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ABOUT THE COVER

Supervising Communications Technical Officer, Stuart Shaw, took this photo of Lake Druzhby in the Vestfold Hills (near Davis research station) during a field trip to Trajer Ridge in June 2014. The photo was taken at about midday, with the winter twilight providing a colourful backdrop to the glassy surface of the frozen freshwater lake. Stuart used a flash to highlight the bubbles trapped in the ice as the water froze.

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

Australia's Antarctic national interests are to:

- Preserve our sovereignty over the Australian Antarctic Territory, including our sovereign rights over the adjacent offshore areas.
- Take advantage of the special opportunities Antarctica offers for scientific research.
- Protect the Antarctic environment, having regard to its special qualities and effects on our region.
- Maintain Antarctica's freedom from strategic and/or political confrontation.
- Be informed about and able to influence developments in a region geographically proximate to Australia.
- Derive any reasonable economic benefits from living and non-living resources of the Antarctic (excluding deriving such benefits from mining and oil drilling).

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From the Director

In April the Australian Antarctic community celebrated the launch of the Australian Government's *Australian Antarctic Strategy and 20 Year Action Plan*. This exciting and timely Strategy sets out the vision for Australia's future engagement in Antarctica, while the accompanying Action Plan details the steps the Australian Government will take to achieve it. Together, the Strategy and Action Plan will ensure Australia continues to build its leadership role in Antarctica.

The Antarctic Strategy and Action Plan were informed by an independent report and recommendations commissioned by the government, and prepared by former Australian Antarctic Division Director Dr Tony Press, released in late 2014. As leader of Australia's Antarctic program, the Antarctic Division will coordinate the delivery of the Action Plan. Among our commitments will be further establishing Australia's position of science leadership in Antarctica, including by:

- Delivering a new icebreaker ship during 2019–20, with enhanced marine science and logistics capability, and integrating its operation with other national shipping assets.
- Establishing an overland traverse capability with associated ice core drilling and mobile station infrastructure and research support. This will support an internationally collaborative project to retrieve a one million year ice-core climate record.
- Developing a full business case for establishing year-round aviation access to Antarctica.
- Improving our krill research infrastructure in Hobart, to conduct research that will contribute to the sustainable management of the Southern Ocean krill fishery.
- Establishing collaborative relationships with key international partners, to share capabilities and facilitate more efficient science, operations and policy outcomes in Antarctica.

The Antarctic Division is also continuing its discussions with Defence with a view to establishing a regular program of flights to Antarctica using the Royal Australian Air Force C17-A aircraft. Last season we conducted five highly successful proof of concept flights, moving more than 109 tonnes of machinery and cargo into and out of Antarctica (see page 24). This efficient and additional means of moving heavy assets will improve options for supporting science projects, as well as our regular resupply activities.

Collaboration has always been an important part of working in Antarctica and will increasingly be so as nations active in Antarctica seek to maximise the efficiency of their science, operations and policy outcomes. In recent meetings Australia has agreed on shared priorities with both China and the United Kingdom, including enhanced scientific cooperation, advancing policy discussions for environment protection, and the use of Hobart as an Antarctic Gateway (see page 32).

This season the spirit of cooperation was again apparent when Japan, the United States, China and France came to our assistance during the grounding of the *Aurora Australis* at Mawson research station. Despite this setback, our Antarctic neighbours' support enabled us



to successfully complete all our science and resupply priorities. This included conducting and supporting a major marine science voyage to the Kerguelen Plateau (see pages 8–12). The comprehensive sampling conducted across the Kerguelen Plateau region will enable the development of an observing program that will help measure the current status of the East Antarctic ecosystem, and future trends as a result of climate change.

Overseeing our Antarctic science program is our new Chief Scientist, Dr Gwen Fenton. Since 2003 Gwen has managed the science planning and coordination of all projects within the Australian Antarctic Science Program. Her depth of knowledge of Antarctic science, and her background in marine research, are great assets to the program, and I warmly welcome her to the role (read her story on page 20).

Last, but not least, we were reminded this year that operating in Antarctica is not without risk, with the sad loss of Helicopter Resources pilot David Wood, who was working in support of our program at Davis research station. While safety is our number one priority in all that we do in Antarctica, this tragic event is a reminder that we must all remain vigilant to the risks we face and continue to strive for better and safer ways of doing our work. David will be remembered during our mid-winter ceremony.

Dr NICK GALES

Director, Australian Antarctic Division

Grand Wastewater Designs (revisited)

A 12-month trial of an Advanced Wastewater Treatment Plant (AWTP), destined for Davis research station, has shown the plant can produce drinking quality water from wastewater, while reducing energy consumption and the amount of waste discharged into the environment.

The success of the trial, conducted at TasWater's Selfs Point wastewater treatment plant in Hobart (Tasmania), puts Australia's Antarctic stations a step closer to reliable, self-contained, low maintenance water recycling.

Australian Antarctic Division engineer, Mr Michael Packer, said the new AWTP will take treated effluent from the station's secondary wastewater treatment plant, installed in December 2015, and improve on its quality.

"The secondary treatment plant is very good at removing most of the nutrients and pathogens but it doesn't remove all of the chemical contaminants, such as some inorganic compounds, pharmaceuticals and endocrine disrupting chemicals," he said.

"The AWTP will deal with any residual contaminants and pathogens using seven different treatment barriers. These multiple barriers provide a very high level of protection and surety that the quality of the water is always maintained."

Second to none

The secondary treatment plant treats kitchen and bathroom waste using a standard 'membrane biological reactor' process – using microbes to digest nutrients and filtration to remove solids (*Australian Antarctic Magazine* 25: 30-31, 2013). The resulting clean water is discharged to the ocean via a pipe at the water's edge, while the solids are returned to Australia.

The plant was installed in response to an environmental impact assessment conducted by Antarctic Division scientists in 2009-10, which showed that existing waste management practices were causing an accumulation of some contaminants in the environment. Two further secondary treatment plants will be installed at Casey and Mawson stations in future years.

"There are similar membrane biological reactor plants built by German company, Martin Membrane Systems, in Antarctica, however ours is close to the leading edge in technology terms," Mr Packer said.

"We've worked closely with the company to ensure the plant is highly automated, low maintenance and has a lot of monitoring capacity, so that we can continuously confirm we are achieving the standards that we aim for.

"We can also reduce the plant's operational size over winter, when there are 10 times fewer people on station, and return it to full capacity in the summer."

One of a kind

When the AWTP is installed at Davis in early 2017 it will be the only one of its kind in Antarctica. The bespoke plant was built at the Australian Antarctic Division, with funding, research, design and testing input from academia and industry partners, including the Australian Water Recycling Centre of Excellence, Victoria University, University of Melbourne, RMIT University, Veolia, AECOM, Curtin University, TasWater and Coliban Water.

The 12-month trial of the plant proved that it works under more demanding conditions than are expected in Antarctica.

"The effluent coming out of TasWater's Selfs Point secondary treatment plant is not as clean as the effluent from the Davis secondary treatment plant, because it uses a more traditional biological nutrient reduction process than our Antarctic plant," Mr Packer said.

"However, our AWTP proved quite capable of removing pathogens and chemicals to values well within the standards set by the Australian Drinking Water Guidelines."

As the AWTP is designed to produce drinking quality water (although there are no immediate plans to use it for this purpose), it aims to achieve up to a 13 'log reduction' in pathogens. To put that in context, a two log reduction kills 99% of pathogens, a three log reduction kills 99.9% of pathogens, and so on to 11 decimal places.

To do this the plant uses an arsenal of germ-killing and molecule-blasting technologies – ozone disinfection, microfiltration, biological activated carbon, reverse osmosis, ultraviolet disinfection and chlorination. These processes kill and/or remove bacteria, viruses and protozoa, and break up large chemical molecules, such as hormones, into smaller ones, which are filtered out later. Throughout the treatment process a range of 'critical control parameters' have been defined, to alert the Antarctic Division head office of potential problems, and trigger the shut-down of the plant if the parameters are breached.

While the effluent quality has met expectations, some trial work needs to continue to ensure the plant can operate autonomously, with only annual maintenance

required by a skilled operator. As the AWTP's operation is dependent on the flow of effluent from the secondary wastewater treatment plant, it is designed to shut itself down and go into 'preservation' mode – to preserve sensitive filter membranes – when flows are low. The plant then ramps up again when flows increase.

"The AWTP works on a batch basis and will provide up to 22 kilolitres of clean water per day at full capacity," Mr Packer said.

"But it needs a few hours each day to flush filters and in winter it might only run once every two or three days.

"We've shown that the plant can be operated remotely and that it can automatically start and stop routinely, however we still have some work to do to ensure minimal operator input."

The trial has also shown that if water from the plant was recycled for reuse at Davis station it

could reduce energy consumption related to water management by 69%, by reducing the need to desalinate water from a nearby tarn.

"If we reuse the water we'd save more than 33 000 litres of diesel a year, so the potential for energy saving is high," Mr Packer said.

As well as Antarctica, the AWTP is well suited to potable water production in other remote areas around the world, using source waters from sewer, mining and stormwater systems. As a result, the project has attracted international attention, with institutions in both China and India expressing interest in collaborating in the development of similar treatment systems.

WENDY PYPER

Australian Antarctic Division



1. The secondary treatment plant newly installed at Davis research station in December 2015. This photo shows the inlet buffer tanks (front right) where wastewater from the station enters. An even, controlled flow is then directed through the various treatment processes. Once treated, sludge is directed into the sludge tank (front left) and treated water is collected in the effluent tanks (back left) before being pumped to the ocean outfall. (Michael Packer)

2. Aeration blowers that provide oxygen to the biological process, and some of the analytical instruments for measuring the quality of the wastewater in the secondary treatment plant. (Michael Packer)

3. The Advanced Wastewater Treatment Plant set up at the Australian Antarctic Division. The plant's treatment barriers include a reverse osmosis (RO) system and biologically activated carbon filter (bottom right quadrant), ozone and microfiltration (bottom left), and chlorine and ultraviolet light (top right). A 'clean in place' system that automatically cleans the RO and microfiltration filters is installed top left. The plant is expected to be installed at Davis station in 2017. (Michael Packer)

4. The secondary wastewater treatment plant installation team at Davis research station after a successful start-up of the plant. (Michael Packer)

Drone use set to rise in Antarctica

Three kilograms of bladed electronics sit poised for take-off from the edge of *Aurora Australis*' helideck. Call-sign *Inspire 1*, a remotely piloted aircraft (RPA), or drone, is undergoing tests of its potential to assist the crew navigating through sea ice during the ship's annual resupply voyage to Casey research station.

The 2015-16 summer marked the Australian Antarctic Division's first operational use of this camera-carrying technology, and the custom-painted fluoro-orange 'quadcopter' passed with flying colours. The trial confirmed drones are an easy to deploy 'eye in the sky,' well-suited to supplementing satellite-obtained sea ice imagery with views of the conditions immediately ahead of the ship on any given day. Indeed, these small aircraft are a less expensive, easier to deploy and environmentally friendlier proposition than using helicopters to undertake quick reconnaissance flights.

Unsurprisingly, drones are becoming relatively commonplace in Antarctica. An eight-bladed model has been used by Australian Antarctic program researchers to collect data on the health of moss beds in Antarctic Specially Protected Areas. Elsewhere, fixed wing and vertical take-off and landing drones have supported wildlife monitoring, vessel surveillance and fuel spill mapping, and are flown for recreational purposes. Other potential applications include geophysical

exploration, documenting glacial retreat, supporting meteorological and ocean-sea ice-atmosphere interaction studies, detecting crevasses and searching for missing persons.

Still, and notwithstanding rapid changes in technology, flying drones in Antarctica is not without challenges; the voyage carried several back-up units as a precaution. More than 100 degrees of compass declination must be factored when flying in the Casey region, alongside the magnetic interference generated by thousands of tonnes of steel ship. Indeed, compass calibration and GPS issues are likely behind the many anecdotal reports of drones' erratic behaviour in high latitude environments; insufficiently experienced operators have lost their aircraft to 'toilet-bowling' (irrevocable circling) and 'fly-aways'. Landing on a moving platform can also be a problem if the aircraft heads back to the coordinates of its departure point. Furthermore, battery life is reduced by exposure to low temperatures, and strong winds are liable to affect drone stability.

The ice reconnaissance trial involved introducing increasingly complex flights to quantify and resolve the significance of each of the anticipated performance issues. *Inspire 1* flew up to 75 m above the ship's deck, undertaking five incident-free sorties in the few days that the ship transited ice. They included one flight in 17 knot winds and another in lightly falling snow.



