the observer points the gun at the seal and presses a record button, then enters species and group size data via the keypad. The angle of declination of the gun, in combination with the altitude, is used to calculate the distance of the seal from the flight path, which together with the exact time from the keypad entry, forms the 'tag' for that observer.

After the survey, distance/time 'tags' for sightings by front and back observers are compared to determine the number of 'captures' and 'recaptures'. From there the number of missed seals in the strip can be estimated, which combined with the number counted gives the total number of seals on the ice in the strip.

But there are still some missed animals to account for. Seals are marine mammals, spending much of their time foraging in the ocean. The above methods have been aimed only at seals that are visible, out on the ice.

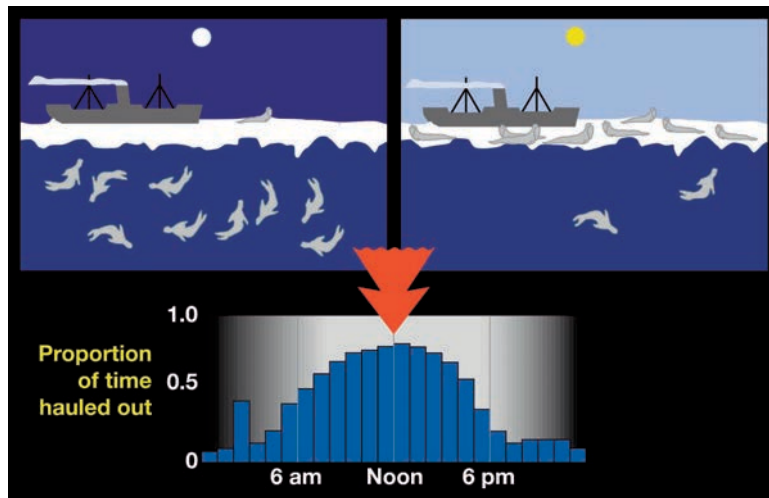
To estimate the proportion of seals in the water, we need to study the haulout behaviour of the seals. This is now possible with the development of small electronic dive recorders glued to the fur of a sample of captured animals (the recorder later falls off with the moult). These dive recorders have a conductivity sensor that measures when the seal is in and out of the water, data which can then be transmitted to the researcher by satellite.

Catching a seal in the pack-ice is very difficult, and re-catching the same animal some time later nearly impossible. But a satellite link means that once a dive recorder is attached to an animal, it does not have to be recaptured to retrieve the data. The transmitted data can be used to estimate the proportion of time seals spend on the ice and in the water at any time of the day, and so provide a correction for seals in the water.

No survey will provide a completely accurate result. Surveying over so large an area of remote ocean will always be less accurate than surveys undertaken in smaller areas or in more favourable conditions elsewhere. But the various techniques described above have given us data

that is several times more accurate than anything we have had previously, and which we can apply with confidence to larger Southern Ocean ecosystem questions.

Colin Southwell, Antarctic Marine Living Resources Program, AAD



Satellite tracking devices attached to a sample of seals are used to estimate the proportion of time seals spend on the ice and in the water. Around noon solar time most seals (up to 80%, right frame) rest on the ice and few are in the water. Early and late in the day, and through the night, most seals forage in the water. The change in behaviour through the day is reflected in data obtained from tracking devices (graph).

COLIN SOUTHWELL/PETER BOYER

How we support our marine scientists

With Australian Antarctic science increasingly focusing on Southern Ocean studies, in 2001-2002 the Australian Antarctic Division is undertaking two marine science voyages, bringing together scientists and technicians from research organisations across Australia and the world. AAD science support staff have a major role in preparing for and participating in these voyages.

The first of two marine science cruises this summer, Voyage 3, will be a seven-week voyage from late October supporting about 80 scientists and technicians gathering data on many aspects of the oceans, sea ice, atmosphere, and the range of life within them.

Besides prioritising requests from scientists to ensure maximum support, AAD science support staff will be

- ensuring that the 10 built-in and 9 portable laboratories aboard Aurora Australis are ready.
- designing and building 600-litre non-contaminating microcosm containers for growing and studying phytoplankton.
- organising installation of a crane on the ship's bow to enable ultra pure water sampling undisturbed by the ship while the vessel moves at slow speed.

- providing and operating instruments to collect environmental data during the voyage, including continuous wind, salinity, fluorescence (a measure of phytoplankton activity), position, speed, heading, solar radiation, depth and other hydro-acoustic data.
- operating conductivity-temperature-depth (CTD) instruments, to be lowered up to 6000 metres to the ocean floor to collect samples of the water at specific depths and measure its properties.
- developing a bow-deployed pump system, upgrading a gantry system for moving CTD equipment on deck, providing computer and other electronics support and integrating external researchers' equipment.

Jon Reeve, Science Technical Support Manager, AAD



PETER GORMLY

Measuring penguins from a distance

IF WE ARE TO CONSERVE THE LIVING RESOURCES of the Southern Ocean, we need to monitor the region's ecosystems so that we can distinguish between changes due to harvesting and those caused by environmental variability. These are essentially the aims of the CCAMLR Ecosystem Monitoring Program (CEMP).

Australia has supported CEMP with field studies since 1990 centred on the breeding biology and foraging ecology of the Adélie penguin. The studies seek to determine the degree to which the harvest of krill, the major food of Adélies, can effect their breeding performance. Parameters being monitored include the penguins' weight on arrival to breed, the duration of parents' incubation shifts, age-specific annual survival and recruitment, duration of foraging trips, breeding success and chick weight at fledging.

Standard methods were established with the aim of detecting a 10 percent change in a parameter with a 95 percent degree of confidence.

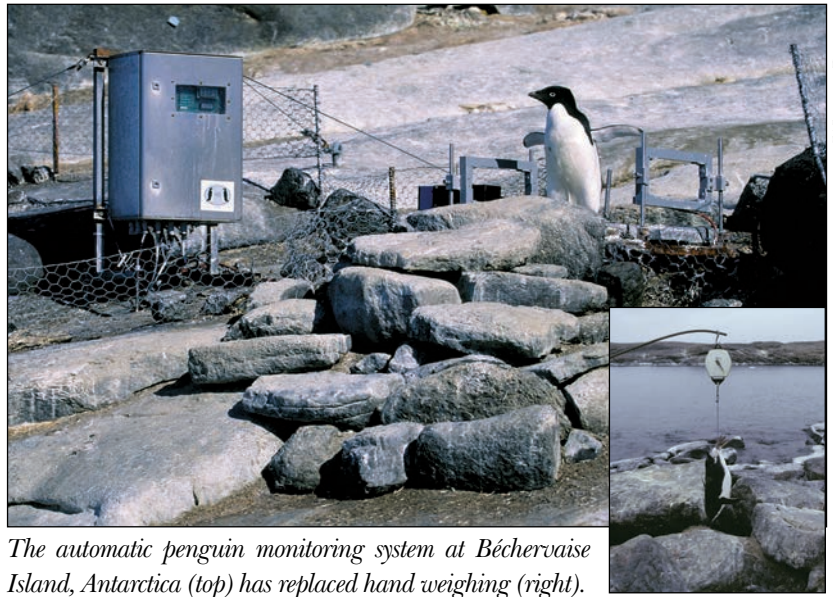
The CEMP program required that animals be captured for measurement. But we decided to automate the data collection with a system for weighing and identifying penguins as they walk freely to and from their colony. This system would enable weighing and recording of large numbers of penguins with minimal stress and trauma.

Our first automated penguin monitoring system (APMS), developed by AAD technicians, was installed at Béchervaise Island near Mawson in November 1990.

The system involved use of infra-red beams to determine birds' direction of travel. The 600 mm-wide weighing platform was placed on the natural pathway taken by the penguins as they moved between their colony and the sea. Guiding fences were set up on either side to ensure birds crossed the platform. The following and subsequent seasons adults and chicks were given an electronic identification tag which was implanted under the skin. All adults were sexed by cloacal examination.

At this point the system became a remote sensing device. It is solar powered and the data can be retrieved by computer on site or remotely via radio and telephone.

At the heart of the system is the novel method of determining the weight of an unrestrained penguin crossing the weighing platform. We have called this *dynamic* or *in motion* weighing. The dynamic weight bears a statistical relationship to the mass of the bird but the method of measurement is different from that of both mass and weight. Mass, an absolute number, is determined by direct comparison with a standard weight on a balance (set of scales), while weight is determined by a device – a spring balance or a weighing platform – that measures the effect due to gravity.



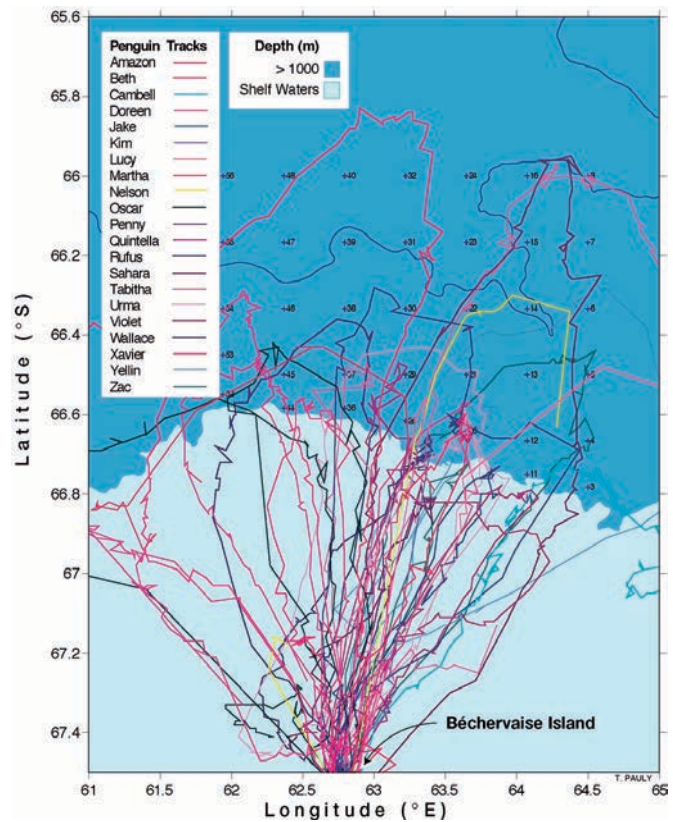
The automatic penguin monitoring system at Béchervaise Island, Antarctica (top) has replaced hand weighing (right).

WAYNE PAPPS

KNOWLES KERRY

The system records a series of instantaneous weights as the penguin moves across the weighing platform. The dynamic weight of the bird is then calculated from these through an algorithm which takes into account all instantaneous weights obtained, including the ramping up and

to page 40



TIM PAULY

Travel routes of Adélie penguins as they forage for krill for their chicks at the edge of the continental shelf. Signals from satellite-tracked transmitters fixed to selected penguins give the exact location of each bird whenever a signal is received.

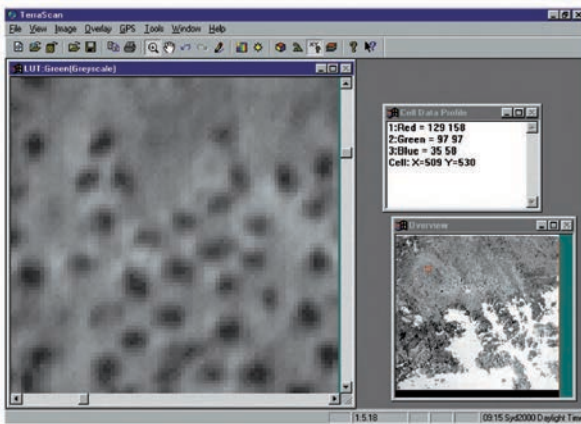
New techniques for counting penguins



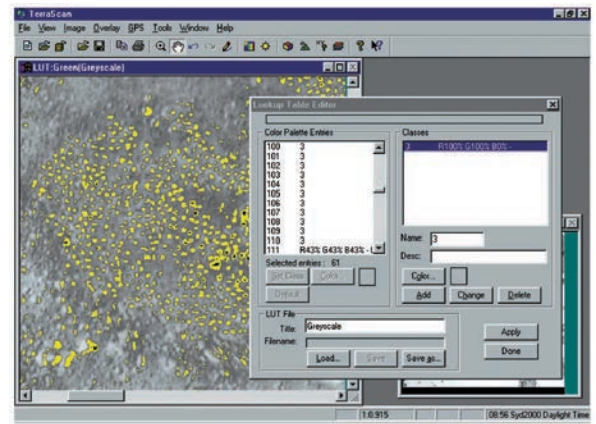
THE WIDESPREAD MONITORING OF PENGUIN POPULATIONS around the Antarctic and on subantarctic islands is dependent on methods to determine annual population sizes (breeding pairs) accurately. Monitoring has typically relied on ground visits to colonies, and photographs of colonies, either oblique or aerial, from which birds were counted manually. These methods require considerable time and effort. Techniques that either increase the precision of individual counts or increase the number of counts for a given effort would improve

our ability to identify statistically significant population changes. Scientists from the Australian Antarctic Division have developed customised software that can quickly determine the numbers of penguins in aerial photographs accurately. The software uses readily available hardware and is relatively cheap, both of which are prerequisites for its broad scale adoption and application.

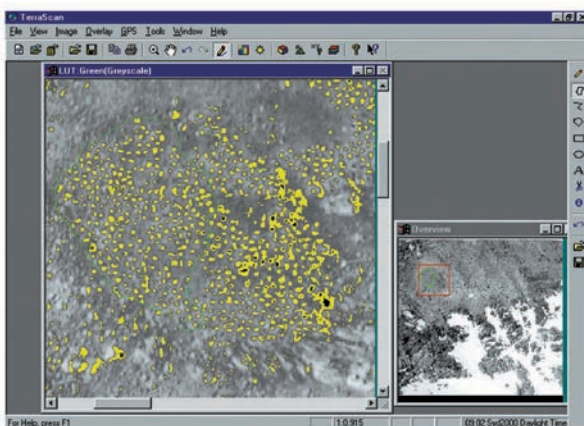
Eric Woehler, Roger Handsworth, Henk Broelsma & Martin Riddle, Human Impacts Research Program, AAD, & Keith Stove, Hydro Tasmania



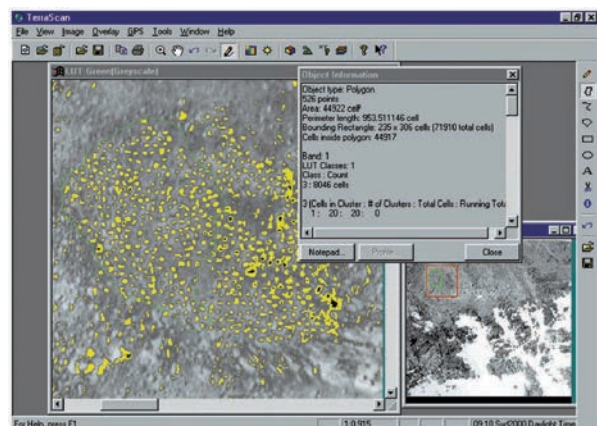
1. A 600dpi TIFF scan of an aerial photograph is converted to a 256 grey-scale image. The image is enlarged to identify individual penguins. Repeated selection of penguin pixels determines the grey-scale range of (penguin) pixel clusters to be used.



2. Once the grey-scale range is determined (eg 35 - 115 above), a colour is used to identify all pixel clusters within the selected grey-scale range on the image. If the range is too broad, 'blurring' will occur, and adjacent penguins will not be separated. Shadows and rocks will contribute some noise to the analyses.



3. A polygon is drawn around the colony or area to be counted. Non-nesting penguins, rocks, shadows and other non-penguin pixel clusters can be excluded.



4. A conservative estimate of pixel clusters (penguins) within the colony or specified area is provided. We are currently investigating the use of higher resolution scans (1200 dpi+) and changing the pixel-cluster threshold to enhance separation of adjacent penguins, and thus provide greater accuracy in census estimates.

Molecules and microchips: tools to unravel the secret lives of marine predators

MARINE MAMMALS AND SEA BIRDS OF THE SOUTHERN Ocean live in some of the most remote and inaccessible environments on earth. As we travel the surface waters of their home on our way to and from Antarctica, we see only a fleeting view of a few animals, but learn little of why they are there, what they are doing, what they are hunting, and what might be hunting them. Answering questions such as these does more than satisfy scientific curiosity. We can only establish sustainable limits to the commercial fisheries of krill, squid and fish with some understanding of dynamic food chains. This means learning more than just who eats who, but also how much of a commercial species a predator might eat, and where, when and how it hunts for its prey.

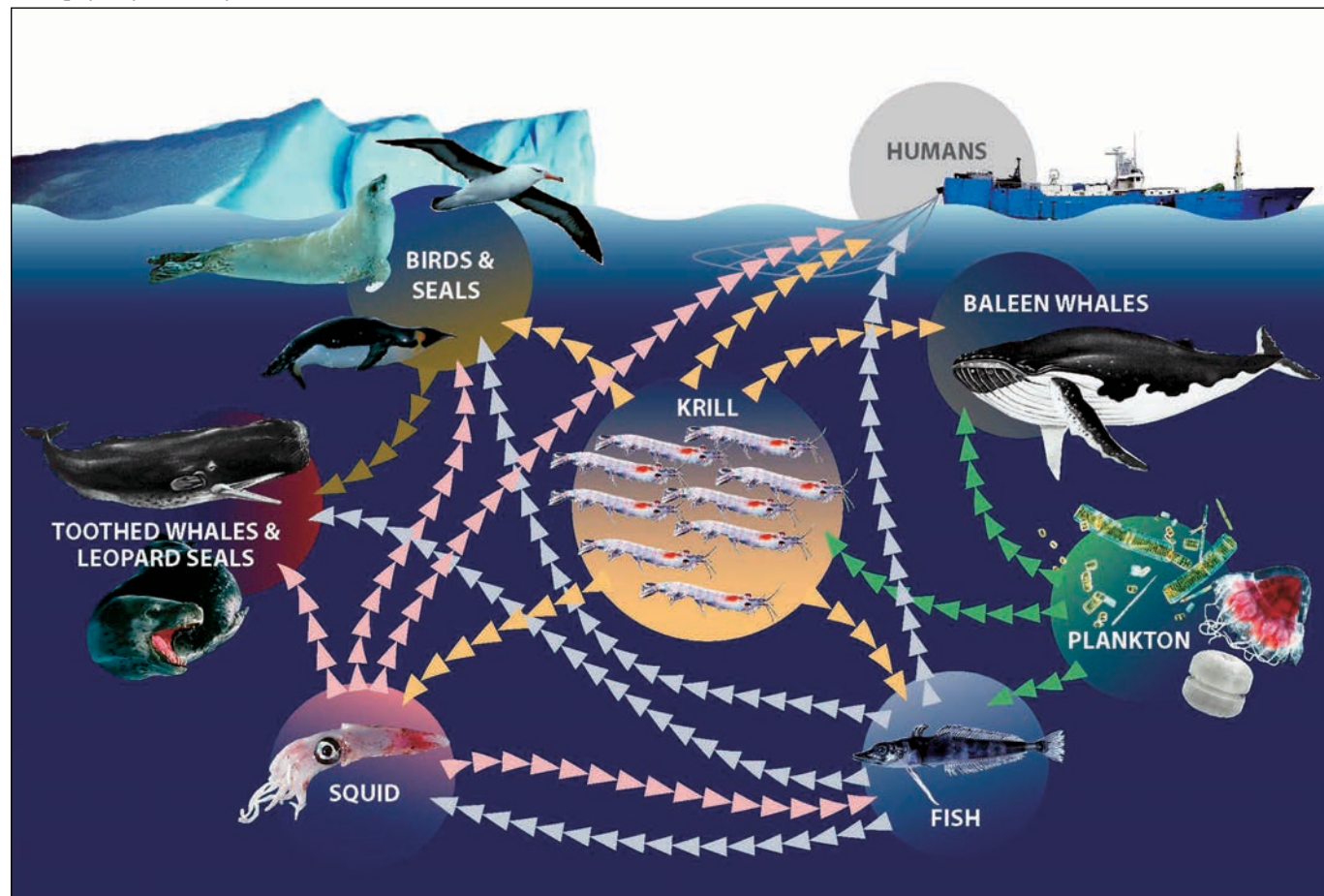
Whilst these questions sound simple enough, answering them has proved an enormous challenge. As with so many complex endeavours, technology has provided the tools to move forward. Two developments in particular have provided tantalising insights into the diving behaviour of those marine predators that are small enough to catch and handle. The first is a miniaturised data-logger that records parameters such as water depth and temperature,

light levels and swim velocity. The second is a radio transmitter that is tracked by satellite. When we use these instruments in combination, we're able to collect information about the travelling routes and dive depths of most species of seals and penguins. We are also able to get some idea of what they eat by sifting carefully through their faeces or vomits for recognisable remains of prey (not a pleasant task!). Notwithstanding these advances, the data have many biases and limitations, and important predators such as whales remain almost unstudied.

The Australian Antarctic Division has formed a new group called the Applied Marine Mammal Ecology (AMME) group within the Antarctic Marine Living Resources (AMLR) Program. The focus of this new group is to apply novel and ethically acceptable technologies to explore food-based relationships between southern ocean predators and commercially exploited species. An exciting combination of molecular and electronic tools is being developed. The molecular work incorporates the powerful approach of DNA-based studies, where, for the first time, faeces will be analysed for the DNA of all ingested prey. Other molecular analyses will complement

A simplified food web for the Southern Ocean

to page 17



PAULINE DE VOS

A bottom-up approach to remote sensing

WHAT HAS MEASURING LIGHT LEVELS UNDERWATER GOT to do with identifying human impacts? When studying the effects of human disturbance to the environment it is always important to ensure that comparisons are between similar environments. In the sea this normally means comparing communities from similar depths, wave conditions and sea-bed types. However, all natural systems are variable both in time and space. The key to any study that sets out to detect changes to the environment caused by human activity is separating the signal of impacts from the noise of natural environmental variability. In the Antarctic, disturbance from bergy bits (small icebergs) and the characteristics of sea ice are additional factors that need to be considered.

Research by the Human Impacts Program on the effects of contaminants leaching from old waste disposal sites into the sea indicate that macroalgae (seaweeds) are uncommon in Brown Bay, which is adjacent to the Thala Valley tip (see 'Research into the clean-up of tips at Casey and Wilkes' on p 21), but they are found in dense beds at apparently similar sites nearby. This may be an impact of the tip but, as there are no records of the seabed communities in Brown Bay before the tip was established, it is not possible to say with certainty whether algae were previously present.

Algae are plants and need light to photosynthesise; it is therefore possible that the reason they are not present

in Brown Bay is that they are not receiving enough light. In Antarctica the light reaching the seabed varies according to the characteristics of the sea ice. Locations that lose the sea ice cover early in the summer will receive large amounts of light. In contrast, sites that usually remain covered with sea ice until December or January, such as Brown Bay, will receive less light.



Light meter on the seabed near Casey, 15 m below the surface, which has been recording data for the last two years

MARTIN RIDDLE

Duration of sea ice cover does not explain the whole story. Sparkes Bay, south of Casey, has a flourishing algal community dominated by the large kelp (*Himantothallus grandifolius*) although sea ice remains in the bay until the middle of summer. Snow lying on top of sea ice considerably reduces the amount of light penetrating to the sea-floor. Near the coast the pattern of snow on sea ice is very patchy because hills and large boulders cause snowdrifts to accumulate down wind. Land formations around enclosed bays will therefore influence the amount of light getting to the seabed.

Light meters have been placed on the seabed to record the amount of light at various locations around Casey Station throughout the year. Some locations have abundant seaweeds; at others they are virtually absent. The information from the light meters will help ensure that, as we try to understand the possible effects of contaminated sites on the marine environment, we are comparing like with like.

Martin Riddle, Human Impacts Research Program Leader, AAD

from page 16

this development, as well as the more traditional method of identifying recognisable remains of prey. Getting faeces from seals and penguins is relatively straightforward as they spend some of their lives ashore or on ice, and we can collect the material from those more accessible sites. We can even tell the species and sex of the animal that produced the faeces, as they leave traces of their own DNA in their faeces. Getting samples from animals that do not come ashore, such as whales, is more challenging. For this work, we have recruited collaborators from around the world who work with whales in areas they feed (and therefore defecate). We supply all these researchers with special "scoopers" to collect the faecal material. Fortunately, a whale's physiology requires it to defecate near the surface.

In conjunction with the molecular work, developments

in miniaturised electronics are making it possible to design and build a new generation of instruments. This should enable us to photograph a predator's prey from a small camera on the animal's head; track, and record the diving behaviour of whales over great distances; and record when an animal is feeding during a dive. The molecular and microchip technologies are currently being developed through detailed trials, often using animals from zoos and marine parks, or more accessible animals close to Australia. Applications to address strategic questions in Antarctica will commence in 2002.

The data generated by this new program will provide information for modellers and managers to better ensure the sustainable use of the marine living resources of the Southern Ocean.

Nick Gales, Antarctic Marine Living Resources Program, AAD

Going automatic... Australia's ASP observatories

THE YEAR 2001 MARKS A TURNING POINT FOR THE Atmospheric and Space Physics (ASP) program. For the first time for many years (since 1957 for Mawson, early 1980s for Macquarie Island) there are no people wintering at Mawson or Macquarie Island whose primary role is to support atmospheric and cosmic ray physics research.

Despite this, the ASP program is alive and well at both stations, as well as Casey, which will go automatic from 2002. Autonomous equipment will enable continued logging of essential data under the control of ASP personnel at Australian Antarctic Division headquarters in Kingston, Tasmania. Standard riometer and magnetic pulsation observations will continue at all three stations, as well as fluxgate magnetometer observations at Casey, all-sky imaging at Casey and Macquarie Island, and cosmic ray observations at Mawson.

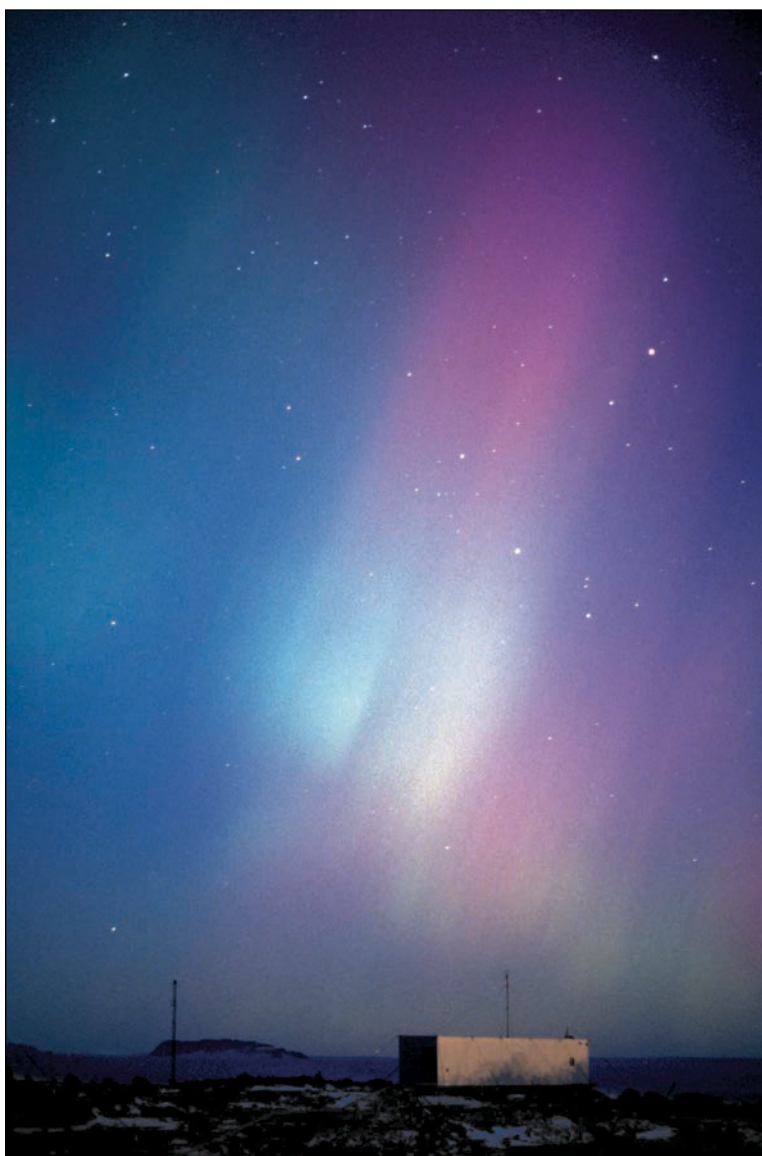
The automation program, which implements a recommendation of *Australia's Antarctic Program Beyond 2000* (1997), puts ASP at the leading edge of instrument automation. The program was aimed at continuing collection of essential data from each station while reducing operational costs to allow resources to be diverted to major programs at Davis, including the Lidar project.

Three new systems have been developed to control and collect data from these experiments.

An analogue data acquisition system (ADAS), designed to collect time-stamped, time series data from any analogue signal is currently used to log data from the riometer, magnetic pulsations and fluxgate magnetometers. Data collection is synchronised to a GPS (global positioning system) chronometer allowing data to be sampled with a time resolution of one millisecond, allowing accurate propagation delays to be estimated from data recorded at multiple sites.

The all-sky imaging system (ASIS), a specialised data acquisition and control system designed to record the night time activity in the skies over each station, uses a monochrome video camera fitted with a fish eye lens to take a circular horizon to horizon image of the sky every 30 seconds. These images are annotated with the time and date and then stored in digital format on hard disk for later transmission back over the satellite link.

Logging of data from the Mawson Cosmic ray observatory is now fully automatic, thanks to enhancement of an earlier automatic system that required weekly visits for essential manual intervention. The current system collects data from the neutron monitor and three surface



KYM NEWBERRY

An aurora illuminates the Cosmic Ray Laboratory at Mawson station

muon telescopes and from the four underground muon telescopes (using the rock to filter out weaker cosmic radiation) on a one minute sampling basis. Also collected are outside and inside air pressure, laboratory and vault temperatures, and wind speed.

The new ADAS system was installed at Casey, Macquarie Island and Mawson in 2000-2001, while ASIS systems were deployed at Casey and Macquarie Island and the updated COSLOG system was commissioned at Mawson.

Data distribution

A major ASP observatory task is ensuring that data gets to the researchers needing it. These experiments provide valuable background data for advanced research elsewhere in the world. To reduce the data collection and archiving workload, arrangements have been made

with IPS Radio and Space Services in Sydney, which has recently become a World Data Centre and also performs ionospheric forecasting. Every five minutes data is sent from each station to IPS in Sydney and then fed into forecasting models, and 24-hour files are sent to IPS for long term archiving. The Australian Geological Survey Organisation (AGSO) receives daily copies of the magnetic data from Casey.

Cosmic ray data are transmitted back to Kingston each day and even the large all-sky imaging files can be squeezed back over the satellite link during off peak times.

The permanent satellite data links between Kingston and the stations provide limited bandwidth. New software allows scheduling of large data transfers at off peak times to make efficient use of the link. While some data files are required at up to three different destinations, care is taken to avoid multiple transfers of the same data over the ANARESAT link. Copies of transferred files are made at Kingston and sent to interested agencies.

So who fixes the equipment when it breaks down? And how do we monitor data quality remotely?

Remote power switches at each station are a first line of defence, providing mains power to ASP experiments and allowing individual items of equipment to be switched on and off under commands transmitted via satellite. Kingston staff can thus reset any recalcitrant equipment and switch off sensitive optical equipment over summer to save on power and protect the equipment.

Of course, unattended observatories raise the risk of reduced data quality with no specialist skills on site to monitor data as it is being collected and repair problems as they occur. The ASP program still relies on people at each station making regular equipment inspections. The all-sky imager dome still needs to be cleaned and

station lights monitored. Physical equipment failures can still only be resolved with the human touch, although as older equipment is gradually upgraded even this requirement will be minimal.

All new automatic systems use email to keep in touch with Kingston headquarters. Any error conditions are stored in log files which are sent to Kingston to enable problems to be detected and rectified as soon as possible.



Electronic equipment for the automation of the Mawson ASP laboratory

Future developments

The ANARE physics community has been encouraged to automate future experiments before deployment at stations, and to locate experiments at Davis where this is consistent with scientific objectives.

The DPS-4 Ionosonde will be moved from Casey to Davis in 2001-2002 so that it can be supported by wintering expeditioners. The GPS chronometers at Casey, Mawson and Davis will be upgraded to ensure accurate and dependable timing. An all-sky imager system will be reinstalled at Mawson after some renovation work, and ADAS and ASIS systems will be deployed at Davis, enabling expeditioners to concentrate on major research work.

Monitoring of ASP instruments and their environment will be done using webcams (such as checking build-up of grime inside the all-sky imager domes) and the Australian Antarctic Division's building monitoring and control system.

Mechanical switches and knobs on future ASP equipment will be replaced with digital controls that can be activated and adjusted remotely. New systems will be designed specifically for autonomous operation.

*Lloyd Symons, Science Technical Support, AAD
& Ray Morris and Marc Duldig, Atmospheric and Space
Physics Program, AAD*

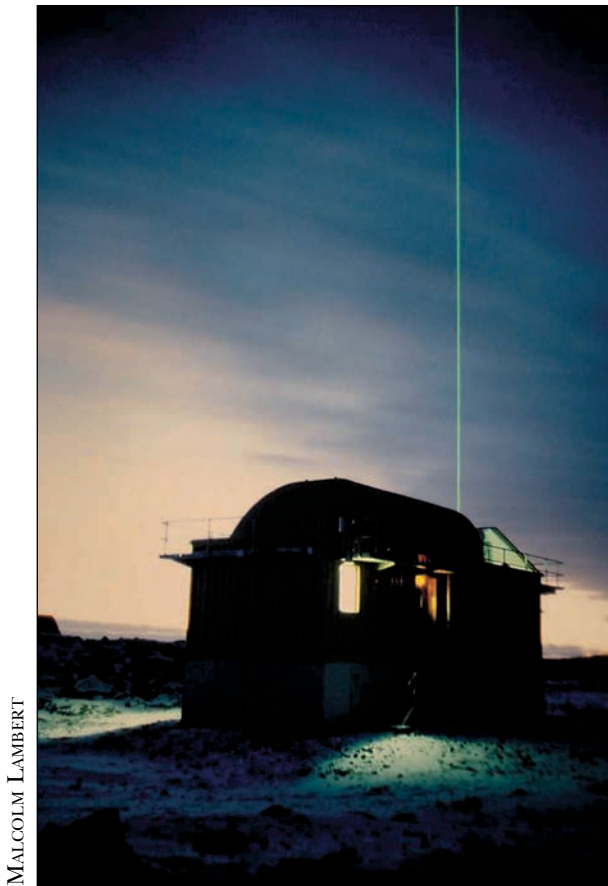
Network technology aids in operating the LIDAR

THE DAVIS LIDAR HAS BEEN COLLECTING NEW DATA ON the upper atmosphere since February 2001 (*Australian Antarctic Magazine* #1, p 29). Operation of this complex instrument has been aided by novel applications of computer technology developed by the ASP and Science Technical Support groups.

Consideration of issues related to laser safety and weather necessitate that the Lidar is not a fully autonomous system. However, a large amount of the control of the instrument is automatic, and the capability

exists to operate and modify the observing program from any remote site with access to the Internet.

The Lidar has three levels of instrument control. The bottom level is provided by dedicated microcontrollers. Each of these 'modules' performs a specific hardware task, such as firing the laser, moving a filter into the optical path, or running high speed rotating shutters. The most complex of the modules controls and monitors the operation of a Fabry-Perot spectrometer, which forms the heart of the detector system.



MALCOLM LAMBERT

The green LIDAR beam and the LIDAR Observatory

At the middle level of the control system are four networked PCs. The PCs do specific jobs; one is the main controller and communicates with the majority of the modules, a second controls the temperature inside the spectrometer, a third collects general monitoring data such as temperatures and voltages from around the system, and a fourth logs data from the spectrometer.

At the top level is a computer workstation that schedules the operation of the whole system through 'jobs', passing commands to the PCs via the network. The workstation collates the data files produced, and does some real-time analysis for the operator to view. The data are then transmitted to Kingston for detailed analysis.

The majority of the electronic systems have been developed in-house using a design philosophy developed by Peter Yates and David Rasch. David and Lloyd Symons have developed the majority of the control software in PIC micro code and LabVIEW, while David Watts, Damian Murphy and Andrew Klekociuk have developed the analysis and job

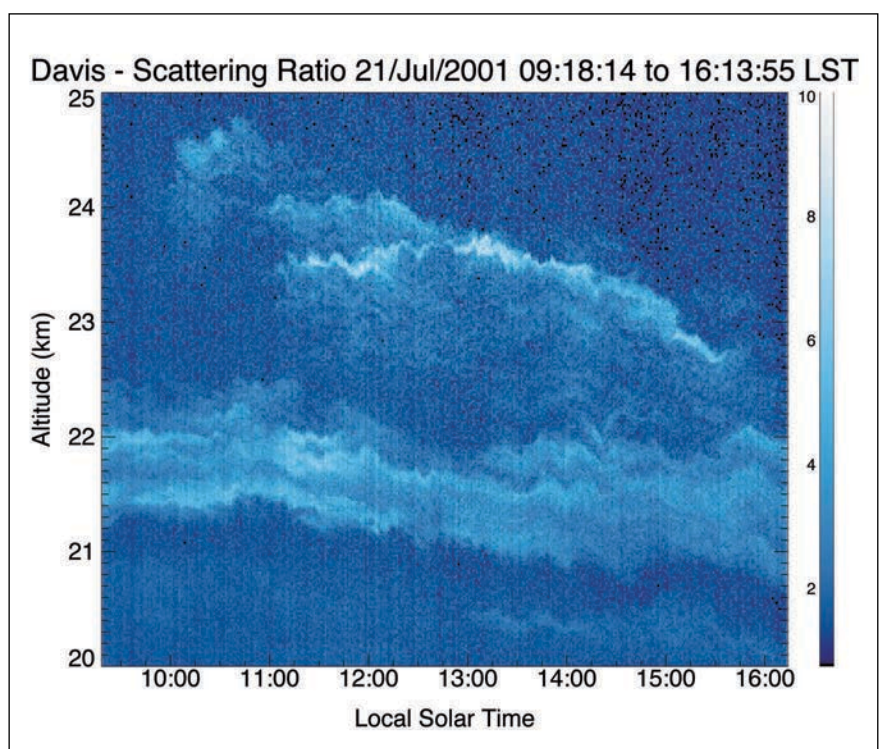
control system in IDL (Interactive Data Language).

The flexibility of the system means that the observing program can be rapidly altered when phenomena of specific interest are detected. An example of this ability involved detection of tenuous clouds in the stratosphere during July 2001 by Malcolm Lambert, the Lidar physicist at Davis. These so-called Polar Stratospheric Clouds form at high latitudes in winter typically between altitudes of 15km and 25km. The clouds occur in regions where the temperature is below about -80°C , and are formed from crystals of sulphuric acid, nitric acid and water ice. The surfaces of the cloud particles provide a catalyst for the destruction of ozone, and so the observation of the clouds is of specific interest in understanding the nature of the Antarctic and Arctic 'ozone holes'.

When the clouds were first detected above Davis, the Lidar observing program was altered from Kingston to undertake high vertical resolution measurements. With 18 metre resolution, these are amongst the most detailed Antarctic observations that have been made using Lidar, and show complex structure that is indicative of the passage of small temperature perturbations associated with propagating atmospheric waves. The clouds themselves were subvisual due to the lack of direct solar illumination in the polar mid-winter night and would have gone completely unnoticed if not for the Lidar observations.

Further observing programs related to the clouds are planned with the aim of coordinating with other Antarctic ground-based and satellite measurements.

Andrew Klekociuk, Atmospheric and Space Physics Program, AAD



ANDREW KLEKOCIUK

Polar stratospheric clouds at altitudes between 20km and 25km above Davis

Australia continues as telecommunications innovator

SINCE AUSTRALIANS SET UP THE WORLD'S FIRST WIRELESS link with Antarctica in 1912, telecommunications have played a big part in our far-flung Antarctic and Southern Ocean research programs. This legacy of innovation has found expression in modern times with Australia's 'ANARESAT', the world's first Antarctic satellite communications system, and with innovations in transmitting critical research data, much of it from remote transmitters in the field.