1. Part of a map of Casey research station comprised of a composite of images taken by the eBee drone. (AAD)
2. James Rennie with the fixed-wing Sensefly eBee drone, which took high resolution images of Casey station for future mapping and planning work. (Sandra Potter)
3. James Rennie and the quadcopter Inspire 1 during flights off the *Aurora Australis* helideck. (Sandra Potter)
4. A view of the *Aurora Australis* docked in Hobart from the quadcopter drone. (AAD)



The regulation of drones is similarly complex. The safety aspects are regulated by the Civil Aviation Safety Authority, and the environmental aspects by the Antarctic Division. Alongside most other activities, Australians' drone uses south of 60°S are subject to an environmental impact assessment and authorisation process under the *Antarctic Treaty (Environment Protection) Act 1980*. The Act makes it an offence to disturb wildlife. Unless a permit has been issued, a 2015 policy released by the Antarctic Division requires that buffers of 750 m vertically and 930 m horizontally are maintained from concentrations of birds and seals – the same distances applying to single-engine helicopter operations. Certain research uses, such as bird colony counts, may also be subject to the approval of an

animal ethics committee. The intensity of operations, and the species exposed and the phase in their breeding season, are among relevant considerations. Problematically, there is limited empirical data on which regulators can draw. Studies undertaken in more northerly latitudes appear to give greater attention to the efficacy of ways of protecting drones from wildlife attack (such as noise-making devices, different livery, flight timings, and the development of rapid-climb functions to evade raptors) than they do to wildlife disturbance.

The ship-based trial was followed by the first Australian Antarctic program use of a fixed-wing model. Amidst the hive of Casey's resupply, a Sensefly eBee flew transects 120 m above ground level, quietly mapping the station area in 100 m swathes at 3.5 cm/pixel resolution. (Flown at a lower altitude, a ground sampling distance of 1.5 cm/pixel is possible.) Marketed as green technology and powered by a 160 W brushless DC motor, these 690 gram foam units – ours from Victoria and replete with eagle talon holes – are thrown into the air to launch, and have a linear landing accuracy of approximately 5m. The imagery obtained will assist the Antarctic Division to gain a better understanding of Casey's footprint and in turn, improve 'town' planning processes. The region's flora includes more than 20 lichens, three mosses and a liverwort that are vulnerable to the impacts of station operations.

Both the DJI Inspire and Sensefly eBee drones were operated by CASA licensed pilot James Rennie of Australian UAV. Video footage taken above the ship may be viewed on the Antarctic Division's news site www.antarctica.gov.au/news/2015/aurora-australis-uses-drone-technology-to-navigate-sea-ice.

DR SANDRA POTTER

RPA Project Manager
Antarctic Modernisation Program, Australian Antarctic Division

Managing drones in Antarctica

Drones offer a unique perspective on Antarctica, but using them requires care and sensitivity to the environment. Also known as Unmanned Aerial Vehicles, Unmanned Aerial Systems, or Remotely Piloted Aircraft, drones have become more technologically advanced in recent years and more compact, lightweight and affordable. This increases their appeal, for a whole range of uses, to expeditioners, scientists and commercial operators. For anyone planning to use a drone in Antarctica, it is important to understand the rules for use.

The Civil Aviation Safety Authority (CASA) has legislation in place that applies to drones. This includes a licensing regime for operators likely to obtain commercial gain from the use of the drone, including for science, government operations and media, or for drones over a certain size. Information is available from the CASA website (www.casa.gov.au) and anyone planning on taking a drone to Antarctica should check whether they first need to obtain a licence.

As operating drones in Antarctica offers some particular challenges and risks, the Australian Antarctic Division has prepared its own operational and environmental policies. These policies provide guidance on the appropriate use of drones in Antarctic conditions, including things like visibility, wind conditions, wildlife, and proximity to station facilities and aviation activities. Any drone flight has the potential to impact on the environment, including by disturbing wildlife, so all drone use in Antarctica must have an environmental authorisation and users must be aware of the conditions under which they can be used.

Some of the images and footage taken from drones in Antarctica is truly spectacular, and there is no doubt that more people will want to fly them, for a whole range of purposes, including just for fun. For more information about using drones in Antarctica contact the Territories, Environment and Treaties Section of the Australian Antarctic Division at eia@aad.gov.au.

RHONDA BARTLEY

Strategies Branch, Australian Antarctic Division



DNA reveals three populations of Antarctic blue whales

Genetic analysis of Antarctic blue whales (*Balaenoptera musculus intermedia*) has identified three distinct populations of the critically endangered deep sea giants.

The finding, published in *Scientific Reports* in March, will inform management measures to help the whales recover from 20th Century whaling, which reduced their numbers from some 239 000 individuals to just 360.

"Although the three groups occur together when feeding in Antarctic waters, we found that they are genetically distinct," Flinders University molecular ecologist, Dr Catherine Attard, wrote in *The Conversation*.

"This suggests that the three groups breed in different locations, possibly even different oceans, when they migrate north in the winter."

If the three populations travel different migration paths to separate breeding grounds they will each be affected by different threats, including noise pollution from seismic surveys and shipping activity, entanglement in fishing gear, tourism and climate change. These differences in threats between populations makes population level conservation especially important, to prevent local extinctions.

Understanding the population structure of Antarctic blue whales has been complicated by their mobile lifestyle and the difficulty and expense of finding and tracking them. Since the 1990s, however, ship-based surveys conducted under the auspices of the International Whaling Commission have collected skin and blubber biopsies from the whales.

Dr Attard and her colleagues, Associate Professor Luciana Möller and Professor Luciano Beheregaray, used DNA from 142 of these biopsies to identify and describe the populations of Antarctic blue whales.

"By comparing similarities and differences in the DNA of individuals, we were able to tell which individuals were part of the same population, and estimate the number of populations," Dr Attard said.

"Individuals from the same breeding population are more genetically similar than those from different populations."

The team found that individuals from the three populations occur together throughout the Antarctic, possibly because blue whales need to rove long distances around Antarctica to find the large amounts of krill that they feed on.

"We suspect that the three populations go their separate ways when they head north to

breed, presumably to the South Pacific, South Atlantic and Indian oceans," Dr Attard said.

"This should be determined by satellite tagging the whales and watching where they go. More biopsy samples could then be taken at the breeding grounds to confirm which populations are which.

"If we can find out where they go, and what hazards they face on the way, we will be a step closer to helping them recover from their near-annihilation by whalers."

WENDY PYPER

Australian Antarctic Division

*Genetic data analysis of samples were funded by the Australian Marine Mammal Centre within the Australian Antarctic Division, as well as Flinders University and Macquarie University. Read the scientific paper at www.nature.com/articles/srep22291 and the study authors' article in **THE CONVERSATION** (9 March 2016).*



Krill 'super-swarm' surprises scientists

Super-swarms of krill and a highly productive ecosystem were among the discoveries of the Australian Antarctic Division's marine science voyage to the Kerguelen Axis*, between January and February this year.

The 8850 km 'K-Axis' voyage, led by Dr Andrew Constable of the Australian Antarctic Division and Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC), surveyed nine habitat gradients across the Antarctic continental shelf, deep ocean and on to shallow banks, to understand the drivers of the krill-based food web in the southern part of the K-Axis, and the fish- and copepod-based food web in north.

In each habitat the team surveyed krill, fish, zooplankton and phytoplankton, and a range of chemical and physical properties including iron concentration, ocean temperature and salinity, and sea ice extent.

"Our preliminary results indicate that the system in East Antarctica is much more productive than we thought," Dr Constable said.

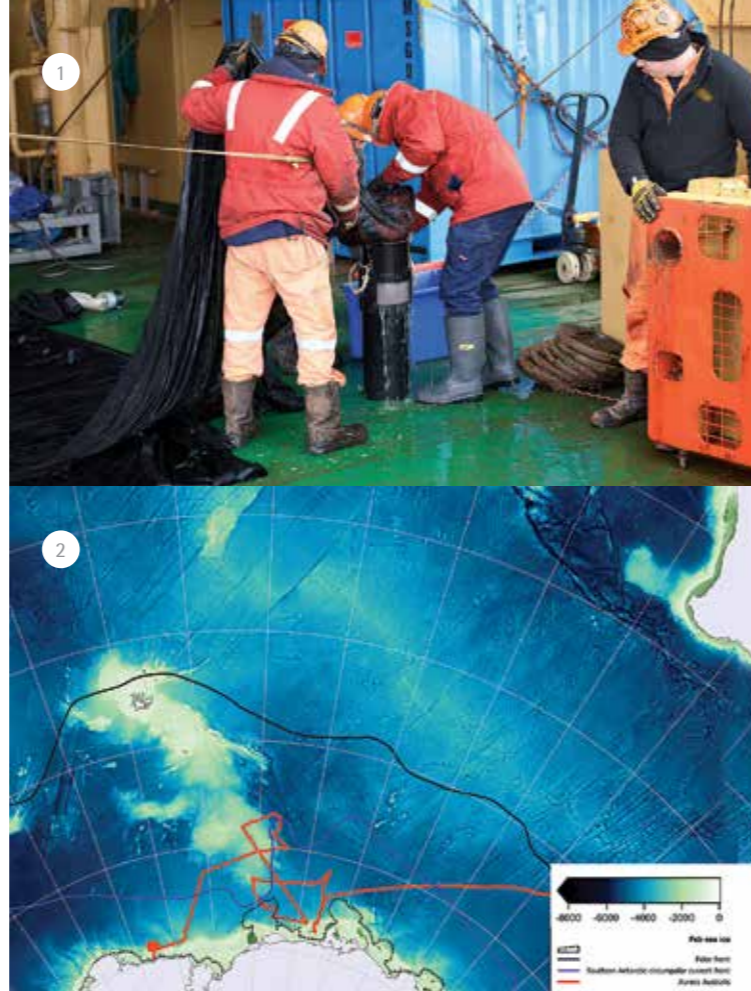
"For example, we found that chlorophyll, which is a marker for phytoplankton, was regularly much more abundant in water deeper than the surface waters measured by satellites. The abundance of grazers, such as salps [floating forms of sea squirts] and small zooplankton, was much greater than expected in areas where Antarctic krill were expected to dominate. And we found that fish occurred in great abundance throughout the ecosystem, and that they represent a different but inextricably linked food chain to krill."

The most surprising discovery was that krill – including a rare super-swarm – were found further north than expected.

"Most studies have found krill concentrated south of the southern boundary of the Antarctic Circumpolar Current," Dr Constable said.

"However we found krill much further north – even north of the Southern Antarctic Circumpolar Current Front– which suggests that sea ice is not a primary factor influencing the distribution of adult krill in this region.

"We also encountered a rare super-swarm of Antarctic krill in 3500 m-deep water to the west of the Kerguelen Plateau and north of the Southern Antarctic Circumpolar Current Front, with more than 100 humpback whales feeding on it."



'The encounter was the first time a super-swarm has been properly observed and measured in the Indian Ocean since an observation in the early 1970s by a fishing vessel. Other large swarms have only been observed much nearer the Antarctic continental shelf in the K-Axis area.'

The encounter was the first time a super-swarm has been properly observed and measured in the Indian Ocean since an observation in the early 1970s by a fishing vessel. Other large swarms have only been observed much nearer the Antarctic continental shelf in the K-Axis area.

The research team now has the first comprehensive ecosystem data set to formulate new and improved theories on krill distribution and movement in the region, and to improve food web reconstruction in ecosystem models.

"Salps are clearly a dominant grazer in the ecosystem. Data on these and different species of krill and zooplankton, and the types of phytoplankton in their diets, will enable a more comprehensive reconstruction of the food web and different energy pathways, which is a major gap in our understanding of Southern Ocean ecosystems," Dr Constable said.

"We'll also be able to add our observations of whales, seals, penguins and flying seabirds in the region, to tracking studies of these animals based out of Mawson and Davis, to identify relationships between land-based and at-sea observations."

The K-Axis voyage on board the *Aurora Australis* was part of an international study that included the US vessel *Roger Revelle*, CSIRO's *Investigator* (see page 10), French ship *Marion Dufresne* and the Japanese vessels *Umitaka Maru* and *Hakuho Maru* – with each ship taking samples and measurements in multiple locations around the Kerguelen Axis.

This comprehensive sampling will enable the development of an observing program that will help measure the current status of the East Antarctic ecosystem and future trends as a result of climate change.

The data from the voyage will be available through the Australian Antarctic Data Centre, the Australian Integrated Marine Observing System, the Southern Ocean Observing System and the Australian Ocean Data Network. The research will also contribute to the Commission for the Conservation of Antarctic Marine Living Resources. Results will be presented at an international conference on status and trends of Southern Ocean ecosystems in Hobart in 2018.

CORPORATE COMMUNICATIONS

Australian Antarctic Division

**The Kerguelen Axis is a line of longitude where the Antarctic Circumpolar Current flows across the Antarctic continental shelf, the deep ocean and subantarctic islands. It runs from the Amery Ice Shelf on the East Antarctic coast, out into the Southern Ocean, between Heard Island and Kerguelen Island.*

The voyage was a collaboration between the Australian Antarctic Division, the University of Tasmania's Institute for Marine and Antarctic Studies, the Australian Research Council-funded Antarctic Gateway Partnership and the ACE CRC. Read more about the research in the previous issue of Australian Antarctic Magazine 29: 2-3, 2015.

1. Scientists and crew empty the krill net during the K-Axis voyage. (Nick Roden)
2. This map shows part of the voyage track of the *Aurora Australis* (orange line) from Hobart (not shown) towards the K-Axis study area – between the southern Kerguelen Plateau and the Antarctic continent – followed by a resupply trip to Davis station. Ocean colours indicate depth. (Mike Summer)
3. Dr Andrew Constable (left) examines salps collected from nets deployed for krill, zooplankton and phytoplankton samples. (Nick Roden)

Volcanic hotspot may fortify ocean life

It's elemental. Iron spewed from hydrothermal vents associated with active underwater volcanoes may be fertilising pockets of highly productive waters in the Southern Ocean.

To find out, an international contingent of scientists spent 51 days aboard Australia's new Marine National Facility, *Investigator*, mapping the seafloor and sampling the phytoplankton-rich waters on the central Kerguelen Plateau, around Heard and McDonald islands.

According to Voyage Chief Scientist, Professor Mike Coffin, a marine geophysicist with the University of Tasmania's Institute for Marine and Antarctic Studies (IMAS), the voyage* aimed to test the hypothesis of a link between active volcanoes on the seafloor and the availability of the 'trace element' iron for phytoplankton growth.

"Active underwater volcanoes drive the circulation of iron-rich fluids that are emitted from the seafloor at hydrothermal vents, and we suspect this iron may be critical to the growth of phytoplankton blooms," Professor Coffin said.

"Phytoplankton are the foundation of life in Southern Ocean ecosystems. They're a food source for other marine life, they supply approximately half the oxygen in Earth's

atmosphere, and phytoplankton blooms affect the concentrations of carbon, nitrogen, silicon and sulphur in the ocean, which in turn influence the Earth's climate system."

Iron biogeochemistry expert, Associate Professor Andrew Bowie of the Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC) and IMAS, said ocean colour satellite images regularly revealed intense phytoplankton blooms on the central Kerguelen Plateau, compared to surrounding waters. Previous voyages to the region have also detected significantly elevated iron concentrations.

"Generally the Southern Ocean is anaemic, with iron concentrations so small it would be like trying to find a pinhead in 1000 Olympic sized swimming pools," A/Prof Bowie said.

"But in the waters around Heard and McDonald islands, we've detected iron concentrations 10 to 20 fold greater than in deeper offshore waters, with nearby waters on the plateau showing significant increases in phytoplankton biomass.

"While we can't say categorically where that iron comes from, we think it is partly being delivered by hydrothermal vents in the waters around the islands, and partly by volcanic ash from the erupting Big Ben volcano on Heard Island, mixing with active glaciers and dispersing in the surrounding ocean."

To look for hydrothermal vents and map the seafloor, the team employed the *Investigator's* continuously operating water column imaging, seafloor mapping, and sub-seafloor profiling acoustic systems, as well as a 'remotely operated towed vehicle' that measured seawater properties.

Together these instruments located more than 100 'acoustic plumes', indicative of hydrothermal vents and/or other seafloor emissions such as methane bubbles, as the ship circumnavigated the islands several times.

"We mapped around 7000 square kilometres on the central Kerguelen plateau and several hundred square kilometres around the islands," Professor Coffin said.

'We mapped around 7000 square kilometres on the central Kerguelen plateau and several hundred square kilometres around the islands.'

"We were surprised by the number of volcanic features on the seafloor around the McDonald Islands and the relative paucity of these features around Heard Island. This may be because the McDonald Islands are younger than Heard Island, so volcanoes are continuing to pop up everywhere, while most of the volcanic activity around Heard Island has coalesced around Big Ben."

When the weather conditions permitted, the team sampled the water column and seafloor around the hydrothermal vents for iron and other trace elements, nutrients, suspended volcanic particles, volcanic sediment and rocks, phytoplankton, microbes, and various ocean properties.

Among the sampling workhorses were eight 'in situ pumps', used to collect and measure particles in the water column. The pumps were lowered to different depths and left to pump and filter hundreds of litres of seawater over several hours.

"Around the islands the filters came up full of black volcanic material that had been resuspended in the water column," A/Prof Bowie said.

"When we added some of these particles to water collected outside the volcanic region, we detected an increase in biological activity."

A/Prof Bowie's team also deployed a trace metal rosette (TMR) at 40 sampling stations. This rosette of a dozen 12 litre bottles collects seawater for iron and other trace element analysis at different depths in the water column. Because any iron contamination will affect the samples, the TMR uses only plastic, titanium and aluminium in its construction, and is deployed, retrieved and stored under clean conditions that prevent contamination from the ship, atmosphere or human operators.

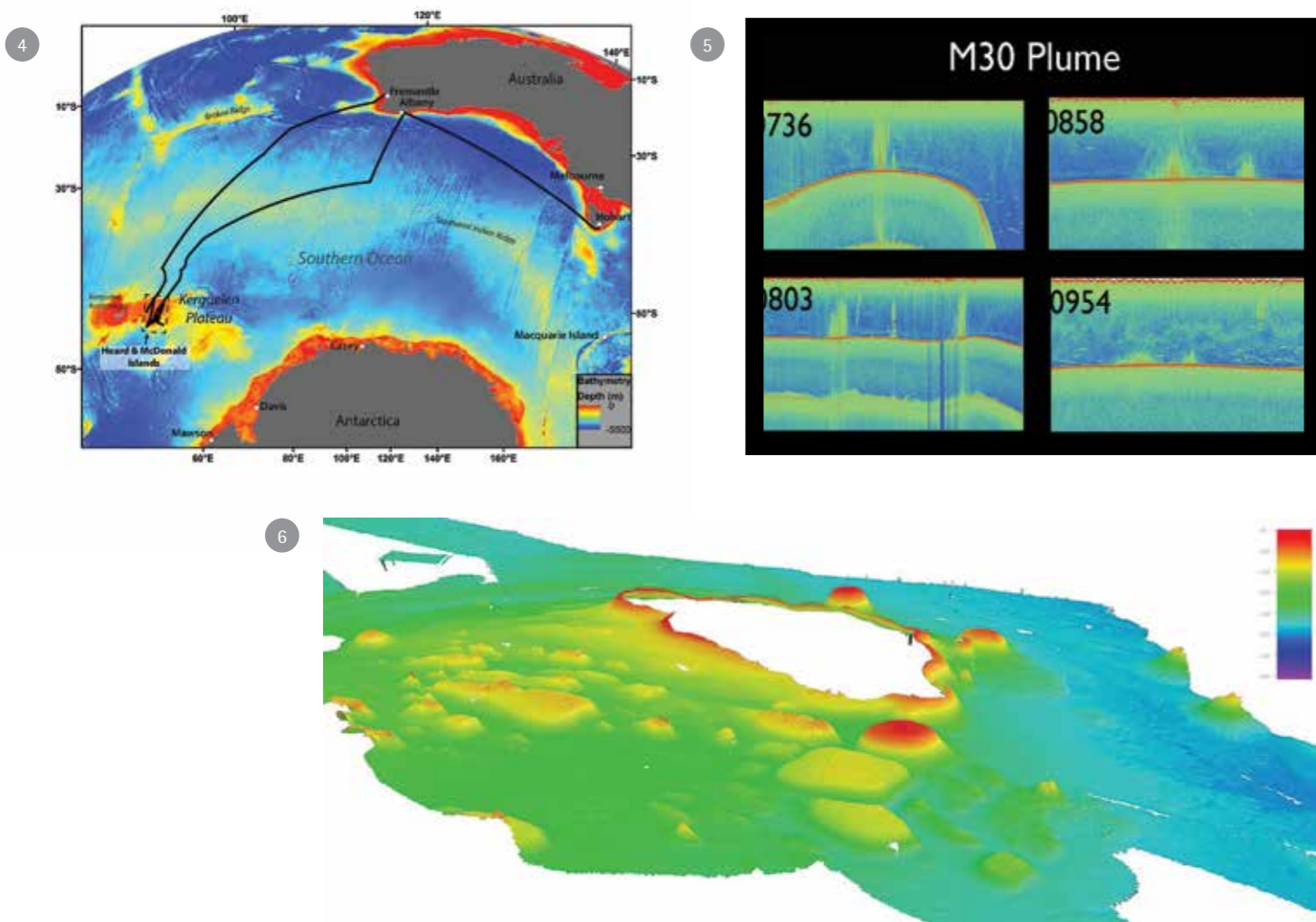
"The TMR samples will allow us to see how the iron concentration changes through the water column, which can help us to see how the iron may be delivered through volcanic ash, from glaciers on the islands, or through hydrothermal vents on the seafloor," A/Prof Bowie said.



1. Scientists were treated to an eruption of the Big Ben volcano on Heard Island during their voyage. Aerosol samples will help identify whether any of the ash in the atmosphere is contributing to a local increase in iron concentrations in the surrounding waters. (Peter Harmsen)

2. The scientists, artists and support staff of the 'Heard Earth-Ocean-Biosphere Interactions' voyage. Voyage Chief Scientist Professor Mike Coffin is front and centre on the steps. Associate Professor Andrew Bowie is in the back row, fourth from the right. (Tom Watson)

3. The trace metal rosette (TMR) was often deployed in challenging conditions in waters above the central Kerguelen plateau. (Peter Harmsen)



Laboratory tests for the 'speciation' of iron will provide information about its origin. Hydrothermal vents create an acidic, low oxygen environment, which results in a form of iron known as ferrous iron (or Fe^{2+}), while regular, oxygenated seawater contains more ferric iron (Fe^{3+}).

"Typically only one or two per cent of total dissolved iron in the Southern Ocean exists as ferrous iron, but around the islands it's up to 30 per cent," A/Prof Bowie said.

Samplers set up in the ship's aerosol lab located in the bow of *Investigator* will also allow the team to assess atmospheric iron transport – including from a rarely seen eruption of Big Ben during the voyage. The volcanic plume could have been transported thousands of kilometres away but it could also have a local effect. The aerosol samples will help tease this out and constrain possible sources of iron coming from above with what's coming from below.

Over the next 12 months the team will analyse their water, sediment and rock samples, and the vast amount of underway data collected on the voyage, to look for the "smoking gun" that links the underwater volcanoes in the region to the iron-rich waters that support the growth of phytoplankton.

"If we can prove that hydrothermally-derived iron exerts controls over the dynamics of phytoplankton blooms, it will be the first demonstration of a link between dynamic solid Earth processes, specifically hotspot volcanism, and biological processes," Professor Coffin said.

WENDY PYPER

Australian Antarctic Division

"The 'Heard Earth-Ocean-Biosphere Interactions' voyage was part of a broader collaborative program of research that included the 'K-Axis' voyage between the Antarctic continent and southern Kerguelen Plateau on the Aurora Australis (see page 8), and other complementary research in the region onboard French, Japanese and American vessels.

The voyage included scientists and students from IMAS, ACE CRC, University of Tasmania, Australian National University, CSIRO, University of New South Wales, Microbial Oceanography Laboratory (LOMIC, France), European Institute for Marine Studies, and the Scripps Institution of Oceanography, University of California, San Diego. Four artists were also involved. The voyage was funded through Australia's Marine National Facility, the Australian Research Council, the Australian Antarctic Science program grant (AAS #4338), and the Australian Council for the Arts.

4. The Investigator voyage travelled some 16 000 km between Australia and the subantarctic Kerguelen Plateau to study the link between underwater volcanoes and ocean productivity. Colours indicate the seafloor depth, with shallower regions coloured red and yellow. (Sally Watson, IMAS)
5. The same acoustic plumes detected at different times one morning by the Investigator's water column and seafloor echosounder near the McDonald Islands. These plumes are suspected to represent hot fluid, containing precipitating chemicals, emanating from hydrothermal vents on the seafloor, and are thought to contribute to the higher levels of iron available for phytoplankton growth in the region. (Frances Cooke, Marine National Facility)
6. A three-dimensional view of presumed volcanic features – sea knolls – around the McDonald Islands (unmapped white area) produced from data collected by the ship's seafloor mapping acoustic systems. Red and yellow colours indicate shallower features. (Erica Spain, IMAS)

Climate models to benefit from subantarctic cloud watch

An array of atmospheric instruments was deployed on Macquarie Island in April to help scientists better understand Southern Ocean clouds and how they can be used to improve weather forecasting and climate models.

Australian Antarctic Division atmospheric scientist and Chief Investigator of the project, Dr Simon Alexander, said a lack of data on Southern Ocean clouds prevents Southern Hemisphere climate models from accurately representing atmospheric energy balance (heat coming into the atmosphere versus heat going out). This in turn affects the accuracy of how models represent and forecast temperatures, the movement of weather systems, sea ice formation and ocean currents.

"Most research on high latitude clouds has focussed on the Arctic, but the clouds above the Southern Ocean are thought to be unique and include 'super-cooled water clouds' which remain as liquid water at temperatures well below freezing," Dr Alexander said.

"As Macquarie Island sits in the path of weather systems which circulate around the Antarctic continent, it's an ideal place to conduct cloud-related research."

Dr Alexander and colleagues from the Australian Antarctic Division, Bureau of Meteorology and the US Department of Energy, installed the instruments to measure the seasonal cycle of cloud, aerosol and radiation properties over the Southern Ocean.

The instruments, which are now collecting data, include a cloud lidar, cloud radar and microwave radiometer that will measure clouds from near the surface up to 10 km altitude (Australian Antarctic Magazine 28: 6-7, 2015). They will help scientists determine whether the clouds are composed of ice, water or a mixture of both.