Douglas Mawson set the standard very soon after the discovery of wireless when his Australasian Antarctic Expedition set up a transmitter at Commonwealth Bay, Antarctica, and a relay station on Macquarie Island. A rotary-arc transmitter and Morse code were used to send weather information and personal messages to Hobart.

With the first ANARE to Heard Island and Macquarie Island in 1948, stations used 500-watt Morse code transmitters to send weather data and official and personal messages. Similar facilities were installed in 1954 at Australia's new Antarctic station, Mawson.

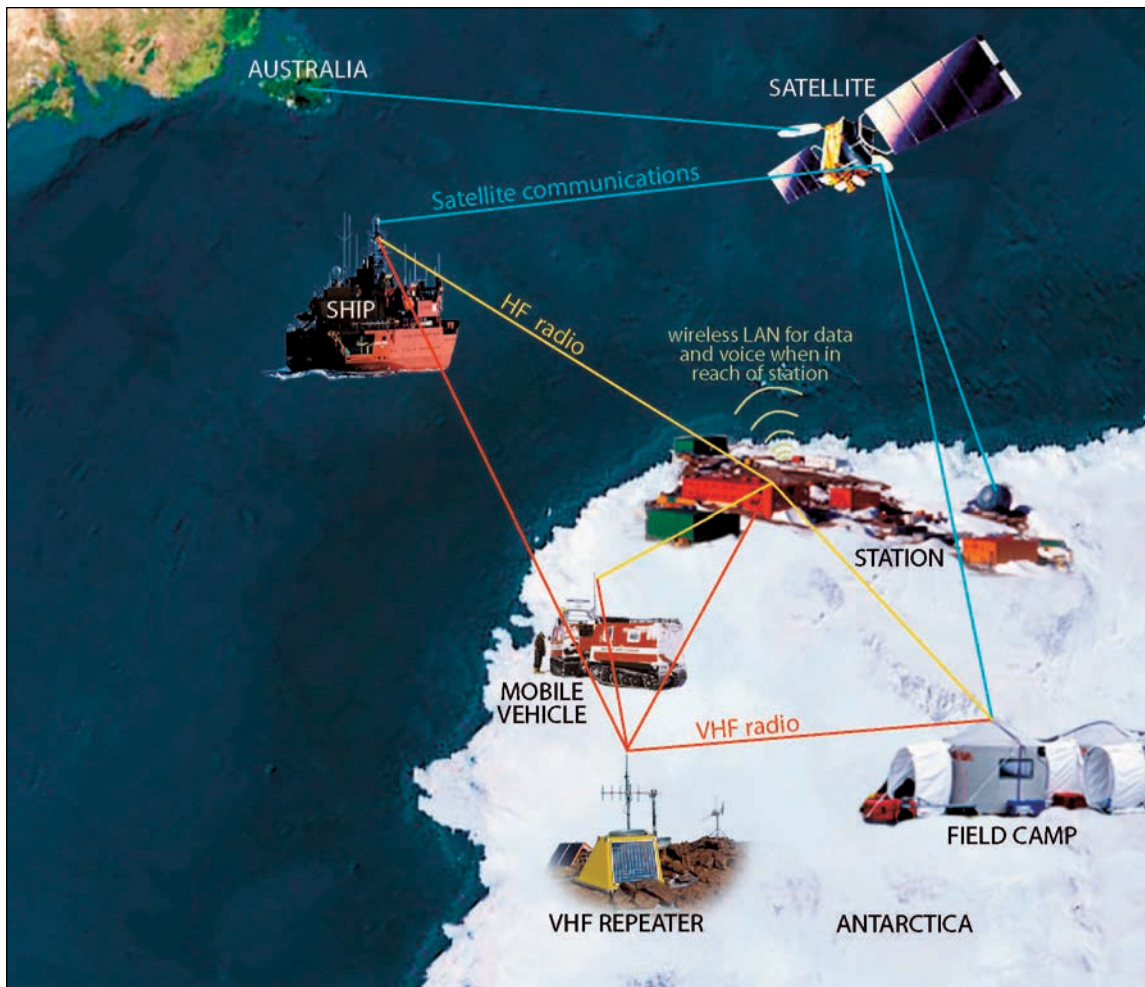
Telex transmissions were introduced in 1962 to handle an ever-increasing volume of scientific, administration and private traffic. Ten-kilowatt transmitters were

installed in 1968 and radio-telephones for official and private telephone calls were introduced at Davis and Mawson in 1969.

In 1978, Australia upgraded its radio telecommunications to HF radio when a leased 50 band telex circuit between Casey and Sydney was opened. This was a full time telegraph circuit which guaranteed error-free data transmissions, except when radio propagation conditions caused total link loss. Casey acted as a relay station for Mawson and Davis.

But HF radio had its problems. Apart from frequent interference from other radio stations, the solar influence on the ionosphere above Antarctica caused major propagation disturbances, including total blackouts due to polar cap absorption. The low-speed HF circuit severely limited the amount of traffic, at a time when there was increasing demand for picture, diagram and document transmission. Perhaps most importantly, Australian Antarctic operations were the last HF service provided by Australia's Overseas Telecommunications Commission (OTC, now part of Telstra), which wanted to close its HF service.

Satellite communications were an obvious alternative,



A diverse and sophisticated range of telecommunications services is now available for all of Australia's Antarctic activities

but had not previously been used in Antarctica. Terminals to connect the stations with the marine satellite communications system, Inmarsat, were set up through the mid-1980s. The Inmarsat trial proved that satellite links were more reliable alternative to HF radio for Australia-Antarctica communications. However, it also showed that Inmarsat as it was then, was costly, limited in its data capacity (though a great improvement over HF radio) and required manual connection for Australian calls.

A more acceptable satellite solution was sought and a contract was let in 1986 for OTC to supply and install a private satellite communications network between each Australian Antarctic station and the Antarctic Division's headquarters in Kingston, Tasmania. The network, known as ANARESAT, uses two Intelsat geostationary satellites to provide telecommunication links between Australia and AAD-owned satellite earth-stations at each of the four stations. A team of eight OTC engineers, technicians and riggers installed and commissioned the first satellite earth station at Davis in March 1987. Mawson was commissioned in January 1988, Casey in March 1988, and Macquarie Island in December 1988. Each earth station consists of a 7.3 m dish antenna, mounted inside a 12 m-diameter dome designed to withstand winds up to 325 km/h, and associated fully redundant electronic equipment.

Two separate systems are operated through the satellite terminal at each station – a 64 kilobits per second data circuit for the AAD's internal voice and data traffic, and a 384Kbps circuit carrying five digital voice channels connected to the public telephone network in

Sydney. An additional 64Kbps Casey-Hobart link is used by the Bureau of Meteorology for two-way transmission of satellite and other image data.

Additional satellite bandwidth to cope with larger future demands can be added to the system with minimal equipment additions, as was the case for the ABC-TV broadcast from Mawson for the Millennium celebrations. The bandwidth to Davis is being increased this year to meet additional scientific data transfer demands.

Inmarsat remains an important part of the Antarctic telecommunications system. Inmarsat-B is the primary communications medium for ships and major field camps for both voice and data. Email servers on ships enable all expeditioners to send and receive email via an AAD developed compression system, to minimise satellite costs. Smaller Inmarsat M and Iridium portable satellite phones are now often used by field parties to provide voice and data (email) communications. An Inmarsat M terminal also provides a backup circuit at each station in event of ANARESAT failure.

Phones installed in most sleeping and work areas at a station are connected to a PABX automatic switching system for both local and international (ANARESAT) calls, the latter using AAD-developed software which records all call costs.

Station computers are connected in an Ethernet local area network (LAN) using a switched 100Mbit fibre-optic backbone allowing easy access to email, printers, file servers and the Internet (via ANARESAT). The network is used to transfer batched and real-time scientific data back to Australia.

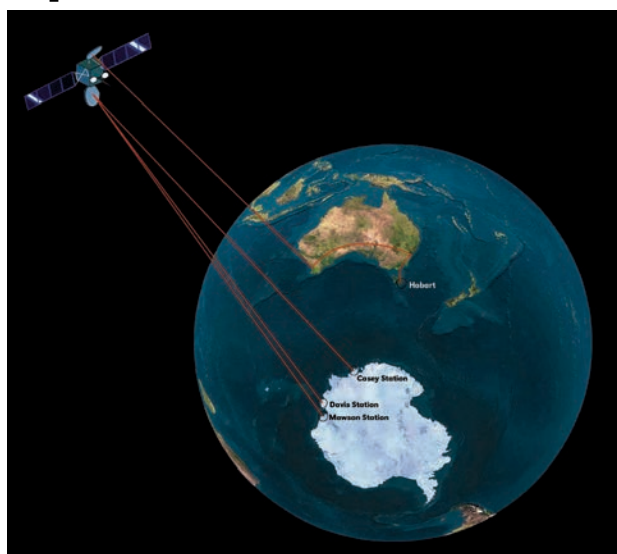
Remote housekeeping at the press of some buttons

Mawson station, midwinter: there's less than one hour of sunlight each day, winds are blowing to 200 km/h and temperatures dropping to minus 30°C. Of the 17 expeditioners working in this isolated place, only six are tradespeople responsible for maintaining the network of large, hi-tech buildings. But they are not alone. 5000 km away, engineers monitor and control the buildings.

A building monitoring and control system (BMCS) has been installed at Mawson, Davis and Casey to improve energy efficiency (see *Australian Antarctic Magazine #1*). Among other benefits, the BMCS brings:

- reduced energy consumption
- less fossil fuels
- increased comfort and safety

Across the three stations, the BMCS utilises 120 controllers to monitor over 3500 sensors and switches and control almost 500 pumps, fans, valves and actuators. Room temperatures, pump speeds and ventilation systems at the stations are fully



PAULINE DE VOS

controllable both on station and from Australian Antarctic Division's headquarters in Hobart, Tasmania using the AAD's wide area network.

VHF radio remains the main short-range communication medium in Antarctica, with radios fitted to most vehicles, boats, aircraft, and field huts, and handheld units are used as required. Access to the ANARESAT phone system is provided by an interface unit. Solar and wind-powered VHF repeaters located on mountain tops, extend the coverage around the main station areas. A paging system using AAD-developed software has recently been installed at the three continental stations to alert key personnel to alarms and emergency situations. HF radio is still used for field parties, ships and aircraft out of VHF range with the addition of a SELCALL emergency calling system.

The AAD telecommunications group is constantly looking for ways to make an excellent system better. Current investigations and initiatives include:

- use of Iridium modems to provide real time data retrieval from the planned airfield automatic weather station network
- continued improvements to the remote email and data transfer system including the testing of HF data modems.
- ways to provide a high speed data link between Davis

and the Larsemann Hills to provide a service for China's Zhong Shan station, as well as for Australian ASP and tide gauge programs, and a satellite data link to the remote Concordia station for the Dome C astronomy project.

- replacement of ANARESAT's original TWT (valve) stages by solid state units and replacement of valve HF transmitters at the continental stations with new 1Kw solid state transceivers, both initiatives will enhance the reliability and functionality of the systems.
- development of a wireless wide-area network to enable ships to connect into the AAD network when in Hobart or at a station providing for scientific data, email and voice traffic. The system will also provide connections to some field projects. The system will use voice-over internet protocol technology, which may also be used to replace the existing station PABX systems.
- development of an airfield communication and navigation system.
- development of a transportable communications centre for major field operations.

Peter Yates, Telecommunications Engineer, AAD

Safer, greener power supplies for Macquarie huts

A NEW MODULAR POWER SUPPLY SYSTEM promises a safer, more environmentally friendly way of delivering power to Macquarie Island field huts. The system includes solar and wind generation capability to minimise fuel usage in the relatively untouched Macquarie environment.

The modules are a response to a Tasmanian government report on the condition of the island's field hut electrical systems, including fuel storage, and consequent health, safety and environmental issues. The first two modules were installed last summer at Bauer Bay and Green Gorge, and three more will be delivered to Brothers Point, Hurd Point and Waterfall Bay field huts in 2001-02.

The 'remote area power systems' can generate power from three sources – petrol, sun and wind – and store it in batteries. They feature self-contained weatherproof accommodation, external to the huts, for all power needs.

The modules incorporate batteries, petrol generator, fuel storage, refuelling pumps, solar panel, wind generator using a collapsible mast, instrumentation for monitoring battery condition and charging, full electrical protection, and capacity to drop out to protect battery cells from excessive discharge.



ROBB CLIFTON

The modules can easily be transported by helicopters when necessary. An identical unit is kept at the station for training and spares. Installation is easy: they are levelled using adjustable feet, tied down with guys, the mast is raised and cables rolled out to the hut. Maintenance and access are straightforward, with all parts consistent between installations and careful attention to corrosion proof fastenings.

Glenn Scherell, Electrical Projects Manager, AAD

Blizzard winds to power Australian Antarctic station

THE FURY OF ANTARCTICA'S COASTAL WINDS IS TO BE harnessed to power an Australian Antarctic station. Australian Antarctic Division projects totalling \$6.35 million and involving German and Australian technology will result in Antarctica's first large-scale wind turbine installation, providing nearly a megawatt of power to Australia's Mawson station.

The turbines are to be provided by the German company Enercon and installed by the company's Australian agents, Powercorp Pty Ltd, of Darwin. A contract for the work, which will begin next summer, was signed in Darwin in August 2001.

The wind turbines are the first serious attempt by any country to obtain a significant electricity supply from the world's most powerful winds - the gravity-induced katabatic winds that howl down to the coast of Antarctica from the inland icecap, reaching speeds over 250 km/h.

The Mawson system will generate almost 50 times the power of existing Antarctic wind-power systems while having a much lower environmental impact than the current option of burning diesel fuel, now used throughout Antarctica. When the system is fully developed, an Antarctic station will for the first time be able to use a renewable source to meet virtually all its energy needs.

The use of diesel fuel to power Australia's Antarctic activities is from an environmental perspective far from ideal. The fuel must be transported from ship to shore and stored at stations before being used. While the risk of spillage has been minimised it remains a possibility.

The Mawson wind turbine system will rank among the world's most innovative, including the installations at Windy Hill, Queensland, and Denham in Western



Photomontage view from the Red Shed at Mawson following installation of the first turbine.

Australia. It will feature three 300 kW wind turbine generators with associated power house control equipment. The turbines will be three-bladed, variable speed machines of 30 m diameter, mounted on a 34 m tapered steel tower.

The powerhouse control equipment, manufactured by Powercorp, was originally designed for small, isolated Australian and South East Asian communities. Powercorp will modify the system to integrate the wind turbine generators into Mawson's power grid to provide completely clean, renewable heat and electrical energy for up to 80 percent of the year.

Equipment will be delivered and foundations built in the 2001-2002 summer, with the powerhouse control systems and wind turbine generators installed the following summer.

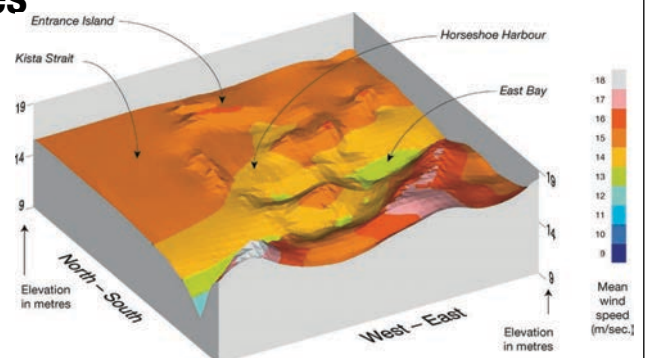
Wind modelling finds best turbine sites

Australian Antarctic Division engineers have been studying the potential of the Antarctic katabatic winds as a source of energy. Working remotely from the Division's Kingston offices and using anemometer data from Mawson station, the location and size of future wind turbines has been optimised, and their potential yield has been calculated.

The proprietary package 'Windfarm' is usually used for wind farm sizing. It has been used on the Mawson Alternative Energy Project to refine the project scope from an initial estimate of four turbines to a present estimate of three.

Using topographical and wind data, a three dimensional image of the wind speed at Mawson has been produced (see diagram). From this, the best turbine locations can be selected. A knowledge of the station load profile and the power curves for the turbines has allowed the yield for several combinations of turbine quantity and size to be calculated and these variables to be optimised.

Having selected a turbine and a site, modelling can also be used to calculate the noise and visual impact of the turbines. 'Windfarm' can also relate the topographical information to photographs to create images of the turbines as they will look (see photograph in story above).



Three dimensional model of wind speed at Mawson station

Tide gauges that withstand stormy seas and Antarctic ice

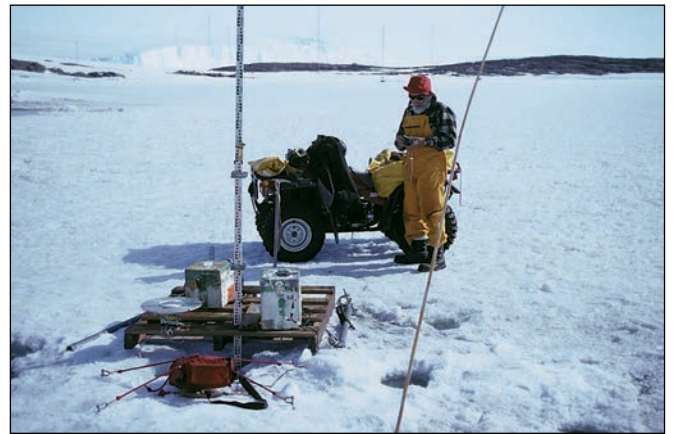
WE MEASURE TIDES FOR MANY DIFFERENT RESEARCH and operational purposes. Such measurements have a practical value in determining sea level for mapping elevations and ocean depths, tidal predictions for shipping, and in the calibration of satellite altimeters.

Tide measurements also have a research value. Sea level data helps us understand long-term climate change as well as continental readjustment, heat transfer across the continental shelf, and other oceanographic phenomena including observation of the recently-observed Southern Ocean oscillation.

The Antarctic region had no effective tide-measuring network until recently. The Australasian Antarctic Expedition installed tide gauges at Cape Denison and Macquarie Island in 1912. Several gauges have operated in the region since then, but only for short periods.

Antarctic and subantarctic coasts are difficult places for measuring tides. Rough seas and floating Antarctic ice regularly destroy both sea-bottom and shore structures. In 1991 the Australian Antarctic Division, with support from other national research and administrative bodies, made a concerted effort to obtain long-term tide data by installing gauges in Antarctica and the Southern Ocean.

At Macquarie Island, access to the sea was gained via an inclined bore hole, with the gauge and electronics in a sealed fibre glass dome at the top of the hole. In Antarctica, 600-kg concrete moorings containing gauges in areas relatively free of icebergs have operated for eight years at Mawson and Davis and at Casey for five. A new shore gauge at Mawson will use an inclined borehole to



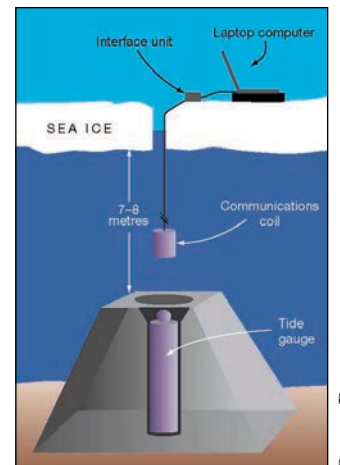
CHRIS WATSON

Equipment used to download and calibrate the gauge, and to establish the height difference between the tide gauge benchmark and the AUSLIG GPS base station (Mawson, December 1997).

the sea, heated to stop the water from freezing.

The tidal data will need to be gathered for another decade or more before any long term sea level trends can be detected.

Henk Brolsma, Mapping Officer, AAD

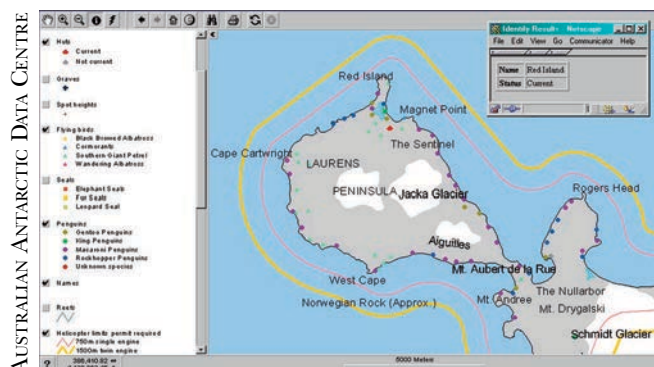


PETER BOYER

ANARE bottom-mounted tide gauge installation

A moveable feast: explore the AAD's interactive maps

MAPS ARE NOT WHAT THEY USED TO BE. WITH WEB technology users can now create their own maps interactively. The Australian Antarctic Data Centre is serving interactive maps of Australian Antarctic stations and nearby areas as well as Heard Island and Macquarie Island. There are also maps of the whole of Antarctica, respectively showing territorial claims and presenting the spatial coverage of remotely sensed data held by the AAD,



including aerial photography and satellite images.

Using just a Web browser, anyone can pan across an area and zoom in or out to view features of interest at the desired scale. Feature attributes, such as coordinates, the name of a feature, the height of a contour or the date of an aerial photograph can also be queried. Such customised maps can then be printed from the user's computer.

A series of interactive maps was developed in support of environmental management of the abandoned Wilkes station. Photographs of many map features may be viewed using a hotlink tool – simply click on the feature and the associated image will be displayed. The Atlas Cove interactive map displays survey data from the 2000–01 season and includes photographs taken at the site of the old station.

Try it! The Data Centre's interactive maps can be accessed from: <http://www-aadc.aad.gov.au/mapping/>.

David Smith, Australian Antarctic Data Centre, AAD



Antarctic visions: making the most of digital imaging

ANTARCTICA REMAINS VERY ISOLATED, ACCESSIBLE ONLY TO RELATIVELY few people. But from the earliest years of its exploration the images brought back from this remarkable place have captured the imagination of people who can never hope to go there. In Captain Cook's time the media were watercolour and rough pencil and ink drawings. Photography opened up new possibilities exploited with consummate skill by the pioneers of classic Antarctic photography, the Australian Frank Hurley and Englishman Hebert Ponting.

Since the birth of ANARE in the 1940s expeditioners and professional photographers have produced some unforgettable images of man and nature in this ice-world. In the process, they have captured moments in time of great value to science. Pictures of subantarctic glaciers from the 1950s are showing scientists the extent of glacial retreat (an important climate change indicator); early images of bird colonies reveal fluctuations over time in species numbers (an indicator of ecological changes).

The technology of the World Wide Web takes Antarctic photography to the world. The classic panoramas seen here were created using a combination of conventional photography and digital image technology. The original images for the 360° panoramas were taken in portrait (vertical) mode using a 35mm film camera on a special-purpose tripod head. The 18 images for each panorama were then scanned into a computer at high-resolution and 'stitched' together in a special software program before being re-touched digitally to eliminate seams and other irregularities. They may also be viewed as 'QuickTime-VR' images – 'virtual reality' pictures, often a full 360° as these are – which can be explored by panning around and zooming into the scene. Such images have wider application in training, security, pre-visit orientation and other needs. A series of QuickTime-VR images of natural and station views in Antarctica can be seen at the AAD website at <<http://www.aad.gov.au/explore/default.asp>>. A historical panorama of Australia's Atlas Cove station on Heard Island is currently being prepared.

The AAD holds a huge archive of Antarctic pictures dating back to the time of Hurley and Ponting. A total of 350,000 still images – colour and black-and-white, glass plates, prints, slides,

negatives, and digital images – cover subjects as varied as micro-organisms to people, ice crystals to aerial and satellite images. In addition, the Multimedia Library holds high-quality videotape records of historical and current movie film, fully shotlisted and recorded on database, amounting in film terms to around 500,000 feet. The collection has been showcased at Australia's Parliament House in Canberra for the past seven years, to audiences of over 100,000 people each year.

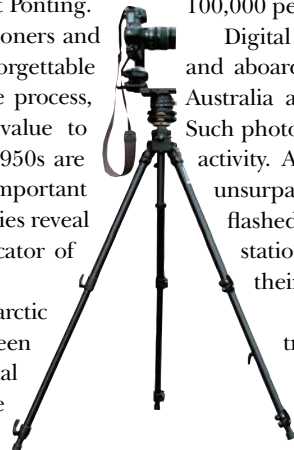
Digital cameras, now permanently available at each station and aboard ships, make it possible to send Antarctic images to Australia and other parts of the world almost instantaneously. Such photography has wide application in every aspect of human activity. As a research and publicity tool the digital camera is unsurpassed. X-rays and other medical digital images can be flashed to Australia to enable a diagnosis to be back at the station within an hour. Families can exchange photographs of their respective lives across great distances.

The AAD has taken a leading role in converting traditional images to digital media for these and many other purposes. The conversion has enabled a much higher degree of security for original images because of reduced handling, as well as provision of 'loss-less' duplicates. Its database of historical and current digital images and film footage has been greatly enhanced by former ANARE expeditioners, including the first AAD director, Dr Phillip Law, who have freely given their knowledge and expertise to identify images.

The AAD Multimedia Unit has added value to its image library by creating posters for science conferences – a valuable publishing medium for scientists – and for other professional and promotional purposes. Many of the scientific posters won plaudits and awards at international meetings for their authors and designers.

Peter Boyer, Information Services Manager, AAD

Panorama, top: The emperor penguin colony at Auster Rookery, taken in early November 1999. The images that make up this panorama were shot with a 28 mm lens. Below: Casey station taken from Reeves Hill in late January 2001. This pan was shot with a very wide angle lens (17 mm) to enable the foreground and sun to be included.



The season ahead: science on a grand scale

THE 2001-2002 ANTARCTIC SEASON IS ALMOST UPON US AS we ready ourselves for another ambitious field season. In some ways the coming season will be less hectic than last year's, because we are not returning to Heard Island, but the scientific objectives are no less important.

Early in the season we will be conducting a major marine science voyage, departing from Hobart on 26 October and returning on 15 December. About 80 scientists from Australia and overseas will undertake a detailed examination of the physical and biological characteristics of the ocean along the 140°E longitude and stretches from the south of Tasmania to the ice edge. The ocean is able to store vast amounts of heat, freshwater and carbon and acts as a sensitive accumulator of small changes; it is thus a good place to look for evidence of climate change. Water samples from the surface to the ocean floor will give evidence of temperature, salinity and chemical composition and of how water masses and heat are transported through the ocean, and the interaction of physical and biogeochemical processes will provide clues to how the spring bloom of alga is controlled. Nine portable specialised containerised

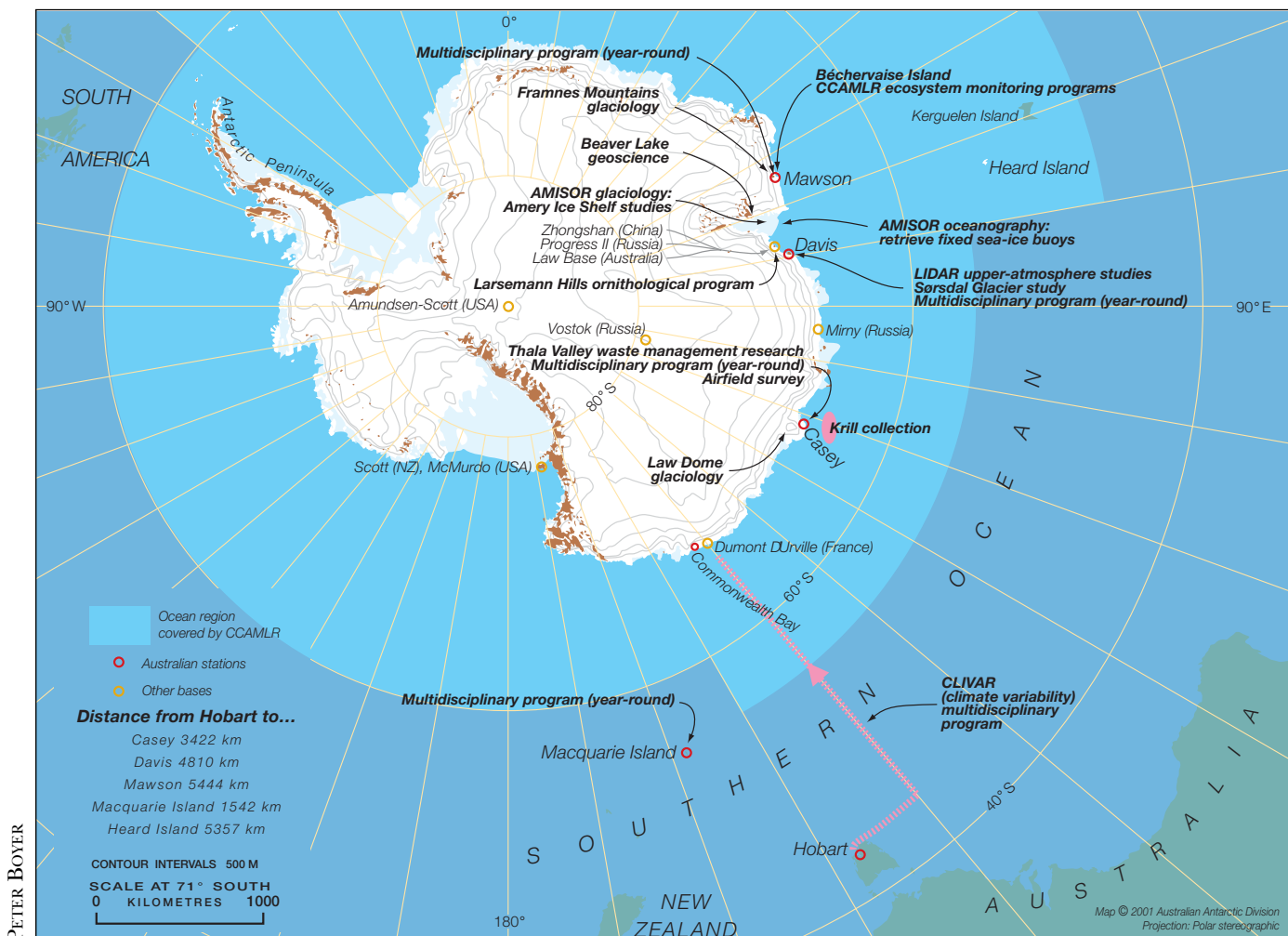


MIKE CRAVEN

The 'flubber' used as a surface supply of water for the hot water drill in the Amery Ice Shelf glaciology program.

laboratories will adorn the helideck, trawl deck and above the hangar of the *Aurora Australis*, and every built-in laboratory will be used to the fullest extent.

Work on the Amery Ice Shelf will continue with a field party established for another season drilling. Last season a hole was successfully drilled through 370 m of sea ice and



Australian Antarctic field research activities 2001-2002

Australian Antarctic shipping program 2001-02

The following shipping schedule for the 2001-02 season was correct as at 8 October 2001. However, published voyage timings are subject to change without notice and may be brought forward or delayed by several days. The most current information is available on the AAD's website at <http://www.aad.gov.au/goingsouth/schedules/0102_ship_sked.asp?>.

Voyage 2 *Aurora Australis*: Macquarie Island and Casey summer deployment
Departing Hobart 28 September 2001, returning Hobart 26 October

Voyage 3 *Aurora Australis*: Marine Science (CLIVAR)
Departing Hobart 30 October 2001, returning Hobart 15 December

Voyage 4 *Polar Bird*: Davis resupply, deployment of AMISOR team at Amery Ice Shelf and summer personnel at Mawson
Departing Hobart 12 November 2001, returning Hobart 27 December

Voyage 5 *Aurora Australis*: Casey Resupply and Changeover
Departing Hobart 17 December 2001, returning Hobart 10 January 2002

Voyage 6 *Polar Bird*: Davis and Mawson changeover, Mawson resupply
Departing Hobart 30 December 2001, returning Hobart 5 February 2002

Voyage 7 *Aurora Australis*: Marine Science (Prydz Bay AMISOR Oceanographic Program and Sea Ice Thickness Program) and retrieval of summer personnel from Davis
Departing Hobart 12 January 2002, returning Hobart 21 February 2002

Voyage 8 *Aurora Australis*: Macquarie Island resupply
Departing Hobart 23 February 2002, returning Hobart 6 March 2002



GRANT DIXON

a number of instruments were introduced into the hole. This season a further hole will be drilled at the location where in 1968 a field party spent the winter. This year's hole will be about 450m, and it is hoped that the field party will extract an ice core from the point at which glacial ice overlies marine ice. An upward-look sonar device will be introduced into the hole to provide information on the process of melting and refreezing of ice shelf. Scientists on Voyage 7 will retrieve oceanographic instruments that were deployed across the face of the Amery last summer, to provide data on water movements, temperatures and composition as an adjunct to the ice studies.

On land there will be a large number of ongoing studies across the disciplines. The study of the effects of the Thala Valley tip site will continue with a major thrust to assess the effect of pollutant run-off into to waters around Casey Station. Work on the biochemical and physiological adaptations to life in extreme environments will continue at the saline lakes at Davis Station. Macquarie Island will see a return of botanists studying the effects of global climate change on a range of organisms, and at all our stations there will be usual buzz of activity as we advance our range of programs.

Professor Michael Stoddart, ANARE Chief Scientist, AAD

Proposals sought on Antarctic air transport system

Eight air transport companies – seven of them Australian-based – have been asked to submit proposals to develop an air transport system for Australia's Antarctic program. These companies had previously been short-listed to provide air transport between Australia and Antarctica.

The AAD is seeking proposals from the companies to enter into an agreement to develop an air transport system incorporating both an Australia-to-Antarctica component and a capability for flying within Antarctica itself.

Detailed proposals specifying the type of aircraft used and many other aspects of such a system are being sought.

The deadline for proposals was 21 September. With advice from aviation and other consultants, the AAD is now determining the company or companies best able to provide the service.

The decision on whether to proceed with the air link will be made after an assessment of the proposals is completed, including risk, cost-benefit and environmental analyses.

Heard Island uncovered: 2000-01 summer ANARE

A MAJOR EXPEDITION TO HEARD ISLAND LAST summer involved 55 research and support personnel working from the main camp at Atlas Cove, a secondary camp at Spit Bay and a small camp at Brown Glacier. Some coastal travel between the northern and eastern parts of the island was possible by inflatable rubber boats. The research teams supported 22 wide-ranging projects in the fields of archaeology, geology, geodesy, botany, genetics, zoology, and human impacts. (Details of projects can be found at <http://www.aad.gov.au/science/heard0001>) The abandoned ANARE Atlas Cove site was also substantially cleaned up and rehabilitated.

Archaeological studies looked at the lifestyles of mid-19th-century sealers in an inhospitable environment. Excavations revealed a mixture of temporary camps (one incorporating a whaleboat) and purpose-built constructions. The discovery of a locally-made musical instrument emphasised that sealers often stayed far longer on the island than they were expecting to.

Heard Island is just south of the Antarctic Polar Front, a major oceanic and climatic boundary, which makes it an important locality for studying the impact of climate change. A team of glaciologists found that since 1947 Brown Glacier on the east coast has retreated 1.1 km, decreasing in area by 33 percent, and has lost 38 percent of its total volume. Focussing on investigating responses to environmental change and seeking information for conservation protocols, a multidisciplinary international team gathered data on the island's terrestrial and coastal ecosystem biodiversity and species distribution and function.

A survey of Heard Island's fur seal population counted 1,012 pup births, a 3-fold increase since 1987-88, an increase of 20.2 percent a year since 1962. The breeding population was estimated to be about 4,000 seals and the total population around the end of February was about 28,000 seals.

Early in the season, helicopters were available for some successful aerial photography to assist detailed mapping of the coastline as well as providing information for seabird and seal surveys.

Samples of the earth's lower crust and upper mantle brought to the surface by erupting lavas, called mantle xenoliths, were collected to help interpret the submarine



DANA BERGSTROM



PAUL SCOTT/PAUL SCOTT



JENNY SCOTT/DANA BERGSTROM



PAUL SCOTT/PAUL SCOTT

Kerguelen Plateau upon which Heard Islands sits. Evidence for the geomorphological evolution of Heard Island, especially glacial events and their relationships to volcanic events, was gathered. Volcanic activity from Mawson Peak was often observed, including a spectacular eruption in February, and a second active vent was discovered below the summit in November 2000.

A symposium in Tasmania early in 2002 will look in detail at outcomes of the expedition.

Dana Bergstrom & Paul Scott, AAD

Big Ben: the fire beneath the ice

A SPECTACULAR NIGHT-TIME ERUPTION OF Heard Island's Big Ben in February 2001, following a summer of plume and vapour sightings, was an emphatic reminder that this volcano remains well and truly active.

From the outset of the 2000-2001 Heard Island summer season, vapour was seen coming from the Mawson Peak summit (2745 m) of Big Ben – Australia's highest mountain outside Australian Antarctic Territory. This was followed by a series of observations at most times when cloud lifted from the summit:

- 19–20 October: fumes over several hours seen from *Aurora Australis* off northern coast.
- 28 October: Strong plume seen from near Red Island.
- 9 November: Close-up observations of gases venting through ice dome at summit and at location 250 m down southern slopes.
- 13 November: Brown fumes seen from Fairchild Beach, northeast coast.
- 14 November: Plume estimated to approach 300 m high observed from moraine crest east of Browns Lagoon, from which summit is hidden by 2,300 m-high ridge 2.5 km downwind.

Observations reached a spectacular finale from the evening of 2 February 2001 until early the following morning. Witnesses at Atlas Cove saw orange-coloured



STU FITCH

Night-time view of Big Ben erupting on 3 February 2001, viewed from Atlas Cove

light reflecting off high cloud. The diameter of the illuminated area was estimated to vary from 1 km to 4 km, depending on passing cloud. Plumes were strongly back-lit, making them visually dramatic. At least two distinctive glows from red lava were observed (see photo above). Emissions appeared to diminish about 1 am on 3 February, cloud finally obscuring the view.

Venting had subsided considerably by daylight. From a high point on Laurens Peninsula, what seemed to be a black lava flow was seen on Mawson Peak, about 15 km away. It was estimated to be about 100 m wide by 1500 m

Active past disguised by sparse record



Oblique aerial photograph of the icy summit dome of Mawson Peak on 9 November 2000 KEVIN KIERNAN

The 20-km-wide volcano that dominates Heard Island is about a million years old. Its present summit, Mawson Peak, appears to have formed only within the last 10,000 years after collapse of the western side of the mountain. Because Heard Island is seldom visited and usually shrouded in cloud, observations of volcanic activity are rare. There were no recorded observations

before 1881 and 1910 – long after the seal hunters had left – when clouds of smoke were reported. About 30 observations of activity were recorded during the Atlas Cove station years (1948-54).

There is a 31-year gap in records before a lava eruption with bluish-coloured plumes was observed from aboard *Marion Dufresne* on 14 January 1985. Red glows around the summit were seen from *Nella Dan* on 1 and 2 October 1985 and from Atlas Cove on 4 November 1985. Plumes were seen from South West Bay on 17 November 1985 and from the Space Shuttle between 7 October and 3 November. Australian investigations at the summit in 1986-87 found a lava lake gently emitting smoke and steam, and a small explosive emission occurred on 4 January 1987.

During the year-long research presence at Spit Bay in 1992, Big Ben was particularly active, with many sightings of steam issuing from the summit. Eruptions of plumes from the summit, hidden from Spit Bay by a ridge 4 km to the east, were vigorous enough to be seen many times, sometimes rising hundreds of metres above the ridge. Two earthquakes were experienced. The largest of these, on 18 December 1992, may have been associated with an eruption producing a 4.5 km lava flow subsequently found on Big Ben's southern flank.

Kevin Kiernan

long, but size estimates were complicated by distance, lack of a comparative scale and an acute viewing angle.

The ups and downs of Australia's highest peak

It is hard to put Big Ben's eruptions into perspective because visits are so intermittent, but the 2000-2001 observations add useful new data to the record. Included in these observations were changes to Big Ben's form and height.

The first full ascent in 1965 revealed a furrow at the summit 7.6 m deep, 23 m across and 76 m long. In 1983 climbers found a rocky summit from which steam was being emitted. The 1986-87 ANARE expedition found a cylindrical crater 40-50 m in diameter and 50-70 m deep containing a lava lake. But by 1992 a split in the summit cone had formed a wedge about 150 m deep, releasing lava down the southern flank of the mountain. The next summit observation in January 2000 revealed a vent 10 m long from which smoke billowed continuously.