"We will be able to determine the altitude at which the various cloud phases occur, how frequently they occur, and how they are related to weather systems," Dr Alexander said.

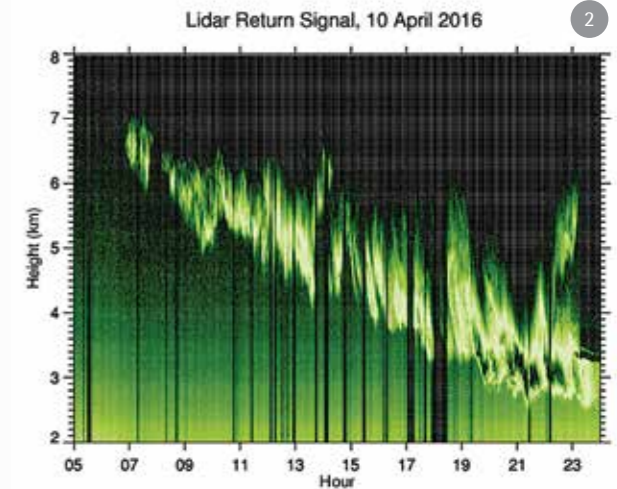
Current knowledge of Southern Ocean clouds and the atmosphere rely heavily on satellites, yet these have difficulty measuring low-level clouds and the data has proven difficult to validate. The data from the ground-based observations at Macquarie Island will allow the team to validate the satellite data over the Southern Ocean.

The instruments will remain on the island for up to two years, with some to be transported to Antarctica to record similar cloud properties above Davis station later this decade.

The project is supported by the Australian Antarctic Division, the United States Department of Energy's Atmospheric Radiation Measurement (ARM) program, the Bureau of Meteorology, CSIRO and the University of Canterbury in New Zealand.

CORPORATE COMMUNICATIONS

Australian Antarctic Division



1. The atmospheric instruments deployed on Macquarie Island include a ceilometer, microwave radiometer and various broadband radiometers provided by the US Department of Energy's Atmospheric Radiation Measurement program, along with the Bureau of Meteorology's cloud radar (partially visible at the lower right). The data gathered will be used to evaluate weather forecasting and climate models and validate satellite cloud retrievals. (Jeff Aquilina)
2. This graphic shows clouds recorded over Macquarie Island by the Australian Antarctic Division lidar on 10 April 2016. The cloud base descends from 6 km altitude to 2.5 km altitude throughout the day. Black vertical stripes indicate missing data due to lower-level clouds. (Andrew Klekociuk & Simon Alexander)



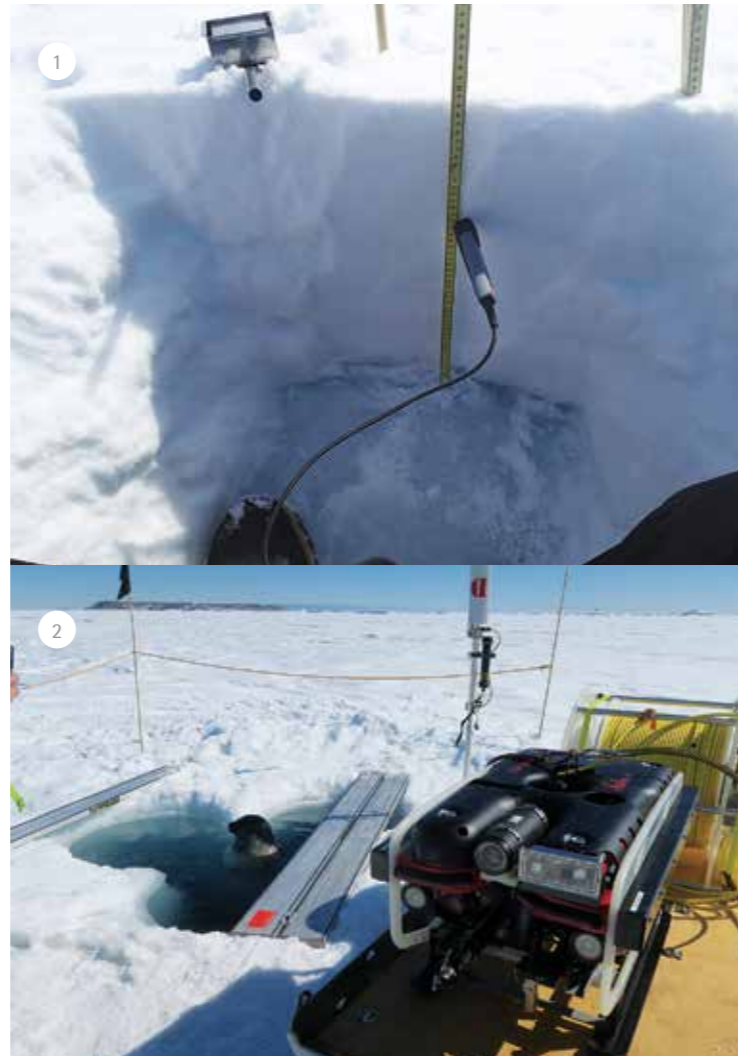
Focus on the East Antarctic fast ice

Early this season Davis station saw an influx of 12 sea-ice researchers studying various aspects of the near-shore fast ice, through four complementary science projects. Two of the project leaders, Drs Klaus Meiners (fast-ice algae) and Petra Heil (fast-ice physics), review some of the work.

Land-fast sea ice ('fast ice') is the dominant cryospheric feature of the near-shore zone. It is a sensitive indicator and modulator of Antarctic climate processes, and a structuring component of Antarctic marine ecosystems. Our projects focussed on characterizing the fast ice and overlying snow within the atmosphere-ocean system before, during and after the spring transition, and linking these to changes in the fast-ice associated algal biomass.

After a delayed arrival our team was quickly deployed, thanks to excellent station support, including speedy access to our science cargo and early field training. Over three weeks the fast-ice physics and ecosystems team worked along four detailed transects. At each of these a remotely operated vehicle or 'ROV' was deployed under the sea ice to measure the physical and biological properties of the fast-ice sub-surface (*Australian Antarctic Magazine 29: 12-13, 2015*). The ROV was equipped with a radiometer (light sensor), cameras, and an upward-looking sonar to detect ice draft (ice extent below the surface) as it 'flew' under the ice along its 128 m transects.

During these dives the ROV-mounted radiometer collected more than 2940 light spectra. An 'L-arm' radiometer was also deployed through holes in the fast ice at 48 locations across the transects, to collect simultaneous data of ice-algae biomass and under-ice light spectra. Together, these radiometer data will be used to estimate the amount of algae, and to understand its spatial and temporal distribution in



1. In this 49 cm-deep snowpit the sea ice surface is visible at the bottom. The photo shows a probe measuring snow temperature, and a metal cutter of known volume used to acquire snow density samples up the snow column. (Rob Massom)
2. This Remotely Operated Vehicle carried a range of instruments to study the sub-surface of the ice, including a radiometer, used to take under-ice light measurements to determine algae growth and distribution in the bottom layers of the fast ice. (Pat Wongpan)
3. Dr Petra Heil measuring and recording snow depth and GPS position using a GPS-MagnaProbe device. (Rob Massom)



the Davis fast ice and the physical drivers of ice-algal growth in coastal Antarctic environments.

To investigate the physical environment, coincident snow-thickness and ice-surface temperature measurements were taken along the ROV transects. At least two snow pits were dug along each transect to examine snow cover, which affects light penetration and algae growth. These snow pits provided information on the vertical distribution of snow temperature, salinity, density, grain size and other parameters. Ice cores were retrieved to derive vertical profiles of ice temperatures, salinity, density, structure and oxygen and deuterium isotope composition.

Complementing the survey were intensive snow-thickness measurements over the wider area, which were referenced to the ice surface using GPS. The teams also retrieved more than 130 sea-ice cores across the broader study area, to measure the size and form of ice crystals and to determine ice algal biomass using classical techniques.

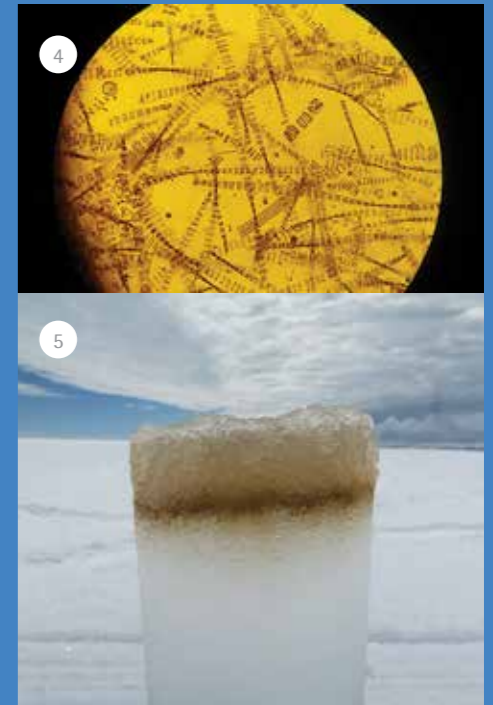
As part of an over-winter project a pair of sea-ice mass-balance stations (measuring gain and loss of ice) have been recording vertical profiles of ice and snow temperatures (at 2 cm intervals) as well as the temperature of the near-surface ocean and atmosphere. To merge these observations with seasonal changes in the deeper oceanic layers, vertical profiles of

the ocean properties were collected at the transect sites as well as next to the over-winter ice mass-balance site.

We had a fantastic time at Davis. Despite some delays we completed our sampling program successfully, thanks to the excellent support by the entire Davis station personnel who provided field training, maintained vehicles and repaired broken scientific gear, amongst other things, throughout our stay.

We will undertake specialised technical analysis of our samples once they are returned from the field. However, based on early data exploration there is a strong indication that the blizzard we experienced during the middle of our sampling delayed the spring melt of the sea ice and thus extended the algal season in the Davis fast ice. We speculate that potential future changes, such as in Antarctic snowfall during spring, may have flow-on effects on ice-covered marine ecosystems. The collected data will help to test this hypothesis.

PETRA HEIL and KLAUS MEINERS
Australian Antarctic Division



4. A microscopic view of sea ice diatoms collected from fast-ice cores. These algae have silicate frustules and form colonies and chains, and are adapted to the low light conditions under the ice. (Florian Deman)
5. Some 130 ice cores were collected across the transect sites to measure algae biomass using classical methods. (Pat Wongpan)

This Image

Most of the fast-ice team (absent: Marie Bigot). (Grant Jasiunas)



Drones take ICECAP flights to new heights

Long-range drones took Australia's East Antarctic Ice Sheet studies to new heights this past summer.

Between February and March 2016, Wilkins Runway hosted test flights of 'Tiburon Junior', developed by Intuitive Machines, a Houston (Texas) based engineering company. The flights represented the next phase of the ICECAP* project which, over the past seven years, has been simultaneously surveying ice sheet structure and underlying bedrock topography and geology, while monitoring how certain areas of the ice sheet are changing. Beginning in summer 2017-18, Tiburon Junior's big brother, 'Tiburon', will join the survey team.

Australian Antarctic Division glaciologist Dr Jason Roberts said the drones, carrying variations of the scientific equipment normally installed in a seven tonne Basler BT-67 aircraft, will ultimately allow the project team to more efficiently monitor ice sheet change and explore new and difficult to access areas in the continental interior and offshore.

"While the Basler remains our primary workhorse, the drones give us more flexibility to operate over the continental shelf, because they don't need safety equipment to fly over water. So they can fly further and they can fly over sea-ice covered areas that would be difficult to get to by ship," he said.

"The larger drone also has about twice the range of the Basler, so we can fly further inland, and both drones can fly slower than

the Basler, which improves the resolution of our data because we have less space between data points."

Ice gains and losses

ICECAP aims to uncover information that will enhance modelling of ice sheet dynamics and the understanding of the role of the East Antarctic Ice Sheet in global climate and sea level rise. Antarctica has an annual accumulation rate of 2200 billion tonnes of snow, which is equivalent to about six millimetres of global sea level. This is offset by the loss of ice as it flows from the interior to the coast, where it calves off as icebergs, or melts into the ocean. The balance of these losses and gains determines whether Antarctica causes overall rises or falls in sea level. Understanding the flow path of this ice, and how it might be changing, is a critical piece of the puzzle.

"Bedrock topology and composition affect the path and speed of ice flow," Dr Roberts said.

"So we want to know where there are mountain ranges, basins or flat plains under the ice and what type of rocks are under there. For example, are they 'hot', naturally radioactive rocks that can lubricate the movement of the ice sheet by contributing to the formation of liquid water at its base?"

To find out, the airborne ICECAP toolkit includes ice-penetrating radar, laser altimetry, a camera, gravity meter, and geomagnetic

equipment, to measure ice thickness and structure, ice surface elevation, the presence of liquid water, and bedrock depth, structure and composition.

Drone deployment

This summer's test flights of Junior, conducted by members of ICECAP and Intuitive Machines, focussed on cold weather operations and establishing the logistics required to operate in Antarctica. Junior carried a nine kilogram payload to observe the ice sheet surface, including multispectral imaging, high-definition video and a laser altimeter.

University of Texas Institute for Geophysics geophysicist, Dr Jamin Greenbaum, said that the deployment demonstrated Junior's potential to accomplish a subset of ICECAP priorities next season.

"Given how well Junior flew and that it can fit within Wilkins' operational scope, we're confident that next summer it will be ready to offload some or all of the ice surface monitoring work that the ICECAP Basler normally does," he said.

"Monitoring the ice sheet – observing whether the ice surface is rising or falling over time – with Junior, will allow the Basler to focus on areas requiring the combined set of heavier instruments. Junior also burns far less fuel than any piloted aircraft, so it is a more appropriate platform for flying where larger aircraft have already surveyed."

This experience will set up scientists and the drone's developers to operate the larger Tiburon, with its nine metre-wingspan and 130 kg scientific payload, in two years.

"This season was primarily a pilot run with the smaller drone, and next season will focus on ice surface monitoring," Dr Roberts said.

"In two years' time we'll begin flying heavier ICECAP instruments on the larger Tiburon drone, across the continental shelf and inland."

A key task for Tiburon will be to better map the geometry of the bedrock beneath ice shelves, between Dumont D'Urville and the Shackleton Ice Shelf, to improve how ocean models represent the interaction of warm water with the ice sheet.

Using the Basler, the team will also deploy temperature/depth probes in the same region along the continental shelf, to measure the bedrock depth and provide temperature information to oceanographers.

Deep discoveries

This work follows the discovery in March 2015 of deep channels in the bedrock beneath the Totten Glacier that could allow warm ocean water to infiltrate its base, causing potentially destabilising melting (*Australian Antarctic Magazine 28: 12, 2015*). ICECAP has also shown that the Aurora Basin, which drains into the Totten Glacier, is much deeper than previously thought and sits on bedrock far below sea level.

"Twenty one percent of the Aurora Basin is more than 1000 m below sea level, compared to earlier estimates of 0.2 percent," Dr Roberts said.

Leader of the Australian Antarctic Division's climate program, Dr Tas van Ommen, said these findings suggest the region is more like West Antarctica, where there appears to be gradual but irreversible ice loss.

"If the Totten Glacier were to retreat all the way into the deep Aurora Basin it would lead to sea level rise of at least 3.5 metres," he said.

"Such a change would take several centuries and is equal to, or a little larger than, the potential contribution from all of West Antarctica."

The ICECAP team will also use the drones and Basler to continue the search for deep ice that could provide an ice core with a one million year climate record.

"We've found a site called 'Blob-A', near Dome C, that appears to have ice of the right thickness, about 2.5 km deep, with nice, horizontal internal ice layers and no evidence of liquid water at its base," Dr Roberts said.

"Horizontal layers allow us to accurately date the ice all the way to the base when we drill a core, unlike layers that are folded or twisted over each other.

"If Blob A harbours such an ice core, it will help us understand the cause of a dramatic shift in the frequency of ice ages about 800 000 years ago."

WENDY PYPER

Australian Antarctic Division

"ICECAP (International Collaboration for Exploration of the Cryosphere through Aerogeophysical Profiling) is a collaboration between the Australian Antarctic Division, Antarctic Climate and Ecosystems Cooperative Research Centre, Australian Research Council Special Research Initiative, the University of Texas at Austin Institute for Geophysics, the US National Science Foundation, the UK's Natural Environment Research Council, and the G. Unger Vetlesen Foundation.

1. Two copies of Tiburon Junior that were deployed to Wilkins Aerodrome between February and March 2016. (Jamin Greenbaum)
2. Scott Arndt, lead designer of Tiburon Junior, shows off "Junior", with its 3 m wingspan. The drone can carry a 9kg scientific payload that will allow ICECAP scientists to measure the elevation of the ice sheet. (Joe Bibby)

This Image

This Basler BT-67 aircraft has been used by the ICECAP project to survey ice sheet structure and underlying bedrock topography and geology for the past five years. While it will remain the workhorse of the project, the equipment suite it carries is currently being modified for use in drones. (Paul Helleman)



Antarctic ice cores enhance Australian water management

Antarctic ice cores can extend existing climate records and provide catchment-specific climate information for water resource managers.

Since the mid-1800s climate records of rainfall and temperature have been collected across Australia. The patterns and statistics obtained from this data have since been used to design water and catchment management systems (such as drought and flood mitigation strategies) and water resources infrastructure.

But is 100 years of climate data long enough to show the full range of rainfall possible in Australia and can we adequately manage water resources in our catchments based on this data?

To answer these questions scientists at the Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC) and Australian Antarctic Division are extending existing instrumental climate records for Australian catchments, using thousands of years of sea-salt data obtained from ice cores collected at Law Dome in East Antarctica.

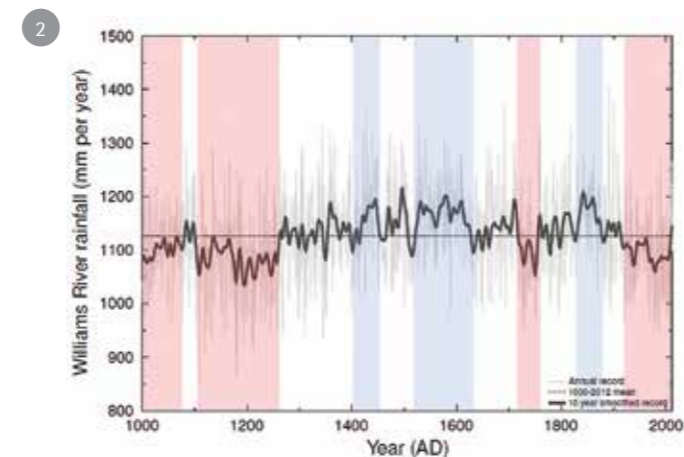
Ice-core sea-salt levels reflect winds over the Southern Ocean, which are connected to large-scale weather patterns that affect Australia. Previous studies have demonstrated how sea-salt variability recorded at Law Dome is related to eastern Australian rainfall, with higher sea-salt levels being associated with higher rainfall and vice versa.

This relationship has recently been exploited to develop a catchment-scale, 1000 year annual rainfall reconstruction for the Williams River catchment; an economically important catchment in the Newcastle region of New South Wales that provides water for urban, agricultural and industrial activities.

The reconstruction shows that significantly longer and more frequent wet and dry periods were experienced in the past 1000 years compared to the past 100 years (see graphic). Although the last 100 years has been drier on average, it is not unprecedented in the context of the last 1000 years, with a particularly dry period evident in the 1100s and 1200s. In addition, there are longer wetter periods in the 1000 year record than have been seen in the recent period. These findings allow us to better characterise flood and drought risk in the Williams River catchment and have implications for managing water resources and infrastructure in the catchment.

This is the first time the link between Antarctic ice cores and Australian rainfall has been exploited to provide catchment-specific climate information for use by water resource managers. The catchment-scale rainfall reconstruction will be utilised to produce a streamflow reconstruction, which can then be incorporated into water resources modelling and management. This will ultimately increase water security and improve the environmental health and sustainability of critical water supply catchments. The method can be expanded to other catchments in Australia that reveal a similar relationship to East Antarctica.

CARLY TOZER and TESSA VANCE
ACE CRC



Read more in: Tozer, C. R., Vance, T. R., Roberts, J., Kiem, A. S., Curran, M. A. J., and Moy, A. D. An ice core derived 1013-year catchment scale annual rainfall reconstruction in subtropical eastern Australia. *Hydrol. Earth Syst. Sci.* 20, 1703-1717, doi:10.5194/hess-20-1703-2016, 2016.

1. Ice cores collected from Law Dome in East Antarctica contain sea-salt concentrations that reflect winds over the Southern Ocean. These winds in turn are connected to large-scale weather patterns that affect Australia. (Joel Pedro)
2. Graphic showing annual rainfall variability in the Williams River catchment over the past 1000 years, based on sea-salt data from Law Dome ice cores. Red and blue bands highlight predominantly dry and wet periods, respectively. (Carly Tozer and Tessa Vance)



1. New (2016) Macquarie Island Station Leader, Esther Rodewald. (Glenn Jacobson)

'Esther Rodewald's experiences in the world of film and television sound perfectly suited to her new role as Macquarie Island Station Leader.'

Lights, camera...Macquarie Island

At first glance you may think that someone working in a production office for television shows such as *House Husbands*, *Angry Boys* and *Lonely Planet*, would have little in common with a subantarctic station leader.

But Esther Rodewald's experiences in the world of film and television sound perfectly suited to her new role as Macquarie Island Station Leader.

"Working in a production office you have to answer lots of questions, research how to do things – such as chartering a plane or moving people between camps – and then manage those logistics," she said.

In fact, Esther's self-described perfect day sounds much like a station leader's lot.

"I'm used to jobs where you can't be in a set routine because you don't know what tomorrow is going to bring. I enjoy figuring out how to do multiple things at once, and working with a team to achieve a common goal."

People and travel are also a big part of what drives Esther. In her early career, not long out of the Sydney College of the Arts, she worked as a Production Coordinator for the iconic Australian film *The Adventures of Priscilla, Queen of the Desert*. With a small cast of three and a young, energetic crew, they travelled around Australia – on a "family road trip" – to shoot the low budget film.

"Relationships get quite intense quite quickly, but then filming ends and you go back to your real life. You might not see people for years, but when you do it's like a family reunion and you just pick up where you left off."

As someone who "gets excited if a job comes with a boarding pass", Esther has spent a lot of time living in one-horse towns, but also big cities such as London, New York, Havana, and Paris. For her most recent film, a psycho-thriller called *Berlin Syndrome*, she spent two months in Berlin.

"When you go to a place to work you see it very differently to a tourist," she said.

"In Berlin we stayed in an apartment and caught a train to and from work. We did the grocery shopping. We met the locals and visited their homes and got to see how they lived.

"You might miss seeing some of the iconic sights of a city, but the place across the road knows how you like your coffee."

While the only coffee on Macquarie Island will be the do-it-yourself kind, Esther is looking forward to the remoteness and simplicity of being 1500 km from the hustle and bustle of city life and the relentless expectation of an online presence and 24 hour connectedness. In fact, it was a trip to Iceland with a friend that got Esther thinking about Antarctica.

"After the trip I googled Antarctica and ended up on the Antarctic Division website, which just happened to be advertising jobs," she said.

While she was initially uncertain about the application of her skills to the station leader role, a chat to a former station leader soon convinced her.

"He said that scientists sound a lot like actors – because when you're talking about priorities, everyone thinks that what they're doing is the most important thing that has to be done today. So as a station leader, you have to be the person that balances all those things," Esther said.

The challenge is a drawcard for Esther, who revels in being amongst people who are passionate about their work and who actively contribute to their own success and the success of what they're engaged in.

Esther is also excited by the prospect of seeing wildlife, particularly penguins, and getting in tune with the seasonal cycles of the island. She's looking forward to engaging with her team and the work that they do. And she's happy to be part of a family of "13 new best friends".

While Esther is very much a behind the scenes go-getter, when you next watch *Priscilla Queen of the Desert*, look out for the waitress in the red wig.

WENDY PYPER
Australian Antarctic Division



Career challenges shape new Chief Scientist

At 16, the new Chief Scientist of the Australian Antarctic Division, Dr Gwen Fenton, applied to study physiotherapy in Melbourne. But when she discovered she was too young to enrol she began a science degree at the University of Tasmania – initially just for a year.

Several decades on, Gwen has excelled in a career spanning marine research, marine environmental policy development, and the coordination and planning of the Australian Antarctic Science Program. All the while, she and her scientist husband raised two children as they pursued an uncertain and demanding profession.

"Life was quite complicated with a young family, but I worked half a day, every day until I could go full time, so that I would remain employable," Gwen said.

"It was not an easy path, but it was very satisfying and I got to do a lot of different things that gave me the skills and experience I rely on today."

Gwen had a head start as a scientist. Her mother majored in zoology at university and her father was a cosmic ray and aurora physicist with both the United States and Australian Antarctic programs during the 1950s.

"I was always interested in science and familiar with pictures and stories of the Antarctic, but it never occurred to me that I'd end up at the Australian Antarctic Division," she said.

"I did do some physics, but it was a bit too close to home because my father and uncle both taught at the university. I always liked the sea, so I majored in botany and zoology."

Gwen did her Honours project on the krill species *Nyctiphanes australis* – one of the key food-web species in the coastal waters of south-eastern Australia and southern New Zealand. She used stable isotopes (heavier and lighter forms of the same chemical element) to look at "who was eating who". She extended this food web research during her PhD to mysid (shrimp-like) crustaceans in Tasmanian

waters, and discovered three new genera and 12 new species.

"I did a lot of field work off Bruny Island, and getting qualified to SCUBA dive for my PhD was part of the fun," she said.

"Some of my fieldwork involved 24 hour sampling with a small team, where we were diving every three hours to collect samples to study population dynamics and diet."

Gwen graduated with her PhD at the age of 24 – two years earlier than most doctoral students – and went on to spend 11 years working in post-doctoral research. During this time she developed a technique to age fish that enabled her to show that the deep sea fish, orange roughy, could live for more than 100 years.