On 9 November 2000, inspection by helicopter revealed the summit to have assumed the form of a steep, irregular ice dome festooned with massive mushrooms of overhanging rime. Gases were seen venting through the apex of the dome (see photo below). Clean white ice separated this spectacular steaming white peak from a second emission point lower on the southern slope. Following the spectacular eruption of 2-3 February 2001, the summit topography of Big Ben may have changed again. As if surveyors do not already have enough problems trying to determine the altitude of such a weatherbound and remote mountain!

How many vents?

The 2000-2001 field work brought new insights into a persistent issue about the number of volcanic vents on Big Ben. In January 1950 and February 1952 up to three distinct red glows were reported, one from the summit and the others attributed to vents on the southern flank. Similarly, two distinct red glows were observed from *Nella Dan* in October 1985, suggesting that a second vent existed. But when detailed inspections in 1986-87 failed to find

additional vents, the previously-seen multiple glows were attributed to magma ponded in the summit crater and spilling down the mountain flanks.

However, small vents may come and go, especially if they are rootless vents such as leaks (honitos) fed by shallow lava tubes, or lateral breaches under the walls of a cone. The heavy snowfall high on Big Ben will quickly bury and hide areas where venting may have ceased. Results from the recent work indicate at least two vents indeed exist, one at the summit of Mawson Peak and at least one separate, lower vent in the vicinity of the 1985 flow.



STU FITCH

Night-time telephoto view from Atlas Cove of two eruption points and ice slopes near the summit of Big Ben illuminated by the eruption.

The observations from near Red Island on 28 October 2000 suggested the presence of a second emission point on the southern slopes, well below the steaming summit. This was confirmed during the inspection by helicopter on 9 November 2000 when a distinctly separate area of activity was found about 250 m below Mawson Peak near the head of Lied Glacier. Gases were issuing from crevices in a belt of exposed rocks at this site, which was separated from the summit vent by several hundred meters of clean, white ice.

The exact points from which lava erupted on 2-3 February 2001 were obscured from view by the high shoulder of Big Ben. Nevertheless, two vents appeared to be involved, one possibly at the summit of Mawson Peak and at least one other lower down (see photo above). Estimates from Atlas Cove suggested the main vent was perhaps 300 vertical metres below the summit, and the two vents were estimated to be about a kilometre apart. This is broadly consistent with the observations obtained at the summit two months earlier. Some witnesses to the February eruption considered emissions may also have been coming from a third vent, based on observations made the following day from Laurens Peninsula. A third vent would be consistent with some observations from Atlas Cove between January 1950 and February 1954, but there is no evidence for a third vent in photographs from the January 2000 eruption.

Kevin Kiernan, Stu Fitch & Anne McConnell



STU FITCH

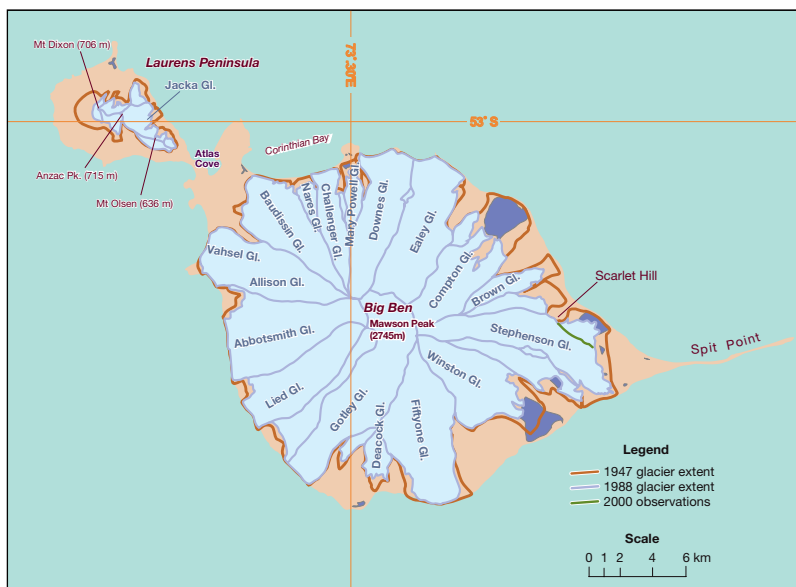
Telephoto view of the eruption, with glacier illuminated by the red glow.

Our subantarctic glaciers: why are they retreating?

THE GLACIERS OF HEARD ISLAND – A 367 KM² volcanic cone in the southern Indian Ocean – are in retreat. The question is, why? At what rate are they changing, and what is causing it? Why do the large glaciers on the windward southwest coast show little if any change? Unravelling influences such as climate change, volcanic activity and topography on the observed pattern of glacier behaviour on this infrequently visited island has been a challenge.

Maps, drawings and photographic images of Heard Island made since it was first visited in the early 1800s are a valuable record of glacial variation. Two Australian aerial photographic surveys – in December 1947 (resulting in the first attempt to produce a reliable map of the island) and 1980 – enabled comparison of many glaciers over this period by Allison and Keage (1986) and Budd (2000).

The estimates of 1947 and 1980 glacier extent were based mainly on composite vertical and oblique aerial and marine photographic surveys. These produced reasonably accurate topographic detail for much of the island, but the western side and Laurens Peninsula were obscured by cloud during most visits. From



The extent of glaciers on Heard Island in 1988. The retreat since 1947 and the change in the Stephenson Glacier (1988–2000) is indicated.

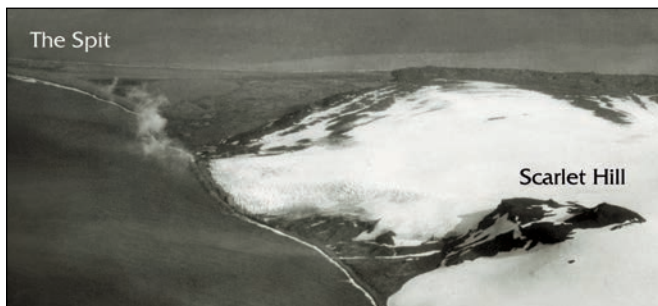
1987, geo-referenced satellite imagery and low level aerial photography enabled a much more accurate assessment of glacier surface extent, type and distribution.

In 1947, Heard Island's glaciers covered 288 km² or 79 percent of the island. By 1988 this had decreased by 11 percent to 257 km². About half of this change occurred during the 1980s, when summer temperatures were about 1.7°C higher than the 1946-54 average. A Spring 2000 visit to the island found that the Stephenson (see photographs at left), Brown and Baudissin glaciers, among others, had retreated further.

At the end of the 1980s, a total of 29 glacier basins and 41 termini with a total estimated ice volume of about 14 km³ covered 70 percent of the island. The island's steep topography means that glaciers are relatively thin – about 55 m deep on average. The largest glacier, Gotley, originating on the island's highest point, Mawson Peak (2745 m) is 27 km² in area and 13.2 km long. Smaller glaciers such as Nares, Mary Powell, Brown, Deacock and those on the Laurens Peninsula have significantly receded, but the larger glaciers such as Gotley, Abbotsmith, Downes and Ealey show little or no change since 1947.

Most recorded volcanic activity appears to have been centered on Mawson Peak (see over, top left) and its southwest flank (see Quilty and Wheller, 2000), but this has had very little effect on the size of the glaciers on that flank, Gotley and Lied. Heat conducts slowly in snow and the melt water quickly becomes steam, resulting in a dampened response (Major and Newell, 1989). Thin deposits of volcanic ash will reduce albedo and accelerate melt, but thicker deposits of debris and cooled lava will

ANARE/RAAF No. 616



ANDREW RUDDELL



Above: The northeastern terminus of the Stephenson Glacier in December 1947. Below: The northeastern terminus of the Stephenson Glacier in October 2000. It has retreated 1.7 km from the coastline since 1947.

ANDREW RUDDELL



Lava flow down the southwest flank of Mawson Peak, onto the Gotley Glacier, January 1993. The Gotley Glacier has a large accumulation zone and is on the southwest coast. It loses about 80 percent of its ice through calving into the sea. Despite its proximity to volcanic activity it has not changed in size over the past 50 years.

remain on the snow or ice for many years, insulating it against solar radiation and thus reducing melt.

In simple terms, a glacier can be viewed as a large 'balance sheet' – what goes in as snow accumulation must go out through melt loss or calving of ice if it extends to the coast. If the water equivalent of what goes in is less than what goes out, then the glacier will be 'in the red' and it will recede back from the melt zone to a cooler, higher elevation where both components are 'balanced'.

Heard Island is cold and steep with a high snowfall. Many larger glaciers are unable to lose much ice in the narrow coastal melt zone. If this zone were wider some of these glaciers would be several kilometers longer, but instead the sea's action removes ice from glacier tongues. For such glaciers, up to 80 percent of their volume loss is through calving. Loss through melting is unlikely to be considerable even if conditions were significantly warmer.

The smaller, shorter glaciers are much more sensitive to temperature effects. Laurens Peninsula glaciers, whose maximum elevation is only 500 m above sea level, are particularly vulnerable. With a warming of 1°C the accumulation zone above the end-of-summer snowline elevation of about 300 m would recede to about 450 m elevation due to rain and increased melt. With an accumulation zone reduced to a range of only 50 m elevation, the glacier retreats until the elevation range of the melt zone is similar in size. This illustrates much of what has been happening for Laurens Peninsula glaciers since 1947, during which time their total area has decreased by over 30 percent. Jacka Glacier in the early 1950s had receded only slightly from its position in the late 1920s, but by 1997 it had receded about 700 m back from the coastline (see photographs at right).

The fluctuation pattern evident in the diversity of glaciers on Heard Island indicates a climatic cause rather than a change in volcanic activity.

Field studies on the Brown Glacier last spring have provided a better understanding of the physical characteristics and climatic dependence of this representative Heard Island glacier. Two months were spent measuring ice thickness, velocity, accumulation, surface elevation and past position. An automatic weather station was installed near the accumulation zone and has been providing some surprising information on the nature of relatively warm foehn winds.

Heard Island glaciers have a relatively small ice volume, so the contribution to sea-level rise through glacial melt is not a concern. However, the unique climate signal that is coming from this predominantly oceanic region is of vital importance. It indicates that the change observed elsewhere in Southern Hemisphere mid-latitudes – in New Zealand, Patagonia, Kerguelen Island, South Georgia and Bouvet Island – is widespread.

Andrew Ruddell, Glaciology Program, Antarctic CRC and AAD

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The Jacka Glacier, Laurens Peninsula (29 January 1955). Taken from the summit of Mount Olsen.



The Jacka Glacier in March 1997. It has retreated about 0.7 km since the early 1950s when it extended to the sea.

Fertile ground for science: terrestrial studies in Antarctica

MOST PEOPLE'S VISIONS OF Antarctica are of immense lifeless ice sheets stretching to the horizon. But there are small ice-free places on the continent where you can find life, such as mosses, as well as freshwater bodies like meltwater streams, tarns and lakes. The subantarctic Heard and McDonald Islands group (substantially ice-free) and Macquarie Island (totally ice-free) are home to more complex tundra-like ecosystems. There are currently about 20 projects in the Australian Antarctic Program on Antarctic and subantarctic terrestrial and freshwater ecosystems.

Investigating the biodiversity of ecosystems is fundamental to any biological research. Biodiversity is an all-encompassing term that describes variation at three levels: taxonomic, genetic, and ecosystem. At the taxonomic level, Rod Seppelt and Hau Ling from the Australian Antarctic Division and their colleagues have been researching variation in species diversity in subantarctic and Antarctic bryophytes, lichens, terrestrial and freshwater algae, fungi and microbes. Ling is close to completing the non-marine algal flora for the Windmill Islands, the region around Casey Station, during which he has discovered several new species of algae. Patrick McBride (Macquarie University) has been working on the taxonomy and ecology of subantarctic freshwater diatoms.

Subantarctic invertebrates are receiving attention from Rieks van Klinken and Penny Greenslade (CSIRO and Australian Quarantine Inspection Service), who are close to completing an invertebrate fauna for Macquarie Island. Herbert Dartnall (Great Britain), Steven Chown, Mick Marshall (South Africa) and Yves Frenot (France) have been documenting new invertebrate species on Heard Island, with new records for freshwater invertebrates, weevils, flies and mites. Dartnall has also found two new species of rotifer.

Mary Skotnicki (ANU) and Patricia Selkirk (Macquarie University) have been investigating the extent of genetic diversity in plants. They have demonstrated that mosses in Antarctica exhibit extensive genetic variation (with levels similar to temperate regions) and that variation within colonies is apparently caused not only by immigration and establishment of plants from elsewhere but also by genetic mutation. These studies are assisting in the understanding of evolution, origins and dispersal mechanisms of Antarctic plants, and their response to climate change. This



Studying Pringlea on Heard Island: attaching thermocouples to measure leaf temperature

DANA BERGSTROM

work is directly contributing to two new international cooperative research programs investigating evolution and regional sensitivity to climate change in Antarctica.

Many other studies are also involved with the climate change sensitivity program. Sharon Robinson and her team from Wollongong University are concerned about increasing ultraviolet radiation levels over Antarctica. Their research is examining the susceptibility of DNA to ultraviolet damage and the effectiveness of protective and repair mechanisms in Antarctic mosses.

Other climate change projects are focusing on how components of ecosystems will respond to changing temperature and associated effects. Dana Bergstrom (AAD) and her team, with Steven Chown, Jako Klok and Valdon Smith (South Africa), Niek Gremmen (Netherlands), Yves Frenot (France) and Kendi Davies and Brett Melbourne (CSIRO), are comparing plant and invertebrate species performance and ecosystem function across Heard, Marion, Kerguelen and Macquarie Islands. Jenny Scott (University of Tasmania) is documenting long term changes in subantarctic vegetation, including vegetation mapping for Heard Island. Andrew Kennedy (University of Western Australia) is examining big patterns in species richness and constructing models that will predict changes in species distributions with climate change.

A number of researchers are concentrating on human impacts. Ian Snape (AAD), with CSIRO and university researchers, is conducting trials on remediation of extensive petroleum-contaminated sites at Casey and Wilkes stations. Joanna Laybourn-Parry (Great Britain) is seeking to identify if humans have introduced species of fungi to Antarctica. In the subantarctic, Clive Crossley (University of Tasmania) is documenting the invasion of two introduced slater-like invertebrates on Macquarie Island, Penny Greenslade (CSIRO) is preparing a comprehensive database of introduced species of spingtails and Jennie Whinam (Nature Conservation, Tasmania) and Dana Bergstrom (AAD), with Australian Quarantine Inspection Service, are identifying potential sources of introduced animals (such as spiders and snails) and weeds with regard to ANARE activities. Such studies are leading to changes in ANARE operations to minimise our impact on our precious Antarctic and subantarctic environments.

Dana Bergstrom, Biology Program, AAD

St Petersburg meeting reflects maturing of Protocol

A DECADE AFTER SIGNING THE ENVIRONMENTAL ('MADRID') Protocol, the structures and processes it put in place to protect Antarctic environmental values entered a new, more mature phase at the fourth meeting of the Committee for Environmental Protection in St Petersburg, Russia, in July.

There has been good intersessional progress on a number of important issues. Foreshadowing of a review of the Protocol's annexes, the meeting demonstrated that the Protocol's values are now well-integrated into the Treaty System.

Dr Tony Press, Director of the Australian Antarctic Division, Professor Michael Stoddart (Chief Scientist) and Tom Maggs (Head, Environmental Management and Audit Unit) attended the CEP meeting as part of the 24th Antarctic Treaty Consultative Meeting.

Adherence to the Protocol continues to grow, with ratification reported by the Ukraine and good progress by Canada – significant because Canadian ratification will broaden Antarctic Treaty influence over activities of ship-based tourist organisations, many of which are Canadian. Continuing work by intersessional contact groups (ICGs) on issues concerning environmental impact, protection of species, management plans and historic sites management was endorsed by the Committee.

Significantly, the Committee also decided to begin a rolling, broad-scale review of the Protocol's annexes, starting next year with Annex II, Conservation of Antarctic Fauna and Flora.

Environmental impact assessment

The Committee endorsed terms of reference for the Antarctic Environment Officers' Network (AEON) to

analyse initial environmental evaluations (IEE), to improve understanding and consistency between parties of IEE processes. Details of this project are available on the Web, under 'Environment' at <<http://www.comnap.aq>>. The Committee also established an ICG coordinated by the USA to look into cumulative environmental impacts, an issue which so far has eluded clear definition and an agreed process.

Conservation of Antarctic fauna and flora

The Protocol's Annex II provides for listing of specially protected species of mammals, birds and plants. An Argentine-led ICG was constituted in the 2000 CEP meeting to examine justification for this list, criteria for inclusion, and types and means of protection. It reported that the category is justified and recommended using International Union for the Conservation of Nature (IUCN) criteria for determining whether species were endangered.

The group was asked to consider:

- how the IUCN 'Red List' criteria could help identify species at risk;
- legal and practical mechanisms for protecting such species; and
- -whether specially protected status should apply to species other than mammals, birds and plants.

Australia coordinated an ICG on human-introduced disease in Antarctic wildlife and presented two working papers on the subject. Australia is now to collate information from other Parties on the practical prevention measures they take, and present a report to a forthcoming meeting.

Scullin Monolith, Mac.Robertson Land, AAT: a place of enormous environmental and ecological value, where Antarctic seabirds gather in millions to breed and raise their young, feeding mainly in the Prydz Bay region. The Madrid Protocol provides special protection for places such as this.



ROB EASTHER

Prevention of marine pollution

The CEP has a strong interest in draft guidelines for Antarctic shipping being prepared by the International Maritime Organisation. A group of experts was set up at the request of the 23rd ATCM and their work was discussed at St Petersburg under the agenda of Working Group II (operational matters). Many CEP members will contribute to further intersessional work on environmental aspects of the guidelines, to be reported to the 25th ATCM in September 2002.

Area protection and management

Annex V of the Protocol, covering area protection and management, will come into force when Recommendation XVI-10 is approved by all appropriate Parties. India reported that it hopes to have made positive progress by the next CEP meeting. All current Specially Protected Areas and Sites of Special Scientific Interest will become Antarctic Specially Protected Areas (ASPA) when Annex V comes into force. A new category, Antarctic Specially Managed Area (ASMA), will also be created.

Australia reported on progress to develop a management plan with China and Russia for an ASMA in the Larsemann Hills (100 km South of Davis station), with the intention to present a draft plan to CEP V.

The Committee referred several draft management plans to ICGs to look at them in detail and report to the next meeting. Citing the example of Parties' differing approaches to exclusion of poultry products from areas designated to protect bird values, Australia is seeking greater consistency between management plans on the protection of particular values. Other concerns were raised at the meeting about inconsistencies between the separation distances from wildlife specified for aircraft and vehicles. The Committee noted that its guidelines for preparing management plans may require review.

The United Kingdom will coordinate an ICG to review the Antarctic Historic Sites and Monuments list.

Australia has six sites listed under the Antarctic Treaty, and will review their status under domestic heritage legislation, as well as whether any non-ATS sites listed under Australian law should be added to the ATS list.

Australia will prepare for the CEP V a draft management plan for the Cape Denison historic site, which contains the huts and other relics of the 1911-14 Australasian Antarctic Expedition led by Douglas Mawson. Officers of the AAD have worked for several years with the AAP Mawson's Hut Foundation, the Australian Heritage Commission and others to finalise a conservation management plan for the site.

Environmental monitoring

The Committee received a report on the preparation by the Antarctic Environment Officers' Network of guidelines for developing environmental monitoring programs at Antarctic stations. The work will continue through 2002 with Australia's participation, and the AEON will present draft guidelines to next year's CEP meeting. Details of this work are available in the 'Environment' section of the COMNAP website at <<http://www.comnap.aq>>.

CEP officers

Australia congratulates the out-going vice chairs of the Committee, Ms Gillian Wratt of New Zealand and Ambassador Jorge Berguno of Chile, and warmly welcomes Mr Jose Maria (Tito) Acero of Argentina and Dr Joyce Jatko of the USA as their replacements. A new Chairman will be elected at CEP V to replace Dr Olav Orheim, whose second term as Chairman will expire at the end of that meeting.

The Committee's final report can be found at <http://cep.npolar.no/inhold/cep_archive/report_list.htm>.