"I'd come across a radiometric method involving the radioactive decay of radium-226 to lead-210 [$^{226}\text{Ra} \rightarrow ^{210}\text{Pb}$], which I thought I could apply to fish ageing questions in Australia. As a fish grows, it takes up radium in its otoliths (ear bones) which then decays at a known rate, providing a natural clock," Gwen said.

Working closely with collaborators at the Australian Nuclear Science and Technology Organisation (ANSTO), and using more traditional methods at the

Queenscliff Fish Ageing Laboratory (Victoria), they began to unearth some very interesting results.

"Other ageing methods at the time suggested that orange roughy lived for about 12 years, so people didn't believe us. But we were able to prove, with good, careful measurements, that the oldest fish we had was over 100."

The finding, when it was accepted, affected the way orange roughy was fished.

"Our work at that time showed that orange roughy don't mature until they are between 20 and 25 years of age, so the existing catch limits were not sustainable for such a slow growing fish."



In 1996 Gwen was offered a Tasmanian government position in marine environmental management and policy development. The work included helping to develop an environmental monitoring program for the salmon farming industry in Tasmania, policy development for marine pests and ballast water, and providing environmental advice for major marine infrastructure developments.

"I learnt a lot about how to negotiate major change with a range of parties and how to work with government," Gwen said.

For seven years she honed the communication and negotiations skills that would support her next career move to the Australian Antarctic Division. Here she led the team running the science application process and the planning and coordination of each season's science projects. She was also involved in long term science planning, and developing the Antarctic Science Strategic Plan.

"I particularly enjoyed having contact with the scientists from all the institutions participating in the program and helping them, where I could, to achieve their projects," she said.

If a voyage or flight was disrupted, for example, it was Gwen's role to explain the impact on current and future science projects within the season, and help minimise the impact so that projects could meet their objectives.

"Season planning each year is complex; working out which scientists are going to travel where, and when, and the logistics that are needed to make their projects work. It is a real team effort and it has been great working with science, operational and policy colleagues across the Antarctic Division to do this," Gwen said.

Throughout it all Gwen has been rigorous about maintaining her independence, deliberately avoiding becoming involved in science projects, and making infrequent trips to Antarctica so that other scientists had opportunities. As a result, she has visited the continent only once by ship – travelling to Mawson, Casey and Macquarie Island in her former science planning and coordination role. More recently, she has had two flights to Wilkins Aerodrome while acting in the Chief Scientist role, and in February this year, as the newly appointed Chief Scientist, she spent a few days at Casey, meeting scientists and observing the science facilities on station.

It is this independence, as well as her deep knowledge of the complexities of the Australian Antarctic Science Program, that Gwen thinks will be valuable attributes in her new role. Her genuine care for people and desire to help them get the most from their projects is also apparent, but she's not afraid to make tough decisions.

"As the delegate for scientific grants and projects I've probably said no to more people than anyone else," she said.

This year Gwen's focus will be on reviewing the science strategic plan and opening the next round of Australian Antarctic science applications. She'll work to strengthen collaborations through the Antarctic Gateway – encouraging East Antarctic partners such as China, India, Japan and France to use Tasmania for aspects of their Antarctic operations. And she'll work to ensure that the science program is ready for the additional capability that the new icebreaking ship will bring in four years' time.

"The new ship will give us a capability beyond anything we've ever had and we need to plan for it," she said.

"We'll have new equipment for seafloor mapping and to deploy underwater vehicles, but that means we'll have a whole lot more data to analyse, and we'll need to attract more collaborators to help run and support the experiments.

"I see the Australian Antarctic Division playing a strong leadership role in helping scientists, nationally and internationally, to coordinate and run projects on the ship."

It sounds like a challenge, but, as her career path attests, one that Gwen is eminently prepared for.

WENDY PYPER

Australian Antarctic Division

1. Gwen outside the communications hut at Casey research station. (Marcel van der Schoot)
2. As an independent arbiter of science projects Gwen has rarely visited Antarctica. She enjoyed a recent opportunity to visit Casey research station in her new role as Chief Scientist. (Marcel van der Schoot)
3. Gwen in the atmospheric research hut at Casey research station. (Marcel van der Schoot)
4. Gwen takes a tour of the Casey research station infrastructure.. (Marcel van der Schoot)



Icebreaker Master retires

Captain Murray Doyle has been a familiar face to those commuting back and forth to Antarctica on the *Aurora Australis* for the last 20 years.

But after some 50 voyages as Master and Chief Officer of the iconic orange icebreaker, Captain Doyle concluded his exciting, sometimes frightening, and award-winning career, with a happily uneventful resupply of Casey station in December 2015.

"Even though the way into Casey was eight or nine tenths ice, it was brashy stuff around big floes, so we could push the floes out of the way...it was a pretty easy voyage," he said.

When you spend as much time navigating the Southern Ocean as Captain Doyle has, however, there's plenty of excitement to be had; not all of it welcome. Once, on a late season trip to Davis, the ship was caught in a blizzard and wedged between two icebergs.

"I called back to Australia and declared it an emergency because the ship was rotating as the icebergs alongside us moved," Captain Doyle said.

"I was worried these big sheets of ice would get pushed up against the propeller. Instead they made a V shape around the stern of the ship and protected us as they rotated.

"We found out later that the ice pushing underneath the hull had caused quite a bit of damage in the tanks, though we were still watertight, so we weren't in any real danger. The closest ship was three weeks away, so we were lucky we got out. That was a scary moment."

Other memorable occasions included two resupplies at Mawson – one when the harbour was blocked by an iceberg and refuelling was done by running the fuel hose over the peninsula, and another completed by long-range fly-off, when the sea ice didn't break out.

Captain Doyle also faced challenges during the early season Sea Ice Physics and Ecosystems eXperiment (SIPEX) voyages in 2007 and 2012 (*Australian Antarctic Magazine* 23: 4–11, 2012), including becoming beset in sea ice for about two weeks and losing a few scientific samples when sea-ice floes unexpectedly broke up. Mostly, however, it's the people and the work that make the voyages memorable.

"Marine science voyages are very enjoyable, with all the mixing of people," he said.

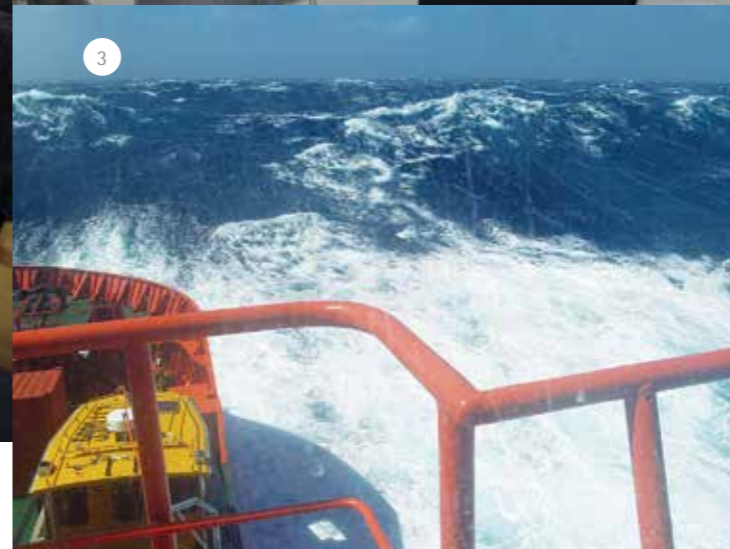
"I've met and worked with a real mix of people over the years, from scientists, tradies and

station leaders, to voyage management. You're always working alongside people and often meet the same people on subsequent voyages, so you build really good relationships. It's very satisfying to see people succeed and achieve what they are aiming for."

Prior to his appointment on the *Aurora Australis* Captain Doyle worked on oil tankers off the Australian coast, Indonesia and the Arabian Gulf. Despite this maritime experience, the unique challenges of navigating an icebreaker meant looking at things quite differently.

"It's not just a matter of going from point A to point B; you've got to be able to read the ice to know what you can get through and what you can't," he said.

Fortunately, charting a path through the ice has been made a lot easier with advances in satellite imagery. When he started on the *Aurora Australis*, ice charts were provided by NASA, but the information was almost a week old by the time the charts arrived on the ship and it was a real "guesstimate" of ice thickness and concentration. Today, satellite images processed through TeraScan and Polar View and



1. Captain Murray Doyle on the bridge of the *Aurora Australis* in 2012. (Dean Lewins)

2. Captain Murray Doyle receives his Antarctic Medal from Governor General Quentin Bryce in 2011. (Sam Groves)

3. Captain Murray Doyle has had his share of excitement in the Southern Ocean, including navigating these big seas during the 2007 SIPEX voyage. (Sandra Zicus)

4. Captain Murray Doyle is presented with a weathered ANARE flag and certificate in honour of his last voyage to the Antarctic continent, by Casey station leader Pete Pedersen, in January 2016. (John Cadden)

'It's not just a matter of going from point A to point B; you've got to be able to read the ice to know what you can get through and what you can't.'

interpreted by sea ice specialists at the University of Tasmania, provide a reliable, next-day assessment of ice conditions.

"The first season that TeraScan was available to us we used it on a trip from Davis to Mawson," Captain Doyle said.

"We would usually go a fair way north and come around all the ice, but we got some very good images and could see there were some big leads going east to west, so we just shot straight across. We saved three days of steaming on that trip to Mawson, and up to 90 000 litres of fuel."

An innovative trial using a quadcopter 'drone' for sea ice navigation (see page 4) on Captain Doyle's last trip south, gave a little taste of the future.

"That was very interesting. To be able to throw a drone up into the air and get a good idea of what was ahead was very useful. I think we will see more of that technology; it's the technology of the future."

Captain Doyle's commitment to the goals and people of the Australian Antarctic program has made an important contribution to the ongoing success of Australia's activities in Antarctica. In recognition of this, in 2011 he was awarded an Antarctic Medal for his contribution to scientific and logistic activities in Antarctica as the Master of the *Aurora Australis*.

He is philosophical about the imminent retirement of the ship and its replacement with a new icebreaker.

"There's going to be a 30 year gap in technology. A lot of things have happened since the *Aurora Australis* was built, so the new ship should be much more efficient and have greater capabilities," he said.

While he has plenty of ideas about how the *Aurora Australis* could spend her retirement from Antarctic duties, he also has plenty of plans for his own retirement, including volunteering for maritime causes and indulging his love of travel.

"A couple of years back I did the Camino in Spain, and I'd like to do one of the other Camino walks, in Portugal or elsewhere," he said.

"I wouldn't mind visiting South Georgia and the Falkland Islands, just for something different. Although I don't know how I'd go on a tourist ship, with all these people standing around in groups photographing everything that moves!"

JILL BROWN

Australian Antarctic Division

Heavy-lift flights boost Antarctic capabilities

Records were broken at Wilkins Aerodrome in Antarctica this season with the landing of the largest aircraft ever on the ice runway – the 270 tonne C17-A Globemaster III – on 5 November 2015.

The Royal Australian Air Force (RAAF)-owned and operated aircraft went on to successfully complete a further four proof-of-concept flights over the course of the season, moving more than 109 tonnes of machinery and cargo into and out of Antarctica for the Australian Antarctic Division. A fifth flight was undertaken to recover three B3 Squirrel helicopters and 30 expeditioners, following the grounding of the *Aurora Australis* at Mawson late in the season.

It is the first time the RAAF has flown missions to the Australian Antarctic Territory since 1963.

Australian Antarctic Division Future Concepts Manager, Mr Matt Filipowski, said the success of the collaborative operation, which was five years in planning, demonstrated that heavy lift flights could fill a niche in the Antarctic Division's operational and logistical needs.

"Our Airbus A319 moves people very well, while our ship moves large, bulk cargo in slow time very well," he said.

"However, there's a niche in the middle for high priority, outsize cargo that needs quick turnaround times and that's too big to fit into the A319."

For example, during the trial flights the C17-A, which can accommodate 72 tonnes of equipment, carried a 23 tonne tractor

to Hobart for repairs and returned it to Antarctica two months later. Without this capability the tractor would have been out of action for two years, as it travelled to and from Hobart by ship.

Mr Filipowski said this capability could change the way Antarctic science projects are supported. In the 2014-15 summer, for example, Australian Antarctic Division scientists conducted an ambitious ocean acidification experiment that required the deployment by divers of scientific equipment beneath the sea ice off Casey station (*Australian Antarctic Magazine* 28: 8-9, 2015), as well as the delivery of containerised computer and engineering equipment and dive compression chambers to the station. This required the pre-positioning of equipment a year in advance of the project starting, followed by removal of most of the equipment by ship in the 12 months after the project had finished.

"With a heavy lift capability that entire project could have conceivably been lifted in one flight, delivered to Casey, and then returned to Hobart in a single season," Mr Filipowski said.

"Instead we had some equipment sitting idle on station for 12 months, requiring resources and space on station, when it could have been put to use back home."

As well as time and resource efficiencies, the C17-A aircraft could support new scientific and operational capabilities.

"If we or our Antarctic neighbours wanted to conduct a traverse we could deliver heavy vehicles. We could deliver containerised laboratories for science projects. And we could develop an air drop capability to deep field science camps or stations," Mr Filipowski said.

"We could also operate helicopters out of Casey for the first time in many years. At the moment they have to remain on station over winter because they're locked into the resupply schedule of the ship – which is in turn dependent on the sea ice conditions. So that's very expensive. But with the C17-A we could potentially get them in to start the season early, and pull them out at the end."

These exciting possibilities do bring new challenges, however, which the proof-of-concept flights highlighted.

"The heavy lift aircraft brings in a great deal of cargo very quickly and one of our challenges is to efficiently move that cargo onward," Mr Filipowski said.

"If the RAAF continue to support us we'll need to work to improve this system and integrate it into our operational supply chains."

While the Antarctic Division has a lot to gain from this collaboration, the relationship is not all one-sided, with the RAAF acquiring valuable cold weather training for their pilots and crew, and experience operating a new generation of highly automated aircraft in the extreme cold.

Director General Air Operations, Air Commodore Joe Iervasi, said that from a RAAF point of view the flights had been a huge success.

"We successfully moved over 109 tonnes of machinery and cargo both in and out of Antarctica, conducted an air drop of four heliboxes from 500 feet and simulated an emergency aeromedical evacuation," he said.



"The opportunity to test the C-17A in these conditions has proven to be an invaluable experience for the Air Force to enhance the capability of this aircraft and Australia's logistical and scientific capabilities in Antarctica."

The proof-of-concept flights were completed in February 2016 and a full review is now underway by the Antarctic Division and RAAF. The Department of Defence intends to engage with the Department of the Environment and reach a Memorandum of Understanding regarding future support to the Antarctic Division, which will include C17-A airlift.

WENDY PYPER
Australian Antarctic Division

1. Pallets of equipment packed inside the C17-A on its way to Antarctica. (Eliza Grey)

2. C17-A Air Commodore Richard Lennon (left) and Australian Antarctic Division Director, Dr Nick Gales, on the first proof-of concept flight to Wilkins Aerodrome. (David Said/RAAF)

This Image
Moving the large amounts of cargo from the C17-A onward is a new challenge for the Australian Antarctic Division. (Justin Hallock)



Century-old artefacts uncovered at Mawson's Huts

More than a century after they were left behind, Douglas Mawson's hard worn leather boots still sit on the shelf where he left them. His pillow still lies on his bunk. Old jumpers and balaclavas and other detritus lie undisturbed on the floor and hang from the bunks of the hut that bears his name.

An expedition to Australia's first Antarctic outpost this summer uncovered these and a trove of other artefacts from the 1911–14 Australasian Antarctic Expedition, for the first time in more than a century.

With the support of the Australian Antarctic Division, the Mawson's Huts Foundation has been working since the mid-1990s to preserve the huts built by Sir Douglas Mawson and his men at Cape Denison. Situated 1500 km south of Hobart, it's probably one of the most remote conservation projects ever carried out. The six-person party was transported from Hobart by the French Antarctic vessel *L'Astrolabe*, and stayed in a field camp while working on the hut for six weeks over December and January (2015–16).

Building on the work of previous conservation efforts, the field party managed to remove most of the snow and ice remaining inside Main Hut. In doing so, they revealed an astonishing array of artefacts; among them a complete set of clothing belonging to Belgrave Edward Sutton Ninnis, who lost his life in Antarctica.

The clothing was left washed and neatly folded in the Mangetograph House, a small wooden structure several hundred metres from Main Hut. Clothing labels and a tailor's receipt confirmed them to have been Ninnis' – who was nicknamed 'Cherub'. He was one of the most popular members of the expedition until his untimely death, when his sled broke through a crevasse while on exploratory trip with Mawson and Swiss skiing champion Xavier Mertz. Mertz also lost his life on the return voyage and it was Mawson alone who made it back to Cape Denison after an epic journey of survival against the odds (*Australian Antarctic Magazine* 22: 4–7, 2012).

Mawson chose the site for the huts on a rare windless day, but later cursed his luck when it turned out to be the windiest place on earth at sea level. Main Hut is one of four buildings surviving from Mawson's time: the Magnetograph House remains in almost original condition while the Transit Hut (used for astronomical observations), and the Absolute Magnetic Hut, remain as standing ruins. The fact Main Hut survives at all is somewhat astounding considering the simplicity of its Baltic pine structure and its location.



1. The Mawson's Huts conservation team on completion of the season's work. L-R: Michelle Berry, Marty Passingham, Sally Hildred, Ian Godfrey, Peter Maxwell and David Killick. (David Killick)

2. Belgrave Ninnis' laundered clothing was found in a neatly folded pile in Magnetograph House. (David Killick)

3. By the end of the expedition the floor of both the living and workshop sections of Main Hut were largely free of snow and ice. For the first time since Mawson's men left, it is possible to appreciate the interior of the hut as it would have looked back in 1914. (David Killick)

4. The Mawson's Huts conservation team had a lot of work ahead of them to excavate ice and snow from Main Hut. (David Killick)



In addition to Ninnis' clothing, Main Hut gave up a trove of personal effects chipped delicately from the ice. There were old woollen jumpers in various states of repair and even a pair of trousers hanging from a hook. There were bottles and boxes of matches, the long-lost legs of the expedition's dining table, and the brooms used to sweep the floor at night. A pair of skuas that had apparently made the hut their home, were found entombed in the ice. One of Mawson's old sled dogs, 'Grandmother', was moved from the hut's verandah area to a temporary home under Mawson's bunk, where the temperature is more stable year-round. The dog was recovered from the polar plateau around seven kilometres inland from the hut in 1997, still curled up on the snow where it had died during a prolonged blizzard.

The restoration of the Main Hut has followed three broad themes since the first major conservation expedition in 1997. The first task facing the Mawson's Huts Foundation was stabilisation of the structural fabric of the building. The second was to overlaid the hut's roof, which had become perilously thin due to decades of wind-blown ice. Finally, there was the removal of tonnes of snow and ice from inside the hut; the focus of the 2015–16 expedition.

Throughout the living section and the workshop of the hut there remained around 30 cm of snow and ice build-up over the floor; even deeper in areas like the hut's kitchen. Making the task even trickier was the presence of valuable artefacts scattered randomly through the strata all the way down to floor level. It made for slow and arduous work, chipping and clearing and removing the ice from the hut. But the reward for the effort was immense for the team members. By the end of the expedition the floor of both

the living and workshop sections were largely free of snow and ice.

For the first time since Mawson's men left, it was possible to appreciate the interior of the hut as it would have looked back in 1914. The transformation was astonishing, and a major milestone in the long-running project.

The team chosen for the expedition was the most experienced ever assembled for conservation works on Mawson's Huts. Between the six members there was a combined experience of 37 expeditions to the continent. The team was led by Marty Passingham – a heritage carpenter and helicopter pilot with extensive Antarctic experience. There were three materials conservators, Dr Ian Godfrey, Michelle Berry and Peter Maxwell. First-timer, Hobart general practitioner Dr Sally Hildred, acted as the expedition's doctor, and I took leave from my day job at *The Mercury* newspaper to take photos, write stories, do the weather observations and run the communications equipment.

The environment around Commonwealth Bay has changed significantly in recent years due to the presence of iceberg B09B. Grounded at the western edge of the bay, fast ice has built inshore of the berg, making access more difficult. This season we deployed from helicopters from the sea ice edge, some 20 nautical miles away. We enjoyed good fortune not normally bestowed on those who venture into the 'Home of the Blizzard'. Our transit

across the Southern Ocean was unnaturally smooth and our deployment from *L'Astrolabe* fast and faultless. The usual cycle of blizzards were also absent, allowing us to make exceptional progress during our six-week stay.

Like with any old building, there is a lot of work still to be done to preserve Main Hut into the future. Future conservation expeditions are expected to perform maintenance and monitoring of the hut's internal environment. There is still snow and ice in many of the less accessible areas of the hut and there remains important artefacts still unseen within. With continued attention the future of this 'Heroic Era' building should be assured well into its second century.

DAVID KILICK
Journalist

Preparing polar doctors of the future

Former astrophysicist, science teacher and helicopter pilot, John Cherry, could certainly take his pick of any number of exciting careers. But it is expedition medicine, and in particular Antarctic medicine, that has really captured his imagination.

Now an intern at the Orange Health Service in regional New South Wales, Dr Cherry has just returned from a month-long visit to Antarctica as part of an extra-curricular medical placement at the Australian Antarctic Division's Polar Medicine Unit.

The placement is part of the John Flynn Placement Program (JFPP), which aims to encourage medical students to work in rural and remote areas when they graduate (*Australian Antarctic Magazine* 24: 30-31, 2013).

For the past three years, Dr Cherry and two other JFPP participants, Jessie Ling and Felix Ho, have spent two weeks a year working with doctors in the Polar Medicine Unit to learn more about what it takes to be an Antarctic doctor. This included restocking medical supplies for Australia's Antarctic and subantarctic stations and the ship, *Aurora Australis*, engaging in teleconferences with doctors on station, and participating in the medical teaching practice of 'grand rounds'.

This season, at the culmination of their placements, Dr Cherry and Ms Ling travelled on the *Aurora Australis* to Casey research station, for some hands-on experience of polar medicine.

"We had almost two weeks on station and we helped with the resupply of the medical facility, we assisted with some minor dental work on a patient, and we had a tour of the facilities," Dr Cherry said.

One of the station doctors arranged for some scenario training, based around a patient who had been exposed to the elements overnight following a trauma on a quad bike. The pair provided initial treatment, then loaded the patient on to a stretcher and took them back to the station for further care.

"It's not often you get to do Antarctic trauma training on a glacier surrounded by penguins. It was quite surreal but very educational," Dr Cherry said.

Dr Cherry was inspired by the clinical excellence of the doctors he met during his Antarctic placement.

"The uniting theme across experienced and first time Antarctic doctors is their well-rounded and excellent clinical skills that allow them to deal with any medical emergency in such a challenging environment," he said.

"While telemedicine and the support of doctors in the Polar Medicine Unit mean they're never alone in Antarctica, they really need such a broad range of skills compared to medical specialists, and it's something I hope to emulate in my future career."

Dr Cherry was also impressed by the sense of community, with everyone chipping in to help with different aspects of station and ship-board life on top of their own responsibilities.

As a result of his time at the Antarctic Division and in Antarctica, Dr Cherry is now considering training to become a rural GP. His current internship and next year's Resident position in Orange is a direct result of advice from Antarctic doctors that rural practice allows doctors to gain skills earlier in their career than they might working in metropolitan areas with a greater workforce.

"As soon as I'm qualified and experienced enough I hope to apply for a position with the Antarctic Division's Polar Medicine Unit," Dr Cherry said.

"Medicine allows you to serve those most in need anywhere in the world, and it gives you the opportunity to travel and seek adventures that you couldn't get with other professions. I want to make the most of that."

The JFPP is funded by the Australian Government's Department of Health and administered by the Australian College of Rural and Remote Medicine (ACRRM). For more information visit www.acrrm.org.au/preparing-for-your-career/john-flynn-placement-program.

WENDY PYPER

Australian Antarctic Division

1. Antarctic doctors of the future, John Cherry and Jessie Ling, during their voyage to Casey station. (Expeditioner Photo)

2. John Cherry (left) and Jessie Ling secure a patient for transport during scenario training at Casey station. (Expeditioner Photo)



1. Antarctic Medical Practitioners Rachel Hawker (left) and Grant Jasiunas (right) with John Cherry and Jessie Ling at Casey research station. Among the highlights of the John Flynn Placement Program students' time in Antarctica were informal career advice discussions with the medical team atop Reeves Hill (pictured) while watching Adélie penguins traversing the ice below, as well as visiting the Mitchell Peninsula, camping at the 'Wilkes Hilton', cross country skiing, and the intense dart and pool matches on station. (Expeditioner Photo)

Antarctica inspires medical future

Over the 2015-16 summer I was fortunate to travel to Antarctica on a month-long return voyage aboard the *Aurora Australis*, as part of the John Flynn Placement Program at the Australian Antarctic Division.

While on the ship, John Cherry (see main story) and I participated in some mock scenarios as part of the medical response team, and helped the ship's doctor in morning clinic in the ship's surgery. During our 11 days at Casey research station, we helped in the medical clinic, unpacking literally a tonne of medical resupply equipment, and discussed career pathways and opportunities in expedition medicine with the medical team. We put our practical skills to the test in the Antarctic environment during a realistic field medical scenario, and I was also able to assist with some dental procedures and had some tutoring in how to perform fillings.

The experience heightened my awareness of the challenges associated with delivering health care in isolated areas and living and working in a small community. As a member of a small group, which is both a working unit and a social community, professional and social roles intersect. As the medical officer, your patients are also your friends and support network.

The trip also reinforced for me the distinct aspects of Antarctic work for the station doctors. The isolation, remoteness and harsh environment result in health issues that are peculiar to this extreme setting, which the station doctor must be able to manage. While modern technological developments, such as telemedicine and the digitization of medical information, have lessened the 'tyranny of distance', medical practice in Antarctica remains uniquely challenging.

These challenges pale in comparison to the tremendous opportunity to work in, and enjoy, the mesmerizing Antarctic landscape and wildlife. The strong sense of community at Casey station, and the enthusiastic welcome from all expeditioners, also made this a truly exceptional experience.