*Tom Maggs, AAD Environmental Manager
and Australian CEP contact point.*

Research into the clean-up of tips at Casey and Wilkes

THROUGHOUT THE WORLD, ATTITUDES TOWARDS THE environment have changed markedly over the last thirty to forty years. Nowhere is this more obvious than in Antarctica. In the past, consistent with contemporary attitudes towards the environment, it was accepted practice to dispose of waste from Antarctic stations by dumping in convenient low-lying areas. Disposal also commonly involved pushing rubbish on to the sea-ice ('sea-icing') so that it would be dispersed as the ice broke up in summer. As a consequence, many

Analysis of soils, waters and marine sediments indicates that many polluting chemicals are present in quantities that exceed natural background levels.



IAN SNAPE

stations in Antarctica now have large abandoned waste disposal sites, some of which extend into the marine environment. Unfortunately the types of materials that were disposed of in this way are sources of contamination that are persistent in the environment. Although it is no longer accepted practice to dump waste in the Antarctic, and all Australian rubbish is now returned to Australia, contamination from old sites still spreads each year into environmentally sensitive areas where impacts can occur.

To begin the process of cleaning up the legacy of contamination in Antarctica, the Australian Antarctic Division has established a Contaminated Sites Taskforce to oversee the clean-up of abandoned waste disposal sites. Before clean-up can proceed, three key questions need answers:

- - What are the practical options for remediation of abandoned waste under Antarctic conditions?
- - What is the current impact of these sites?
- - How should we monitor to ensure that removal does not cause greater adverse environmental impact?



IAN SNAPE

Contaminants are mobilised by water that runs through waste disposal sites – to prevent this, we have established temporary channels to divert meltwater from the centre of the tip until the tip can be removed safely.

Together these questions are the focus of research by the Human Impacts Program at Casey station this year. Casey was chosen because it includes two old stations and their waste disposal sites – Wilkes (1957-69) and Old Casey (1969-88). One of our highest priorities is to clean up the abandoned station and waste at Wilkes. But before we do that we need to undertake research on a smaller scale to perfect our methods.

The Old Casey tip in Thala Valley has been chosen as a stepping stone in the lead up to Wilkes and other sites. It was chosen because the tip is relatively small (~2500 m³) and because it was disturbed during recent attempts to clean-up in 1995-1996. The site in Thala Valley will be used as a case study to investigate the processes of contaminant dispersal, remediation treatment design and performance, and chemical and biological monitoring. Research in Australia this year will focus on improving pilot-scale water treatment technologies that were tested in Antarctica in 2000-2001. These technologies aim to remove contaminants from snow that melts in the tip and that cannot otherwise be diverted. To complement this work, the field team at Casey will be developing chemical and biological monitoring techniques prior to the disturbance that will be associated with clean-up of Thala Valley – which is planned for 2002-2003. This will enable real-time feedback as the clean-up progresses and will help ensure that contaminants are not released into the environment when the tip is removed.

The process of cleaning up the tip will enable us to develop techniques in a controlled way before attempting much larger sites, such as those at Wilkes. A cautious approach is necessary to ensure that a well intentioned but poorly designed clean-up does not cause greater environmental impacts than leaving sites untouched.

Martin Riddle & Ian Snape, Human Impacts Research, AAD



IAN SNAPE

Biological investigations to look at the effects of contaminants on individual plants and animals and whole communities will be used as the basis for monitoring to ensure that clean-up does not accidentally create greater environmental harm, and for setting environmental standards that are appropriate for the special conditions of Antarctica.

Marine reserve proposed for Heard Island region

CONTINUED AND INCREASED PROTECTION OF THE environment and ecosystems in the Heard Island and McDonald Islands (HIMI) region is the aim of a government proposal to declare a new protected area in that isolated area of the Southern Ocean.

In January 2001 the Minister for the Environment and Heritage, Senator the Honorable Robert Hill, announced a proposal to establish a Commonwealth Reserve in the HIMI region, under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The proposed reserve would comprise around 76,000 square kilometres and include the World Heritage listed islands and associated territorial sea, plus several distinctive marine areas, extending in parts to the 200 nautical mile Exclusive Economic Zone (EEZ) boundary (see accompanying figure). A single management regime under the EPBC Act for the new reserve will replace the existing HIMI Wilderness Reserve management arrangements currently in place under the *Territory of Heard Island and McDonald Islands Environment Protection and Management Ordinance 1987*.

The purposes for declaring the reserve, which is proposed for designation as an IUCN Category Ia Strict Nature Reserve, are:

- to protect conservation values of the HIMI region, including the World Heritage and cultural values



EWAN MCVOR

of the terrestrial areas, unique and representative features of the marine environment, and the main foraging areas of land-based marine predators;

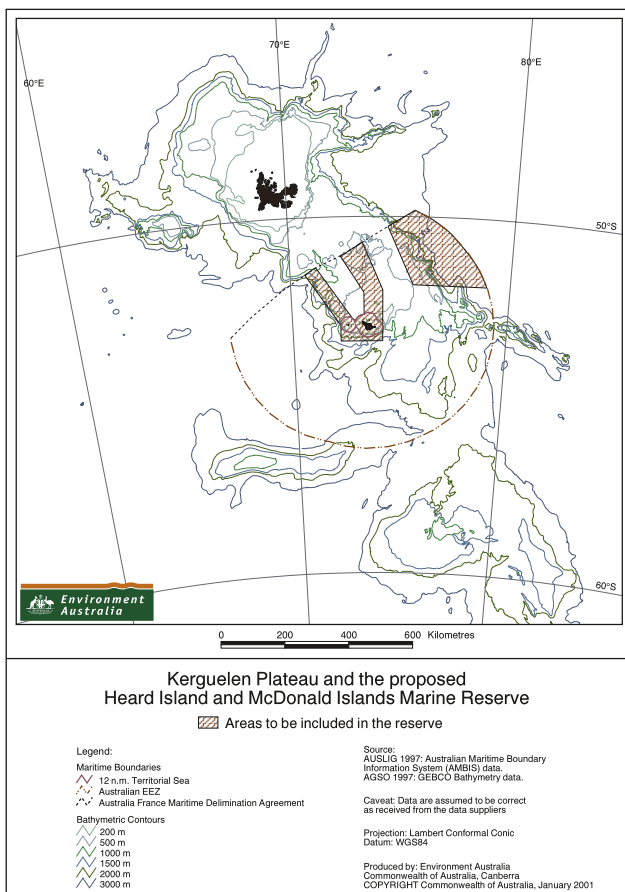
- to provide an effective conservation framework which will contribute to the integrated and ecologically sustainable management of the HIMI region as a whole;
- to provide a scientific reference area for the study of ecosystem function within the HIMI region; and
- to add representative examples of the HIMI EEZ to the National Representative System of Marine Protected Areas (NRSMPA).

Under the EPBC Act, a management plan must be prepared as soon as practicable after a Commonwealth Reserve is proclaimed. Until such times, all visitors to HIMI must continue to comply with the current *Heard Island Wilderness Reserve Management Plan*.

The Australian Antarctic Division will be responsible for preparing the management plan for the new Commonwealth Reserve, and for administering the reserve. The new plan will take into account further knowledge gained since the current plan was drafted, plus changes to reflect the subsequent World Heritage Listing and the subsequent Commonwealth environmental legislation (EPBC Act).

For further information regarding management of Heard Island and McDonald Islands, email <himi@aad.gov.au>.

Ewan McIvor, Environmental Management and Audit Unit, AAD



▶ Antarctica Online

HTML and PDF versions of the current *Heard Island Wilderness Reserve Management Plan* are available at the AAD Environment web page: <<http://www.aad.gov.au/environment/areaprotection/worldheritage/default.asp>>.

The Notice of Intent showing the proposed HIMI Marine Reserve and supporting information can be viewed at the Environment Australia Marine Protected Areas web page: <<http://www.environment.gov.au/marine/mpa/heard/index.html>>.

Heard Island treasure hunt

WE ARE ALL FAMILIAR WITH STORIES OF PIRATES, MYSTERIOUS MAPS AND BURIED treasure, but members of the Australian Antarctic Division and the Australian Archives have been searching for many months for clues to the whereabouts of the original Heard Island declaration, signed and buried in a canister on the island at Atlas Cove in 1947. The AAD intends to reinstate the declaration (or a facsimile of it) on the island and to include a copy in its historical records at Kingston.

The Australian Antarctic Division film archive contains footage of a group of men of the first ANARE standing by a flagpole erected in a tussocked mound as the declaration is read, inserted in a canister and buried beneath the flagpole. Members of the 2000–01 Atlas Cove summer party made a thorough search of the area and, though shifting volcanic sand has changed the topography, the original site of the flagpole was found. However there was no sign of the canister. Some word-of-mouth accounts hint that the declaration may have been dug up and souvenired from the mound soon after it was buried.

The declaration reads as follows:

Whereas in time past the sovereign rights of His Majesty in respect of Heard Island (lat 53° 10'S., long 73° 35'E.) and the McDonald Islands (lat 53° 05'S., long 72° 32'E.) have in divers manners been asserted and exercised:

AND WHEREAS His Majesty's Government in the Commonwealth of Australia has authorised me to organise on behalf of His Majesty's Government in the Commonwealth of Australia the effective occupation of these Islands:

Now therefore I, Stuart Alexander Caird Campbell, declare that His Majesty's Government in the Commonwealth of Australia intends forthwith to continue the occupation of these Islands and to administer them as Australian Territories.

Given under my hand at Heard Island where this record is deposited

(Signed) Stuart Campbell

Date 26/12 47

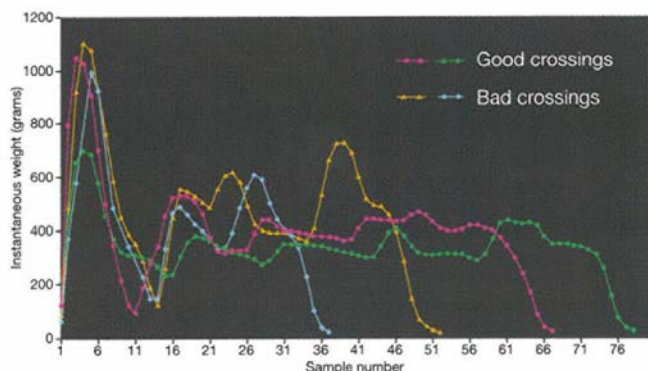
If you have any information about the declaration and its whereabouts or fate, please contact Tom Maggs at the Australian Antarctic Division, Channel Highway, Kingston, 7050 or email himi@aad.gov.au



AAD FILM ARCHIVE

from page 14

down of weights occurring as the animal steps on and off the weighing platform. This weight has a statistical relationship to the mass of the bird.



This figure shows four representative crossings of inbound birds. The best crossings are those which are taken at a leisurely pace, taking 2 seconds to cross the 600 mm wide platform. Quicker crossings reduce the number of instantaneous weights obtained and so decrease the accuracy.

The weighing system was calibrated by placing a series of static loads of known mass on the weighing platform. A regression coefficient – mass versus electronic output – was then calculated and stored. Dynamic calibration, which takes account of the weight of a moving animal, is achieved by experimental and statistical analysis. We have found that repeat weighings of a single bird give dynamic weights that are usually within five percent of each other. A comparison between weights obtained from the automated system and a clock face spring balance shows close agreement usually within the same range.

Occasionally however the weights taken for successive crossings of the same bird will vary widely. This is usually due to the speed at which a bird crosses the weigh bridge. The best crossings are those which are taken at a leisurely pace taking two seconds to cross the platform. Quicker crossings reduce the number of instantaneous weights obtained and so decrease the accuracy.

Knowles Kerry, AMLR program, AAD

Antarctic Treaty Parties meet in Russia

THE 40TH ANNIVERSARY OF THE ENTRY INTO FORCE OF THE Antarctic Treaty was marked with a meeting of the Treaty parties in St Petersburg in July. This was the 24th Antarctic Treaty Consultative Meeting (ATCM XXIV), and involved representatives from 26 of the 27 Consultative Parties, and nine of the non-consultative Parties. The Treaty's anniversary was given specific recognition in a declaration recording recent achievements of the Antarctic Treaty system.

Treaty secretariat to be established

One of the most significant outcomes of the meeting was the unanimous decision to establish a permanent secretariat for the Treaty in Argentina. This decision followed the welcome announcement by the United Kingdom delegation that it joined all other Treaty Parties in agreeing to locate the secretariat in Buenos Aires. The announcement opened the way for a long overdue improvement in the operation of the Antarctic Treaty.

Establishment of the Secretariat is expected to lead to immediate efficiencies in the way the Treaty conducts its business. The Antarctic Treaty is unique among international agreements of this stature in not having a permanent body to support its meetings and maintain its records. Since the adoption of the Madrid Protocol in 1991 the Treaty system has had an increasingly complex environmental agenda and a proliferation of working papers. The burden of holding the annual meetings accordingly increased substantially. The long-recognised need for a mechanism to assist with organising the annual consultative meetings and meetings of the Committee for Environmental Protection has become urgent, as has the need to manage the documents of the meetings.

Discussion on the merits of providing secretariat support commenced shortly after the 1961 entry into force of the Treaty, but consensus on its establishment was not possible. More recently, the differences were not so much about whether a secretariat was necessary, but on where it should be located. Agreement was reached in 1992 that a secretariat should be established, and although Argentina offered to host it in Buenos Aires consensus on locating it there was not immediately forthcoming. Other offers to host it were made from time to time, but none enjoyed complete support.

For those who are interested, Appendixes 2 and 3 of the report of the St Petersburg meeting record the statements from Argentina and the United Kingdom which provided the circumstances for consensus to be reached. Australia was amongst the first at the meeting to congratulate Argentina, and to thank the United Kingdom for its decision.

Establishment of the Secretariat will follow formal agreement to the legal provisions and other matters



ANDREW JACKSON

The Australian delegation to ATCM XXIV, St Petersburg, July 2001. From left: Warren Papworth (AAD), Andrew Jackson (AAD), Richard Roe (DEAT), Michael Bliss (DEAT), Professor Michael Stoddart (AAD), Dr Julia Green (IASOS), Dr Tony Press (Director AAD), Tom Maggs (AAD), Bill Bleathman (Tasmanian Government)

such as the funding and staffing arrangements for the organisation. These will be priority issues for the agenda of next year's ATCM.

Liability for environmental damage

The St Petersburg meeting also saw useful progress on the vexed question of developing rules for liability for environmental damage – an obligation arising from Article 16 of the Madrid Protocol. Although informal consultations were held in The Hague at the Special ATCM in September 2000, these were the first formal negotiations since the previous consultative meeting in 1999. Informal discussions (that is, without the benefit of interpretation into the Treaty's four languages) were held in Week 1 with the intention of exchanging views on recent developments, which included the revised text proposed by the US delegation and the draft text developed intersessionally by the Chair of the negotiations (Mr Don Mackay of New Zealand).

It was clear that some movement was possible, with those seeking negotiation of a regime which comprehensively addresses all possible circumstances of environmental harm prepared to come part way towards the position of those whose preference is for a regime only regulating response action in the case of environmental emergencies. Likewise, those preferring the latter approach indicated some willingness to engage

in a step-by-step approach which, over time, would provide for the development of rules addressing the broader concerns.

While the ultimate scope of the liability regime has not been settled, excellent progress was made on some of the issues which in the past have highlighted the differences of approach. Four such issues were examined in small open-ended contact groups: one addressing the definition of 'operator' and the associated jurisdictional problems (this group was chaired by Australia); another examined the scope of 'response action'; one looked at preventative measures; and a further group examined the meaning, in terms of a liability regime, of 'dependant and associated ecosystems'. The products of these small groups built on the so-called 'areas of convergence' identified during the previous negotiations in Lima.

COMNAP's contribution to the liability discussions, including in a joint working paper with SCAR aimed at providing practical advice, will continue between now and the next meeting.

Other developments

Since the last ATCM in 1999, Australia has been leading an inter-sessional contact group aimed at improving the way information exchange obligations under the Antarctic Treaty and the Madrid Protocol are satisfied. The St Petersburg meeting accepted the proposals from the contact group and agreed to rationalise the information which is exchanged, and to establish a centralised web site which will provide public access to the information. The site will be hosted by Argentina and its establishment will be supported by Australia.

In a complementary development, the Parties will also commence intersessional consultations on ways of improving the efficiency of the Treaty meetings themselves. This work will be coordinated by Germany.

Reports of inspections conducted under Article VII of the Antarctic Treaty and which examined a number of scientific stations in Antarctica indicated high levels of compliance with the Treaty and with the environmental obligations of the Madrid Protocol and its annexes.

A number of issues relating to tourism and private adventure expeditions were also discussed, with a particular focus on safety and self-sufficiency concerns. The Treaty parties have decided to include these issues as priorities for discussion at the next meeting.

An effective dialog between CCAMLR and the Antarctic Treaty was evident, including between the Committee for Environmental Protection and the CCAMLR Scientific Committee, for which Dr Tony Press (Australia) is the CEP's observer. Australia proposed that the ATCM support the work of CCAMLR in combating illegal, unreported and unregulated fishing and encourage implementation of the CCAMLR Catch Documentation Scheme. This was adopted as Resolution 1 of the ATCM.

The St Petersburg meeting was the first at which Estonia was represented since joining the Treaty. Estonia's accession takes the total number of Parties to 45. Also welcome was the announcement that Ukraine has acceded to the Madrid Protocol.

The next Consultative Meeting will be held in Poland, which has offered to host ATCM XXV in Warsaw from 3 to 14 September 2002. Further details of ATCM XXIV can be found in the report of the meeting at <http://www.24atcm.mid.ru/>.

*Andrew Jackson, Manager,
Antarctic Treaty and Government, AAD*

Treaty meeting looks at tourism



GRANT DIXON

The implications of the continuing growth and increasing diversity of Antarctic tourism were raised at the Antarctic Treaty Consultative Meeting in July. The discussion had been triggered by the recent experience of some Treaty Parties with private expeditions which had got into difficulties. A further stimulus came from the information papers submitted by IAATO (the International Association of Antarctic Tour Operators) and by ASOC (the Antarctic and Southern Ocean Coalition).

The safety and self-sufficiency of small adventure expeditions had been highlighted by a number of recent incidents in which expeditions had got into difficulties. In some cases search and rescue had to be provided to small adventure expeditions by national program operators, and other incidents involved damage to tour vessels during extreme sea conditions.

The Treaty Parties have raised a general concern about the potential disruption to research programs caused by non-government activities, and by the lack of adequate insurance in some instances. Concerns have also been raised about potential environmental consequences, including the risks of cumulative impacts in the absence of good monitoring programs.

IAATO reported to the meeting that it had recently changed its criteria for membership and would now accept operators of vessels carrying more than 400 tourists, provided those vessels do not land passengers in Antarctica. IAATO's figures indicate that overall tourism numbers in 2000-01 were slightly down on the previous year (which were possibly inflated by 'millennium' events). However, it is clear that the industry is continuing generally to grow and diversify. ASOC raised a number of questions about the conduct and management of private sector activities.

Recognising the importance of ensuring tourism and other non-government activities in the Antarctic are properly managed, the St Petersburg meeting decided that the matter should be subject to detailed discussion at the Treaty meeting in 2002.

Casey and the Antarctic Treaty negotiations

RICHARD GARDINER CASEY, AUSTRALIAN MINISTER FOR External Affairs from April 1951 to January 1960, is widely reputed to have played a prominent role in the diplomatic negotiations that led to the Antarctic Treaty of 1959. What was his actual role in these negotiations?

The formal negotiation of the Antarctic Treaty lasted for 18 months and took two forms. Firstly, representatives of 12 countries whose scientists had taken part in the Antarctic program of the International Geophysical Year of 1957–58 met in a series of 60 meetings in Washington, DC, between June 1958 and October 1959 to set up procedural arrangements and a framework for discussion. Secondly, a full-scale diplomatic conference began on 15 October 1959 and concluded with the signing of the Antarctic Treaty on 1 December 1959.

Casey did not attend the preparatory meetings, where Australia was represented mostly by Malcolm Booker, a senior officer at the Australian Embassy in Washington. Nor was he keen to attend the conference. He suggested to Prime Minister Robert Menzies that the Attorney-General, Garfield Barwick, should lead the delegation, but Menzies wanted Casey in charge, so that was it.

In the days prior to the conference Casey was active – in his own words, ‘rolling the pitch’ for what was to follow. The documentary record shows, however, that during his 23 days at the conference he did not play a *major* role in shaping the provisions of the Treaty or in overcoming any of the obstacles on the path toward agreement. He departed early, on 6 November, replaced as Head of Delegation by Howard Beale, Australian Ambassador in Washington.



ALAN CAMPBELL-DRURY

So whence comes Casey’s reputation as a significant player? The answer lies not in Washington at the conference but in Broadbeach, Queensland, eight months earlier, where in March 1959 he attended an international conference of the Economic Commission for Asia and the Far East. At this particular time, the Washington preparatory meetings had hit a serious snag.

A major sticking point had arisen over draft article IV of the proposed treaty, dealing with disputed Antarctic claims and rights. The draft article provided for the ‘freezing’ of the legal status quo – a provision seen to be at the very core of the draft treaty. This appeared to be acceptable to 11 of the 12 countries participating, but the Soviet Union was implacably opposed to it, seeking to deal with the the dispute over Antarctic claims and rights separately – perhaps at a later conference.

At the Broadbeach conference, Casey had a private conversation with the leader of the Soviet delegation, Deputy Foreign Minister Nicolai Firubin. The discussion was mainly about the mutual reinstatement of their country’s embassies in Moscow and Canberra following the suspension of formal diplomatic relations over the alleged Petrov spy affair in 1954, but Casey also raised the difficulty over draft article IV in the Antarctic preparatory meetings. Here and in a following letter, he set out to convince Firubin of the value of the draft provision and the folly of the Soviet Union’s position.

By the end of April, 1958, it was clear in Washington at the preparatory meetings that Casey had succeeded in his quest. He had persuaded the Soviet government to change its position on draft article IV, later confirmed in a letter from Firubin to Casey. And from this time, Soviet participation at the preparatory meetings became active and flexible, in stark contrast to its earlier perceived intransigence.



ALAN CAMPBELL-DRURY

Casey’s farewell speech for departure of *Kista Dan*, Port Melbourne, December 1954. Others are (l to r) Captain Hans Petersen, Phillip Law (Voyage Leader and Director, Antarctic Division) and John Béchervaise (Mawson Officer-in-Charge, 1955)

Captain J K Davis and Major R G Casey on board the Discovery in 1929.

In sum, Casey's general contribution to the formal negotiation of the Antarctic Treaty was constructive but limited. But his role in March 1959 in persuading the Soviet Union about the merit of draft article IV – thereby breaching a serious impasse at the preparatory meetings – was clearly very important. Indeed, the substance of this draft provision remains today as the 'keystone' of the Antarctic Treaty. This breakthrough did not happen at the negotiations in Washington, but half-way around the world from there at Broadbeach, Queensland, when Casey met the Soviet Deputy Foreign Minister Firubin.

*Robert Hall, School of Government,
University of Tasmania*



PROBABLY FRANK HURLEY

Assessing influence within the Antarctic Treaty System

THE FIRST OF THE GOVERNMENT'S GOALS FOR THE Australian Antarctic program is 'to maintain the Antarctic Treaty System and enhance Australia's influence within the system'. But what is influence and how is it achieved? This question is the focus of a major research project within the Law, Policy and International Relations Program of the Antarctic Cooperative Research Centre (Antarctic CRC). It is being undertaken in conjunction with the Australian Antarctic Division.

Australia and the Antarctic Treaty System

As an original signatory to the Treaty, Australia has played a significant part in the development of the Antarctic Treaty System (ATS). We were instrumental in negotiating the Treaty and, twenty years later, in the establishment of the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR). The conclusion of the Madrid Protocol in 1991 was also a direct result of Australia's influence within the ATS.

Australia's influence needs to be measured against changes within and outside the ATS. The increase in consultative parties and the demands of the CCAMLR Commission and the Committee on Environmental Protection (CEP) established under the Madrid Protocol, illustrate the scope of change within the system.

Influence within the ATS is more than 'diplomatic clout' measured by success in establishing international instruments. Australia's longstanding commitment to Antarctic science is another area of influence, the importance of which is recognised in the Treaty and in the Protocol. The Australian Government's Foresight report in 1997-98 recognised the linkage between our commitment to the ATS and the significance of longstanding scientific programs. This report emphasised that 'Australia should enhance its influence in Antarctic matters through its lead role in Antarctic science and through its leadership in the Antarctic Treaty System'.

Influence

Exploring influence is a challenge. Significant practical and theoretical issues complicate measurement of influence, and assessing influence within international regimes is difficult as processes and outcomes are generally less 'visible', and effort is not clearly linked to immediate outcomes.

The considerable diplomatic and scientific effort expended over time on Antarctic issues clearly contributes to 'influence'. Reputations for excellence in science or commitments to the system are distinct assets. Presence 'at the table', whether at Antarctic Treaty Consultative Meetings or in scientific working groups, provide further opportunities to influence outcomes, particularly where decision making is based on consensus. The skills and abilities of individuals may also be critical. There are good examples of this from Australia in the development of the Madrid Protocol, the negotiation of the Antarctic Treaty and the development of CCAMLR.

Influence in the Antarctic Treaty System

The research project aims to explore national influence within the ATS at a period in which the ATS itself is undergoing change. The entry into force of the Madrid Protocol in 1998 instituted the CEP. As the CEP evolves its role within the ATS raises a number of important research questions about the relationship between itself and other institutions within the system, particularly SCAR and COMNAP, in relation to advice to the ATCM.

A focus of the research project is the examination of the nexus between national interests and the ongoing development of the ATS, and the influence exerted by individual States. The research is directed at measuring influence and identifying ways in which it is maximised.

*Marcus Howard, Law, Policy and International Relations
Program, IASOS & Antarctic CRC*

Another one that didn't get away!

IN MAY THIS YEAR CONSIDERABLE MEDIA ATTENTION WAS given to the interception, in a remote corner of the Southern Ocean, of an unknown foreign fishing vessel suspected of illegal fishing in Australian waters around Heard Island.

On 12 April 2001 the Togo-flagged *South Tomi* was boarded by defence personnel and fisheries officers, after pursuing the vessel 6,100 km across the Southern Indian Ocean. It was carrying a haul of toothfish worth \$1.5 million.

Australia has sovereignty over a 200 nm Exclusive Economic Zone around Heard Island. In late 1997 and early 1998 three vessels were apprehended by the frigates HMAS *ANZAC* and HMAS *Newcastle*. Following these encounters the Government funded further patrols using civil and defence resources and since 1998 these have formed a critical part of combating illegal fishing in the region.

On 29 March the civilian patrol vessel *Southern Supporter* challenged the *South Tomi* which was suspected of fishing illegally. The vessel initially obeyed an order

to sail to Fremantle, over 4,000 kilometres north-east, but once outside Australian waters turned north-west. *Southern Supporter* commenced a hot pursuit lasting 14 days.

As *South Tomi's* ultimate destination was not clear, France and South Africa – which have interests in the area – were contacted. Both offered assistance and as *South Tomi* headed for the Atlantic, South Africa's President approved Cape Town as a base for an interception. Australian personnel flew to Cape Town to join South African navy vessels. *South Tomi* was boarded on the high seas 320 nm south of Cape Town and then, accompanied by *Southern Supporter*, steamed 8,500 km to Fremantle arriving on 5 May.

Since returning to Australia *South Tomi's* master has been charged with offences related to fishing illegally and disobeying the direction of a fisheries officer. The master has pleaded guilty to the illegal fishing charges and the other charge has been dismissed. Sentencing is expected on 11 October.

Australian authorities will seek to recover the costs



PETER BOYER



The Southern Supporter (right) escorts the South Tomi to Fremantle.

of the chase, including monies paid to South Africa, and establish who are the beneficial owners of the *South Tomi*.

The *South Tomi* incident is notable for the outstanding cooperation from other countries and the logistics involved. It is a graphic example of the strong commitment to combating illegal fishing by Australia and other parties to CCAMLR.

Despite the detention of the *South Tomi* and many arrests of foreign vessels by France, the risk of further

illegal fishing in the region remains high. Australia will continue to work in CCAMLR and in other forums to implement effective measures to combat illegal, unreported and unregulated fishing in the CCAMLR waters.

Ian Hay, *Antarctic Treaty and Government, AAD*

'Hot pursuit' – more than a cliché

'Hot pursuit' is not a catchy phrase invented by a journalist to invoke a sense of high drama, it has a legal meaning within the UN Convention on the Law of the Sea. The right to undertake 'hot pursuit' is detailed in Article 111 which provides that 'the hot pursuit of a foreign ship may be undertaken when the competent authorities of the coastal State have good reason to believe that the ship has violated laws and regulations of that State.' Article 111 requires that the offending vessel be ordered to stop, that the pursuit not be interrupted and only conducted by warships, military aircraft, or other ships or aircraft clearly marked and identifiable as being on government service and authorised to that effect.

A history of the Patagonian toothfish fishery

TODAY THE PATAGONIAN TOOTHFISH (*Dissostichus eleginoides*) is the most valuable fishery in Antarctic or subantarctic waters. Prices can exceed \$US10 per kilo for headed, gutted and tailed fish in the main markets in Japan and the United States. Unlike nearly all other Antarctic fish, the toothfish can grow to a large size (just over 2 m long and 100 kg in weight) and this, together with its high quality white flesh and few bones, make it highly sought after – particularly given the growing scarcity of other premium-quality species from around the world.

This has led in the last few years to a large-scale illegal fishery, which attempts to poach fish from the major areas of distribution of the toothfish around the subantarctic islands and other submarine ridges in the Atlantic and Indian Ocean sectors of the Southern Ocean. Large numbers of vessels fishing illegally were first noticed in 1996 in the western part of the Indian Ocean, but they soon spread eastwards towards Kerguelen and Heard Islands where they were seen by Australian and French licenced vessels in 1997. Although difficult to estimate reliably, it is thought that



DICK WILLIAMS

illegal catches were very high in these first couple of years – possibly two to three times the legal catch of this species from all sources – and probably caused a significant depletion of the fish stock in some localities. As a result of surveillance and arrests by some countries, including Australia, illegal fishing has declined. It still however

remains a serious problem, with illegal catches being similar to the level of legal catches in the 1999–2000 season.

Since the start of fishing activity in subantarctic waters in the early 1970s, toothfish had been a minor bycatch species in the trawl fisheries for marbled rock cod and grey rock cod, particularly around South Georgia and the Kerguelen Islands. It was only in 1985 that commercial quantities of toothfish were discovered at Kerguelen. There had, however, been a substantial fishery off the Chilean coast since the mid-1970s, so markets were already established for this species. Since then, the fishery for this species developed rapidly and expanded to other areas, including South Georgia, Marion and Prince Edward Islands, and Crozet Islands. In 1994 an Australian trawl fishery began at Macquarie Island, followed by Heard Island in 1997. Although started as a trawl fishery, most toothfish is now caught by longline, except for the Australian fishery and part of the French fishery at Kerguelen. In the 1999–2000 season, approximately 14,500 tonnes were caught in the subantarctic waters managed by CCAMLR and a further 11,500 tonnes were taken outside CCAMLR waters off Chile, Argentina and the Falkland Islands.

Patagonian toothfish is now known to occur throughout the southern hemisphere in cool temperate and subantarctic waters, from the east and west coasts of South America eastwards through all of the subAntarctic islands, submarine plateaus and seamounts to the Campbell Plateau south of New Zealand in waters from 300 m to over 2000 m depth. It probably also occurs in the Pacific sector, but little exploration has been done there. It is replaced in the high latitudes close to the coast of Antarctica by its close relation, the Antarctic toothfish (*Dissostichus mawsoni*), for which a fishery is currently being developed.

About Patagonian toothfish



DICK WILLIAMS

PATAGONIAN TOOTHFISH ARE CAUGHT CLOSE TO THE sea bed and most fishing occurs between 400 m and 1500 m depth. They are large, active, predatory fish that feed mostly in the water column on squid and fish, but they have a very varied diet that can include bottom-living organisms such as crabs and prawns. Studies on their age and growth are not yet conclusive, but it appears that they can live at least 45 years, with males maturing at about 10 years and females at about 12 years. Spawning is thought to take place in winter (June–July) in depths of at least 1500 m. Young stages spend some months at least in surface waters before moving to the sea bed where they appear to move deeper as they grow. Tagging experiments suggest, surprisingly for such an apparently active large species, that fish generally do not move more than a few tens of miles over a period of several years. Recently, however, there have been two instances of tagged fish recaptured at different islands several hundred miles from their tagging position, so the extent to which fish interchange between different fishing grounds is not yet resolved.

CCAMLR meetings address critical issues

THE ANNUAL MEETING OF THE CCAMLR SCIENTIFIC Committee's Working Group on Ecosystem Monitoring and Management (WG-EMM) took place in Fiskebäckskil, Sweden from 2 to 13 July 2001. Drs Andrew Constable and Steve Nicol from the AAD's Antarctic Marine Living Resources Program attended the meeting. Progress was made on a number of fronts but the most significant development was the identification of a long-term program of work for the Group. The following were identified as priorities:

- - The identification of small-scale management units
 - breaking down the krill catch limits into smaller, more ecologically relevant, areas.
- - A review of the utility of CCAMLR's ecosystem monitoring program (CEMP) – how do you translate changes in the populations of krill predators into

management advice?

- - The development of predator-krill-environment models and fishery-krill-environment models.

A workshop on the small-scale management units was scheduled for the 2002 Working Group meeting and one on the utility of CEMP was scheduled for the 2003 Working Group meeting.

The annual meeting of the CCAMLR Scientific Committee's Working Group on Fish Stock Assessment (WG-FSA) will take place in Hobart from 8 to 17 October 2001. WG-FSA will provide advice on critical issues such as management of new and exploratory fisheries, annual catch limits in established fisheries and seabird bycatch.

The annual meeting of the Commission for the Conservation of Antarctic Marine Living Resources will be in Hobart from 22 October to 2 November 2001.

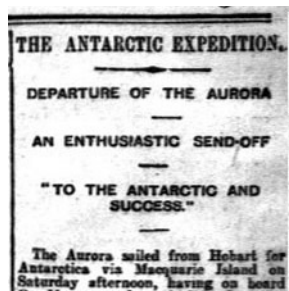
NINETY YEARS AGO

"The *Aurora* sailed from Hobart for Antarctica via Macquarie Island on Saturday afternoon, having on board Dr Mawson and nearly half the members of the Australasian Antarctic Expedition, the scientific instruments, and wireless telegraphy equipment, a large quantity of stores of all kinds, provisions, clothing, sledges, 266 tons of coal, etc. She is to proceed direct to Macquarie Island, where the party which is to remain on the island will be landed, and there she is to meet the *s.s. Toroa*, which has been chartered to take down the remaining members of the party, stores, and supplies, and will probably leave Hobart on Thursday.

Public interest in the expedition has been steadily increasing as the time for the *Aurora's* departure drew on, and an immense crowd assembled to see the vessel leave the port on Saturday. The Queen's Pier, at which she was lying, was densely packed with people, while a large number took up their station on the *s.s. Westralia* – lying at the King's Pier opposite – and on the end of the King's Pier. The other wharves had their quota of interested spectators, and a large number of people watched the start from the Esplanade and the reserve above it. The crowd on the side of the pier alongside the *Aurora* grew so dense as the time fixed for the vessel's departure drew near that it looked as if some of them would provide a sensation by being pushed over the edge. Fortunately everything passed off without mishap.

His Excellency the Governor and Lady Barron (attended by Major Cadell, A.D.C.), came down to the pier to say au revoir to Dr Mawson, Captain Davis, and the other members of the expedition. They were accompanied by the Master Warden (Hon. W.H. Burgess) and the secretary (Mr. J. Adams) of the Hobart Marine Board, and afterwards went as far as Long Point with the *Aurora* in the Marine Board's motor-launch *Egeria*.

The *Aurora*, with all her cargo on board, was well down in the water, and had such a quantity of deck cargo, composed of timber of various shapes and kinds, the aeroplane body in its case, the motor-boat, sledges, cases of benzine, boxes of various kinds, and miscellaneous oddments, so disposed in all available spaces that it was a somewhat difficult matter to get about the deck. On the after-deck, with their feet securely tied, were two live sheep, and a third was snugly stowed away in the motor-boat, with a little hay to console him. A large number of shore



visitors (including a noticeable proportion of Naval Reserve lads) were still on board when the hour fixed for the vessel to leave (4 o'clock) drew near. A false alarm was given a little before that by the *Aurora* pulling out a little from the wharf, and there was a considerable exodus, several elderly gentlemen displaying unexpected agility in order to avoid any possibility of being made involuntary passengers to Antarctica, or even to Macquarie Island. The *Aurora* was not starting on that occasion, but shortly afterwards, punctual to the hour arranged, the casting off of the lines was begun, and the word, "All visitors on shore" was passed along.

Hearty cheers were given by those on shore as the vessel drew away, and these were answered by the occupants of the *Aurora*, while there was much waving of hats and handkerchiefs. Cameras were busy in all directions, and the cinematographs were not idle, so that the memory of the departure of

the first Australasian Antarctic Expedition from Hobart should not be lost as long as pictorial records can preserve it. Occupying a prominent position on the *Aurora's* rigging was a signboard, with a finger pointing ahead, supplied by the Tasmanian Tourist Association, bearing the words "To the Antarctic and Success." The idea that the expedition is making an attempt on the South Pole seemed, however, to be still present in the minds of some of those on the pier, to judge by the remarks heard as the vessel began to draw away, and such encouraging shouts as, "I hope you will bring back the Pole," were heard.

The members of the expedition who sailed in the *Aurora* on Saturday were: Dr Mawson, Messrs F. Wild, W.H. Hannan, E. Webb, C.T. Harrison, A.L. Kennedy, Hurley, Bickerton, Ninnis, Watson, Madigan, Ainsworth, Hodgeman, and Dr McLean. Captain J.K. Davis is in command of the *Aurora*, and has with him the following officers:- Chief Officer, Mr F. Toutcher; second officer, Mr F. Gray; third officer, Mr De La Motte; chief engineer, Mr Gillies; second engineer, Mr. Comer. The *Aurora* carries a crew of 25 all told, and most of the members of the crew were shipped in Hobart."

From 'The Mercury',
4 December 1911, pp5-6.



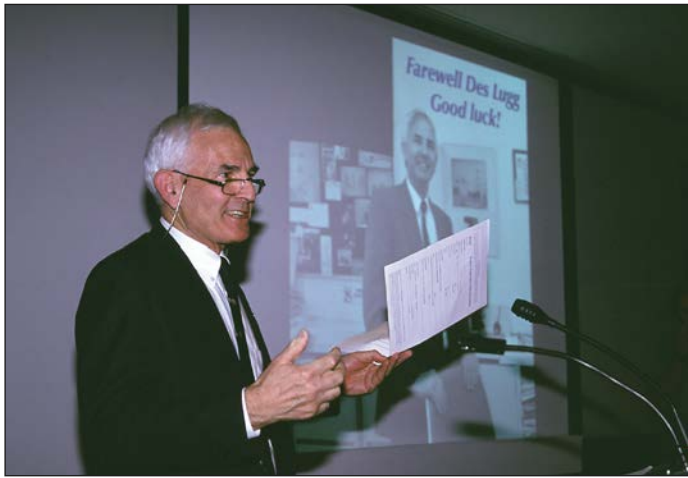
The Aurora leaves Hobart on 2 December 1911, headed 'To the Antarctic and Success'.

PHOTO COURTESY ARCHIVES OFFICE OF TASMANIA

Retirements

Distinguished Antarctic veteran 'retires' to take NASA post

WAYNE PAPPS



Des Lugg reminisces at his farewell function at the Australian Antarctic Division.

Over three decades in charge of Australia's Antarctic medical program came to an end on 1 June 2001 when Dr Des Lugg left the Australian Antarctic Division to take up a prestigious position with the US National Aeronautics and Space Administration (NASA). The move ended an Antarctic career which began in 1962 with Des's posting to Davis as station medical officer. He became head of polar medicine at the Australian Antarctic Division in 1968, a position he has held until this year.

The Minister for the Environment and Heritage, Senator Robert Hill, paid tribute to Des for his distinguished career with the Australian Antarctic Division and wished him well in his new career with NASA. 'Dr Lugg's contribution to Antarctic medicine is unsurpassed, meeting the continuing challenges presented by Antarctic isolation and natural conditions as well as the changing demands of new technology, new programs and new social conditions,' Senator Hill said.