I'm currently in the final year of my medical degree in Launceston (Tasmania), and have a few more years of training ahead before I can apply for a position as an Antarctic doctor. However, the tantalizing prospect of returning to work in the great southern continent will fuel some of the long nights in the hospital ahead. I would especially like to thank my mentor, Dr Jeff Ayton, and all the Polar Medicine Unit staff, who have been so welcoming, encouraging and inspiring.

JESSIE LING



1. Philip with his sound recording gear at Casey station.
(Philip Samartzis)
2. Philip spent some time sheltering from a blizzard beside Jack's Hut, while his recording gear "got hammered" – resulting in some exciting recordings of katabatic wind.
(Dan Wilkins)



Katabatic winds inspire sound rendition of Antarctic experience

Sound artist and RMIT University academic, Dr Philip Samartzis, travelled to Casey station as an Australian Antarctic Arts Fellow in early 2016, to explore the interaction of katabatic wind with the built and natural environments.

My project emerges out of an admiration of the innovative photography of Herbert Ponting and Frank Hurley who, by combining subject, composition and climate, conveyed a deeply mysterious and alien place. I am particularly intrigued by Hurley's depictions of life on the ice through two iconic photographs, *The Blizzard* and *Leaning on the Wind*, both taken in 1912. The photographs convey the ferocity and atmospheric effects of the conditions using a mix of techniques, including staged scenes and composite printing, to viscerally express something almost impossible to articulate through conventional documentary photography. Inspired by these evocative depictions of abstract landscapes shaped by volatile conditions, I wondered how I could produce an equivalent account using sound recording techniques to render an embodied experience of extreme climate.

With images of ferocious gales and phantasmagorical landscapes etched firmly into my mind I undertook three weeks of fieldwork at Casey station, interrogating the effects of katabatic wind on the station and surrounding environment. Katabatic wind

is a low gravity wind that gains force as it travels down elevated slopes. It is particularly prevalent at Casey due to its location at the base of Law Dome, which gently rises to an elevation of 1395 m. When the cooler temperature of a katabatic mixes with the warmer temperature of the onshore wind, an erratic weather system emerges, making Casey the ideal location for my project.

Katabatic wind is particularly notable for the way it shapes the manner in which sound is experienced within the built and natural environment. Its trajectory can push sound away from you or it can draw it closer to you. Its intensity can mask sound and its absence can heighten it. At its most ferocious it simply obliterates everything in its path. A collision with the built environment transforms katabatic wind into an intense series of ascending and descending pitches – a supercharged aeolian harp. Inside the braced, steel-framed and insulated panel buildings, pervades a silence that imposes a profound sense of isolation from the immediate environment. Outside, the volatility is expressed through a variety of resonances emitted by miscellaneous surfaces and materials undergoing tremendous stress. On one occasion, while recording from an ice encrusted cold porch, I was informed that wind gusts were exceeding 185 km/h. The piercing shrieks of the anemometer emerging from the white abyss provide testimony to its ferocity.

Over three weeks I recorded an assortment of sound activated by wind and shaped by the cold. Ice granules dancing across sheet metal, agitated flags, murmuring cables,



brittle plastic sheets billowing in the wind, indifferent buildings and infrastructure, wind gusting across desolate ice fields, and the transformative effects of warming and cooling upon the polar environment.

The sound recordings will inform a new series of compositions for exhibition and performance designed to generate tactile and immersive experiences of the sonic ecology of extreme weather events. In development is a new concert work for Melbourne-based ensemble Speak Percussion, combining multi-channel sound recordings with acoustic instrumentation, including specially designed ice instruments and wind machines. Through the convergence of sight, sound and space, expressed within the mutable framework of sound art and experimental performance, vivid and dramatic impressions of nature in extremis will be achieved.

PHILIP SAMARTZIS

Philip Samartzis is the artistic director of the Bogong Centre for Sound Culture (bogongsound.com.au) and Coordinator of Sound in the School of Art – RMIT University. Philip thanks Creative Victoria for their support of his fellowship.

Rare Antarctic artefacts on display

The first flagpole to fly the Australian flag in the Antarctic, and parts of the first aircraft taken to the icy continent, are now on display at the Mawson's Huts Replica Museum in Hobart.

Recovered from Mawson's Huts at Cape Denison between 2006 and 2010, the rare artefacts have been loaned to the Museum by the Australian Antarctic Division.

The flagpole was attached to the apex of the Main Hut when it was built in January 1912 at Commonwealth Bay by Douglas Mawson and other members of the Australasian Antarctic Expedition (1911–14). It was removed in 2006 (and replaced with an identical but new piece of Oregon pine) and returned to Australia for conservation treatment by the Mawson's Huts Foundation.

The aircraft parts were part of a Vickers monoplane, which crashed during a test flight in Adelaide just days before the expedition left for Antarctica in 1911. The expedition took it anyway and used it as a form of tractor to tow sledges along the ice, but it was not a great success (*Australian Antarctic Magazine* 18: 30–32, 2010).

"Mawson left a wonderful legacy for Australia, and these items provide visitors with a unique link to the past, helping to tell the story of those epic early years of Antarctic exploration," Mawson's Hut Foundation Chairman and CEO, Mr David Jensen, said.



1. Australian Antarctic Division General Manager – Strategies, Mr Charlton Clark (left), hands over the flagpole to Mr David Jensen to display in the Mawson's Huts Replica Museum. (Rhonda Bartley)
2. Air tractor parts from the Vickers monoplane, on display at the Mawson's Huts Replica Museum in Hobart. (Rhonda Bartley)

Australian Antarctic Strategy and 20 Year Action Plan

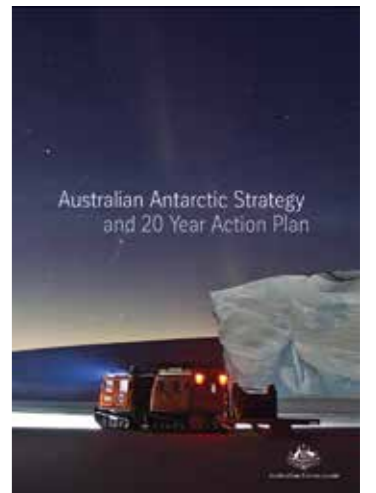
In April the Australian Antarctic community celebrated the launch of the Australian Government's *Australian Antarctic Strategy and 20 Year Action Plan*. The Strategy and Action Plan represents a significant package of measures to build Australia's role as a leader in Antarctica and to strengthen our influence in the Antarctic Treaty system.

The Strategy sets out Australia's national Antarctic interests and the Government's vision for our future engagement in Antarctica. The accompanying Action Plan covers a 20 year period and details the steps the Government will take to fulfil the Strategy.

Key actions include a new icebreaker for research and resupply to replace the ageing *Aurora Australis*, restoring Antarctic science traverse capability, scoping expanded aviation capability and options for year-round aviation access, increased scientific research and international engagement to support a strong and effective Antarctic Treaty system, and enhancing Hobart as an Antarctic research hub and the premier Gateway to East Antarctica.

The Department of the Environment's Australian Antarctic Division is responsible for leading, coordinating and delivering the Australian Antarctic program. Together with agencies across Government, the Australian Antarctic Division will implement the Strategy and Action Plan.

Read more at www.antarctica.gov.au/about-us/antarctic-strategy-and-action-plan.



New icebreaker contract signed

The Australian Government has signed a contract for Australia's new icebreaker with the Australian company DMS Maritime Pty Ltd. The company will be responsible for both the overall design and build of the ship, and the operation and maintenance of the ship over its expected 30 year life. The ship will be built in Romania and is due to arrive at its home port of Hobart in mid-2020.



A model of the new Australian icebreaker.
(©Damen/DMS Maritime/Knud E Hansen)

This next-generation successor to the *Aurora Australis* will provide a step-change in Australia's Antarctic capabilities and is uniquely tailored to meet the Australian Antarctic program's needs. It will have:

- greater icebreaking and cargo capacity;
- increased endurance and operational flexibility;
- a high standard of environmental performance; and
- state-of-the-art research, rescue and resupply capabilities.

To celebrate the central role of the icebreaker for the Australian Antarctic program and the significance of Australia's connection to Antarctica, the Australian Government will seek public input on the naming of the vessel through a competition.

Read more at <http://www.antarctica.gov.au/icebreaker>

Australia-China talks

Australian and Chinese officials met in Hobart (Tasmania) in February, for the first meeting of the Joint Committee on Antarctic and Southern Ocean Collaboration.

The meeting signalled a desire to strengthen cooperation on Antarctic science, operations, policy and enhanced environmental protection. During the meeting, Australia and China agreed on a number of priorities for a joint program of work to guide future activities, including:

- agreeing a focus for future scientific cooperation;
- holding a joint East Antarctic/Ross Sea Workshop on collaborative science in 2017;
- increasing the use of Hobart as an Antarctic gateway;
- advancing policy discussions on enhanced environmental protection and other key areas;
- committing to support each other's national Antarctic programs through an annual logistics support agreement ahead of each season;
- establishing professional exchanges of scientists, officials and scholars on policy, science and operations.

Australia helped facilitate China's first visit to east Antarctica 30 years ago, and the countries have continued to work closely together, providing support for each other's Antarctic programs.

The Joint Committee was established under the China Australia Memorandum of Understanding on Cooperation in the Field of Antarctic and Southern Ocean Affairs, signed during Chinese President Xi Jinping's visit to Hobart in November 2014.

Read more at <http://www.antarctica.gov.au/news/2016/australia-hosts-antarctic-talks-with-china>



Australian Antarctic Division Director Dr Nick Gales with Mr Lianzeng Chen, Deputy Administrator of China's State Oceanic Administration and head of the Chinese delegation for the China-Australia Joint Committee Meeting. (Glenn Jacobson)

Newsletter

Keep up to date with the latest news, events and activities in Antarctica with our online newsletter *Antarctic Insider*.
www.antarctica.gov.au/news/antarctic-insider.

HMS Protector visit

The Royal Navy's Ice Patrol ship HMS *Protector* visited Hobart in December (2015) at the start of a five week patrol to the East Antarctic and Ross Sea.



The Royal Navy's Ice Patrol ship, HMS *Protector*. (UK MoD Crown ©2016)

The patrol aimed to support the work of the Convention for the Conservation of Antarctic Marine Living Resources in upholding the conservation rules of the Antarctic Treaty system and to protect the unique Southern Ocean and Antarctic ecosystem from illegal fishing activities.

During the patrol HMS *Protector*, with the support of six embarked Australian and New Zealand specialists, inspected a number of fishing vessels to ensure they adhered to the strict licensing regulations in the area.

While the ship was in Hobart, Australia and the United Kingdom agreed to shared Antarctic priorities over the next five years. Commitments include: an annual Antarctic dialogue; enhanced scientific and logistical cooperation; closer cooperation to better protect Antarctica's unique environment, including by establishing marine protected areas in East Antarctica and the Ross Sea region; and joint efforts to strengthen the Antarctic Treaty system.



David Wood flying a helicopter in Antarctica. (James Moloney)

Tributes flow for helicopter pilot

Tributes flowed for popular helicopter pilot, David Wood, who tragically lost his life after a fall down a crevasse on the West Ice Shelf in January.

Mr Wood, 62, was a dual Canadian-Australian citizen who was employed by Helicopter Resources and was working with the Australian Antarctic program at Davis station at the time of his death.

Mr Wood is remembered as a skilled pilot and a respected colleague and friend to many in the Australian Antarctic program. He had more than 30 years' experience, which included battling forest fires in the Yukon, flying technical crews to lighthouses in Western Australia, and working in both the Antarctic and Arctic.

On behalf of the Australian Antarctic Division, Director Dr Nick Gales expresses his sincere condolences to Mr Wood's family.

Correcting the Record

Adam Pedler, grandson of Alexander Kennedy of the Australasian Antarctic Expedition (1911-14) pointed out an error in Issue 29, page 27, in the order of men of the Western Base party referenced in photo 3. The correct order is L-R: Harrison, Jones, Watson, Moyes, Dovers, Hoadley, Wild and Kennedy.

In the same story (page 26, Issue 29; about a bottle etched and signed by the Australasian Antarctic Expedition), we indicated that Mr John Buchanan presented the expedition with three bottles of Portugese Madeira. John King Davis' book, *High Latitude*, however, confirms that only two bottles were presented.



Freeze Frame

Glenn Jacobson has worked in the Australian Antarctic Division's multimedia section as a production coordinator since 1984. He produces video and still images for the Antarctic Division's website, various publications and news media.



GLENN JACOBSON

This photo was taken on the first trial flight of the Royal Australian Air Force C17-A Globemaster to Wilkins Aerodrome in November 2015. I had flown down on the Australian Antarctic Division's A319 earlier in the day to capture video and still footage of the landing, and was well positioned part-way down the runway when it arrived. It was exciting to see such a large aircraft land on the ice and the jets kicked up huge amounts of snow. I filmed and photographed the historic event for the Antarctic Division's multimedia library and was lucky enough to fly home on the aircraft. It was a little less comfortable than the A319, but roomy enough to play indoor soccer (not that we did)! I used a Nikon D800 at 1/800 sec, f14, ISO 250.



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