For the past 10 years the focus of Des's research has been on the analogy between living in Antarctica and long duration space flight, a link which he will be able to develop in his new work with NASA. Des was awarded the Polar Medal in 1969, and became a Member of the Order of Australia in 1984.

Des considers the great advances in communications technology and the social changes to Antarctic expeditions, notably the increasing numbers of women travelling south, as the major developments during his time with the AAD. He said that despite the improved communications enabling better 'tele-medicine', Antarctica is as difficult and dangerous a place today as it was in the time of Scott and Mawson.

'Antarctica will always be special to me, even though I came with jet-black hair and look what it has done to me,' Des said at his farewell from the AAD on 1 June. 'Antarctica is not metropolitan Australia. It is a special

place and we must look after it and continue to bend our wills to keep it that way.'

'It's the people who have left the great imprint with me. You cannot imagine what all that support and the little kindnesses have meant in cancelling

out the bits one forgets or suppresses.' he told AAD staff. 'You work for a great organisation whose potential I believe has never been totally tapped. You have a rosy future if you are prepared to take your future into your own hands and work together.'

When Des began ANARE service in 1962, Antarctic medicine was 'a one-man band with little money and equipment'. He led the battle to provide expeditioners with the

best medical services possible, as well as to establish medical research on an equal footing with other disciplines. His success in this is emphasised by his appointment to a Visiting Professorship at the University of Texas Medical Branch (UTMB), based in Texas, and ultimately as Chief of NASA's Medicine of Extreme Environments department, based at NASA Headquarters in Washington DC. Des left Australia in late September for his new life in the United States.

Green pastures and white horizons

With the recent departure of Martin Betts the Australian Antarctic Division farewelled one of its longest serving staff members. When he left on 2 May 2001 he reached another milestone in what is to date a 33 year association with the ANARE.

Martin's Antarctic career began in 1968 when he arrived on Macquarie Island as an observer with the Bureau of Meteorology for the first of his two Antarctic winters. After spending 1969 on the Island he headed further south to winter at Mawson in 1971. By this time the ice was well and truly in his blood and calling him back for more.

His prominence in the life of ANARE became established in 1974 as editor of *Aurora*, the journal of the ANARE Club – a position he held until 1981. During this period he secured a permanent appointment in 1977 at the Australian Antarctic Division as the Publications Officer. As media spokesperson and editor he was instrumental in developing the public profile

of the expeditions and, in 1981, further consolidated his role in public affairs with promotion to the position now known as Information Services Manager. In May that year he produced the inaugural issue of *ANARE News*, the forerunner of *Australian Antarctic Magazine*.

Martin's next substantial career move was in 1986 to the position of ANARE Coordinator, head of the then new planning group which, among other things, integrated the planning of the scientific work of the Australian program, coordinated development of the shipping schedules and administered the ASAC Research Grants scheme.

From 1996 until he left the AAD, Martin was a senior policy officer and took the lead in developing relationships with non-government operators in the Antarctic and in ensuring that environmental and other obligations were fully implemented by private visitors to the Antarctic. He was also responsible for providing advice on the growth of the tourism and adventure markets, and established the bi-weekly internet newsletter ANAN which reports to a world-wide audience on non-government activity in Antarctica.

Along with these sustained contributions to ANARE and the AAD, Martin's great passion was the Antarctic itself and opportunities for personal involvement in expedition work. Between 1977 and 2001, Martin was Leader on 12 voyages and Deputy Leader on five. He was also a Field Leader on four occasions, and made other visits to the Antarctic including on Macquarie Island airdrops and as an observer on tourist over flights. There are few places in the Australian area of Antarctic interests that he has not seen at first hand. In 1988 Martin was awarded the Australian Antarctic Medal in recognition of his contribution in Antarctica.

The reader will note that there has been no reference to his retirement. Ice still runs in Martin's veins. While he has left to pursue his interests in farming beef cattle, he is maintaining strong links with Antarctica and the AAD. In his 'retirement' he continues to assist the AAD by researching and writing material for ANAN, and has recently been contracted to be Leader on *Aurora Australis* for its October voyage to Macquarie Island and Casey.



Senator Ian McDonald (at the time Parliamentary Secretary responsible for Australia's Antarctic Program) congratulates Martin Betts on his Australian Antarctic Medal award.

GLENN JACOBSON

In brief...



New stamps celebrate anniversary

Australia Post has issued a set of 20 new Australian Antarctic Territory stamps to mark an important anniversary for Australia's Antarctic program. 2001 is the 50th birthday of the ANARE Club, founded in 1951 to provide a forum and network for all those who travelled south with Australian National Antarctic Research Expeditions (ANARE). The stamps commemorate a century of Australian achievement in the Antarctic, beginning with the first mainland wintering party of 1898-1900, through Douglas Mawson's expeditions of 1911-1914 and 1929-1931 to the modern ANARE era with a continuing Australian government program. While each stamp tells its own story, it is also a part of a continuing narrative across the century. For the first time on Australian stamps, text explaining each image is printed on the back of the stamps.



The AAD photographic exhibition marking the 40th anniversary of the first Antarctic Treaty meeting is hung in Parliament House, Canberra.

Antarctic exhibitions attract thousands

The Australian Antarctic Division staged a photographic exhibition in Canberra's Parliament House to mark the anniversary of the first Antarctic Treaty meeting held in Canberra in 1961. The exhibition was held in the Presiding Officers' Gallery from 28 April to 30 May and featured the images taken by Australian expedition-photographers.

The AAD also participated in the annual Australian Science Festival at the National Convention Centre in Canberra from 1 to 5 May. The Science Festival aims

to promote science and technology to society through exhibitions, films, workshops and keynote talks. Professor Michael Stoddart, ANARE Chief Scientist, and Dr Stephen Nicol, Antarctic Marine Living Resources (AMLR) Program Leader, gave lectures on Australian research programs in the Antarctic, and Rob King from the AAD's AMLR program organised an interactive display, including a live krill aquarium, that attracted about 40,000 visitors over the five days.



Dr Colin Southwell of the AAD demonstrates 'QuickTime-VR' tours of Antarctica at the Australian Science Festival in Canberra.

The AAD's travelling exhibition "Beyond the Ice", a fresh look at Antarctic science and the big questions it seeks to answer, continues its tour of rural and regional Australia. Now 18 months into its program, the APEX-hosted exhibition is currently in Lithgow, NSW, along with the NSW State Library's travelling exhibition on the photography of Frank Hurley.

Six honoured in Australian Antarctic Medal award

Distinguished service by six Antarctic expeditioners has been honoured in this year's award of the Australian Antarctic Medal. Contributions in field glaciology, telecommunications, logistics, engineering and community leadership and service have been recognised in the award, announced by the Governor-General, His Excellency the Honourable Sir William Deane AC, KBE, on 21 June 2001.

This year's Medal awards – part of the traditional Antarctic celebration of Midwinter – have gone to:

- Alan Elcheikh, of South Hobart, Tasmania, for an outstanding and sustained contribution to Australia's glaciology program over ten years;
- Dr Joe Johnson, of Garran, ACT, for distinguished service as station leader at Casey and Davis and his contribution to feasibility studies for an Antarctic air transport system;
- Dale Allan Main, of Yarramalong, New South Wales, for distinguished service in telecommunications and scientific collecting in Antarctica and at Macquarie and Heard Islands;
- Ian John McLean, of West Footscray, Victoria, for outstanding support to scientific field workers and station communities;
- Peter Sprunk, of Miriam Vale, Queensland, for his outstanding effort and innovation in support of scientific fieldwork and station communities; and
- Michael Stone, of Wundowie, Western Australia, for distinguished service in managing fuel supplies and helping maintain station morale during a difficult year at Casey in 1999.

'Just tell them I survived'

"Just tell them I survived", a book that celebrates women's participation in national and private expeditions to Antarctica, was launched at the Australian Antarctic Division on 4 May. Author Robin Burns (pictured) based this comprehensive account of women in Antarctic expeditions on 130 interviews with women from many different backgrounds, from the first women scientists to visit Macquarie Island in 1959, right through to contemporary 'winterers'. Robin is Senior Lecturer in Education at La Trobe University and her research has previously been in areas of women's issues and the sociology of knowledge and learning. In 1995 she received a ASAC grant for Antarctic fieldwork, and has been concentrating on this area since then.

(Allen & Unwin, rrp \$24.95, ISBN 1865083828)



Robin Burns at the launch of her book, 'Just tell them I survived'.

Antarctic environmental approvals

Anyone planning to visit the Antarctic or subantarctic should be aware of relevant national and state environmental protection measures. On the AAD website at <http://www.antdiv.gov.au/environment/permits/default.asp> can be found information about permit and environmental protection requirements under Australian law. The information is mainly for research scientists, but also informs non-government visitors on their obligations. Activities needing a permit include entering a protected area or the Territory of Heard Island and McDonald Islands, using a helicopter, disturbing seabirds or marine mammals, interfering with listed species, collecting or sampling biological and geological specimens, using weapons and importing and exporting specimens. Some permits cannot be granted unless the activity has been subject to an environmental impacts assessment (EIA) and authorised.

The web-based information complements other related Commonwealth and State departmental websites such as Environment Australia, Australian Quarantine Inspection Service and Tasmanian Parks & Wildlife Service (who manages visits to subantarctic Macquarie Island). Links to these related websites have been provided.

Energy-efficient refrigeration wins engineering award

Keeping food fresh in the Antarctic is harder than it might seem, but an invention by Australian Antarctic Division engineers has made it that much easier while making the refrigeration process more energy-efficient. A new 'Coldpump' cold-store system now in use at Mawson station, 5462 km southwest of Hobart, has been given the top award in its category in the Institution of Engineers Australia's Tasmanian Engineering Excellence Awards for 2001.

The Coldpump system has markedly improved the taste and freshness of vegetables, fruit and dairy products kept in storage for long periods.

Food storage is a critical aspect of maintaining year-round stations in Antarctica. With ship visits to stations suspended for up to nine months through the non-summer period, food must be kept for a very long time. At this time of year, outside temperatures fall to well below zero.

AAD engineer Murray Price was faced with the challenge of developing storage conditions that improved the taste of food towards the end of the storage period while reducing the demand on energy. Energy to drive refrigeration plants is currently provided by diesel-powered generators – to be largely replaced in a few years by wind-generated power.

Murray knew that perishable foods can be stored safely for long periods only at precise temperatures and at a high relative humidity. Putting aside conventional refrigeration compressors and gas, he looked for a system that could draw directly on cold outside air to cool stored food.

The new system comprises external radiators and a system of pipework, pumps and valves which expose coolant (a glycol-water mix) to low external temperatures then deliver it to coil units inside the coldstore to regulate the internal temperature.

On the relatively rare occasions when external temperatures rise too high to maintain the desired storage temperature, a standard compressor-driven refrigeration plant is brought into play.

New hydroponics facilities for Australia's Antarctic stations

A new hydroponics unit was installed at Casey station in the 2000–01 summer. Casey was the first Antarctic station to receive a purpose-built hydroponics facility, which offers the latest technology and a much-needed increase in growing space. Two insulated 20-foot shipping containers were joined together and the interior lined with stainless steel to provide an easy to clean surface. The unit is entered through a cold porch, which provides protection for the growing rooms and space for general storage and outdoor clothing. It was assembled in Hobart, and shipped to Casey early last summer for fit-out by the summer trades group.

Ray Paul from Access Hydroponics in Melbourne designed, supplied and documented the unit. Ray (Mawson plumber 1995) was involved in setting up for hydroponics at Mawson in 1995. He has also

trained ANARE expeditioners in hydroponics techniques and supplied station units for the past few years, all useful experience for designing the new facility. He has designed a similar unit for Davis station, which is due for installation this summer. It incorporates minor modifications, based on Casey's experience this year.



Cameron McHale in the hydroponics unit at Casey tends his tomato crop, with silver beet on the table behind

STUART HODGES

At Mawson the recently vacated Paint Store (ex Auroral Observatory) will be refurbished and fitted out, using the Casey model, but redesigned to fit the existing building. Dedicated work in all station hydroponics facilities has provided a wide variety of salads, vegetables and herbs for expeditioners over the years. It is hoped that new facilities will allow the production an even wider range and volume of produce, with fewer of the pitfalls experienced in the old units. They should also ease the workload for the hydroponic gardeners, who dedicate much of their spare time to the cause.

Casey's record of produce since the start of planting on 13 May certainly augers well for the future: 64kg of vegetables and herbs were produced in 5 months, including tomatoes (Grosse Lisse), Cos and Mignonette lettuce, herbs (basil, parsley, chives, dill and thyme), snow peas, cucumbers, spring onions and silver beet. The success with tomatoes is particularly pleasing, (38.6kg harvested from 24 plants) as there was a relatively poor success rate with tomatoes in the other (old) facilities, despite a lot of hard work.

AAD, Collex join in clean-up effort

The Australian Antarctic Division has joined forces with a leading international waste management company in a multi-year effort to fulfill a long-standing commitment by Australia to clean up abandoned waste sites in Antarctica. An agreement between the AAD and Collex/Onyx Australia – a subsidiary of French-based Vivendi Environment – will result in Collex providing 240 purpose-built containers to transport waste collected from Antarctic sites. After their initial use at Australia's Casey station, the containers will be made available for future work by Australia and other Antarctic nations.

The Minister for the Environment, Senator Robert Hill, said the agreement provides a boost to Australia's work under the Antarctic Treaty to remediate past waste sites in Antarctica. "Australia is committed to protecting the Antarctic environment, and Collex

brings a wealth of experience in waste management to this long and important task," he said.

The Collex-provided containers will initially be used to return rubbish from a site near Casey station, called Thala Valley, which for over 20 years through the 1970s and 1980s was the station's main waste dump. The clean-up, to begin next year, follows a two-year study of the site by AAD scientists to determine how best to remove waste from the area without creating further environmental impacts. The study will continue into the clean-up process, monitoring the work and obtaining data for future work at other sites. AAD crews at Casey will sort waste and load the containers at the tip site. Collex will treat and dispose of the waste on its return to Australia.

The cooperative endeavour between the AAD and the French company Vivendi continues a record of cooperation between Australia and France in protecting the Antarctic environment which dates back to their joint instigation of the historic Protocol on Environmental Protection to the Antarctic Treaty. Specialist equipment employed in this exercise will later be made available to other nations for similar work elsewhere in Antarctica.

Station Leaders for 2002

A management consultant, a career public servant executive, a school deputy principal and a scientist with a PhD in hydrology make up one of the most experienced leadership teams of Australia's Antarctic program for many years.

All four of the 2002 station leaders know the job from previous experience. Michael Carr (Mawson 2000, Macquarie Island 1998, and Davis 1994), returns to Davis; Joan Russell, (Macquarie Island 1994, Casey 1990) returns to Macquarie Island; Marilyn Boydell (Casey 2000) tackles Mawson and John Rich (Macquarie Island 1990) will spend the year at Casey.

The challenges facing them include conducting a tractor traverse in support of a major scientific program in the Southern Prince Charles Mountains (Marilyn); coordinating operational support for the largest of the Australian Antarctic scientific programs (Michael), managing the final stages of a successful feral animal eradication program (Joan) and overseeing establishment of the infrastructure for air flights into Antarctica to connect with the other Australian stations (John).



WAYNE PAPPS



DON REID



DON REID

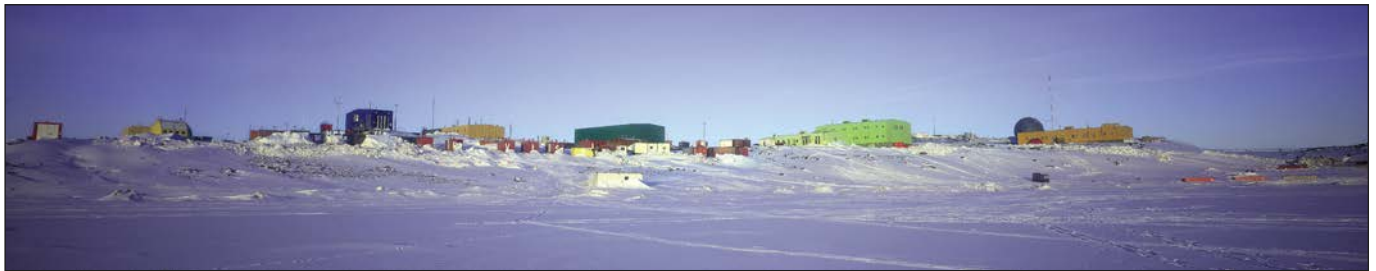


DON REID

From top:
Michael Carr
(Davis), Joan
Russell (Macquarie
Island), Marilyn
Boydell (Mawson),
John Rich (Casey).



Antarctic weather records: Davis station



DIANA CALDER

IN THIS SEGMENT WE BRING YOU HIGHLIGHTS OF THE RECENT weather experienced at each of Australia's Antarctic stations in turn. Last issue we brought you Mawson Station, the western outpost, and we now move eastwards to Davis station.

Weather extremes at Davis for the year 2000

Highest Air Pressure	1009.8 hPa in December
Lowest Air Pressure	954.6 hPa in September
Highest Daily Minimum Temperature	0.6°C on 30 November
Lowest Daily Minimum Temperature	-30.1°C on 21 May
Lowest Maximum Temperature	-27.3°C on 20 May
Highest Maximum Temperature	5.8°C on 24th November
Highest Maximum wind gust	ENE @ 163 km/h (88 knots)

Weather phenomena

	No. of Days	% of the year
Strong Wind (= >22 knots)	103	28
Gales (= >34 knots)	39	11
Blizzard	14	4
Snow fall	113	31
Blowing snow (=< 1km)	15	4

A blizzard is defined as a period of > one hour when the visibility is reduced below 100 m by blowing snow, the temperature is < 0°C and the wind speed is >33 kts.

Month by month overview of 2000, and of the six months to June 2001

January 2000

An average month weatherwise.

February 2000

Noticeably windier than usual but otherwise an average month.

March 2000

Slightly windier than average.

April 2000

Highest monthly snowfall (51.4 mm) for any month at Davis since records began in 1957.

May and June 2000

Average months weatherwise.

July 2000

Almost twice as much snow fell (13.4 mm) as the long term July average (6.8 mm).

August 2000

Another average month.

September 2000

A warmer than average month with a mean maximum temperature of -10.6°C and a mean minimum temperature of -16.8°C compared to the long term means of -13.2°C and -20.1°C respectively.

October and November 2000

Reasonably average months.

December 2000

A sunny month, with an average 14.2 hours per day of bright sunshine compared to the long-term mean of 9.7 hours.

January and February 2001

Windier than normal.

March 2001

The number of days (17) on which snow was observed was a record since observations began in 1957. Note though that the total precipitation for the month was slightly below average.

April 2001

Twice as many days of strong wind (11) and gales (5) compared to the long term averages of 6.1 and 2.6 days, respectively.

May 2001

A windy month with the average daily wind-speed (23.3 km/h) only 0.7 km/h below the previous highest value of 24.0 km/h.

June 2001

An average June weatherwise.

*Steve Pendlebury, Bureau of Meteorology, Hobart
Data contributed by Joe Hopkins and Philip Smart, Senior
Observers at Davis for 2000 and 2001 respectively.*



FREEZE FRAME

Adélie penguins
ponder a swim

I took this shot in mid-December on Béchervaise Island (see cover picture) when the sea ice was starting to get very unstable. While walking around the Adélie colonies I noticed a number of penguins taking advantage of the newly-formed pools of water to take a swim. I felt there would be some great photo opportunities if I could get a bit closer. I used a 70 mm lens to capture this image, with an aperture of F11 at 1/250th of a second on 35 mm 50 ASA Fuji Velvia film. An abundance of light from the sun as well as reflections off the snow and ice during the Antarctic summer create a high level of glare which suit the slower films. In these conditions, apertures of F16 and even F22 are required, depending of course on the speed of the film used. This shot called for an F11 aperture because of the darker coloured water between the floes.

WAYNE PAPPS

Wayne Papps is a photographer with the Australian Antarctic Division. He undertook field photography in the Mawson area during the 1999–2000 season, and visited Casey station in 2001. More of his work can be seen on pages 26–27 and elsewhere in this issue of Australian Antarctic



NORTH

67° 35' 0"

67° 35' 30" S



Australian Antarctic Division
Hobart Tasmania
*Antarctica valued,
protected and understood.*