



Australian Science in the Antarctic
an overview

Science Strategy
2004/05—2008/09

Science strategy for Australia's Antarctic science program

The vast region of ocean and ice to Australia's south – the Antarctic – has a major influence on the climate and ecology of our entire planet. Antarctica's ice sheet with about 70 per cent of the world's fresh surface and ground water and about 90 per cent of its ice has the potential to influence world sea levels. The stormy Southern Ocean is an engine powering currents in the world's oceans. The waters around Antarctica are home for a vast array of marine organisms, not found anywhere else in the world, and a potential future food source. Science is helping us better understand how the Antarctic influences the climate and ecology of our entire planet.

Australia's Antarctic science program is advancing understanding of Antarctica's role in the global climate system and how biological organisms in these extreme environments are reacting to change. Through better scientific understanding of these Antarctic systems and ecosystems, Australia can plan for the challenges of global climate change and better understand the likely impacts on our weather and climate, our oceans and sea levels, and our natural ecosystems. Better scientific knowledge will help inform the development of national policy to realise the opportunities and minimise the risks associated with future environmental change.

Australia – with its claim to 42% of Antarctica – has a huge stake in the Antarctic, retaining a big physical presence and demonstrating a practical and moral commitment to its environmental integrity. Australia's program of scientific research in Antarctica for the period 2004/05–2008/09 will support Australia's role in the Antarctic Treaty System and enhance our influence in it. Scientific research is focussing on:

- environmental protection;
- knowledge of the part played by Antarctica in the global climate system; and
- understanding how biological organisms adapt to the extreme environment and react to change.

Australia's Antarctic science program for the next five years has been finalised after thorough external evaluation by the Antarctic Science Advisory Committee and widespread consultation with the science community.

Much of our Antarctic science involves Australia's participation in major international research programs. Our aim is to strengthen strategically-focussed, high-quality research across the scientific disciplines and further international collaboration. Air transport to, and within Antarctica, has the potential to extend our research capabilities and open exciting new science opportunities for researchers internationally.

Priority for allocation of resources is given to research that underpins the Australian Government's commitment to the Antarctic Treaty system, its policy objectives for the Antarctic program, and its more general policies on science and the environment.

Strategic directions

Australia's Antarctic science program has, for many years, studied complex systems and processes that transcend the boundaries of traditional disciplines and involved collaboration between many agencies within Australia and overseas. Its strategy for 2004/05–2008/09 formalises and facilitates multi-disciplinary research, forging new partnerships to yield greater levels of knowledge and establish undiscovered avenues for scientific research.

For the five-year planning period 2004/05–2008/09 Australia's Antarctic scientific research program will focus on three multi-disciplinary priority research programs:

- Ice, Ocean, Atmosphere and Climate
- Southern Ocean Ecosystems, and
- Adaptation to Environmental Change

As one of the original parties to the 1961 Antarctic Treaty and influential in creating the Environmental Annex to that Treaty, Australia's strong advocacy of environmental protection is reflected in a program of research addressing the effects of human impacts on Antarctica. Over the next five years there will, therefore, be a fourth priority research program on:

- Impacts of Human Activities in Antarctica



Australian Government

Department of the Environment and Heritage
Australian Antarctic Division

Australia's Antarctic science program includes scientific research conducted by:

- the Antarctic Climate and Ecosystems Cooperative Research Centre (in the research programs Climate Variability and Change, Antarctic Marine Ecosystems, Ocean Control of Carbon Dioxide, and Sea Level Rise);
- a significant number of Australian university scientists (with over 50 projects supported annually by the Australian Antarctic Science Grants scheme);
- scientific staff employed by the Australian Antarctic Division; and
- a number of scientists based at overseas universities and institutions.



Ice, ocean, atmosphere and climate

The overarching goal of this program is to better understand and quantify the role of Antarctica and the high-latitude Southern Ocean and atmosphere in the global climate system. Snow and ice dominate Antarctica and the seas around it. They, in turn, are sensitive to shifts in our planet's climate and this makes them valuable indicators of long-term changes and a major contributor to these changes. We know that Antarctic sea ice alters the salinity and temperature of the water below it and plays a big part in the circulation of heat and salinity through the world's oceans. But we don't know yet if changes to this circulation cause climate change or are the result of it. While some of the global energy is carried by ocean currents, most of it is transported in the atmosphere. How this energy transport, and associated atmospheric chemistry, is affected by human activity (such as by increasing greenhouse gas concentrations) is a major focus of Australia's research. The key questions to be addressed are:

What is the role of the Antarctic cryosphere (the region where water is found in its frozen form) in the global climate system and sea-level change?

What are the Southern Ocean processes responsible for climate variability and predictability on seasonal, inter-annual, decadal and longer timescales, and how do these influence sea level? What is the magnitude and current uptake of atmospheric carbon dioxide by the Southern Ocean, and what processes control this?

What changes are occurring in the climate of Antarctica and the Southern Ocean, and what are the links between these changes and the global climate system?

What role do the dynamics and composition of the whole atmosphere play in climate processes, and how are these changing?



Above: Remote measurement of the atmosphere with a high intensity laser. From the returning light we get the temperature and amount of aerosols at all levels between 20-60 km altitude.
Photo: Malcolm Lambert



Above: Instruments are lowered thousands of metres into the depths of the ocean to measure the ocean salinity, temperature and oxygen content, and to collect water samples. These observations build a picture of the composition, structure and circulation of the deep ocean, and of its role in the climate system.
Photo: Mark Underwood

Top right: The radars at Davis station in Antarctica use radio waves to measure corresponding wind directions and speeds.
Photo: Damian Murphy



Below: Analysis of snow which has accumulated on glaciers and ice sheets over many years provides information on past temperature, precipitation and a range of other environmental parameters. Here samples are collected from within a crevasse on a glacier on Heard Island (left) and using an ice coring drill on the Antarctic ice sheet (bottom).
Photos: Shavawn Donoghue, Barbara Smith



Southern Ocean ecosystems

The Southern Ocean, including the sea ice zone around Antarctica, supports a wide diversity of life forms. Elevated biological productivity in parts of the region, such as in the sea ice zone, supports a high biomass of a number of key species and considerable biodiversity.

Australia is a leading nation in the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) in which Australia's policy position is underpinned by sound scientific research. CCAMLR's ecological approach to fishing regulation requires that in determining limits we take account of dependent and related species and this calls for better knowledge of the structure of Southern Ocean ecosystems. This will help us ensure that natural predators of krill, toothfish and other harvested species are not unduly affected by fishing and that accidental catching of other species is kept to a minimum. Studying Southern Ocean ecosystems is science on a vast scale. The key questions to be addressed are:

How are Southern Ocean ecosystems structured?

What are the limits for sustainable harvesting of the Southern Ocean without damaging ecosystems?

What are the main sources of natural and human-induced variability of the Southern Ocean and how do they exert their effects on biological productivity?



Top: Research is looking at the rich diversity of marine life in the Southern Ocean to ensure fishing does not harm key species or the supporting ecosystem.
Photo: Steve Nicol



Above right: Individual species such as this rockhopper penguin are studied to examine their role in the complex web of interactions that now includes commercial fishing.
Photo: Eric Woehler

Above left: Researchers are looking at ways to reduce seabird mortality in longline fisheries, important for the conservation of seabirds, in particular albatrosses, petrels and shearwaters.
Photo: Graham Robertson

Left: The seasonal sea ice zone that surrounds the Antarctic continent is an important habitat for marine life. Research is aimed at understanding how the physical environment might change in the future, and the impact of any change on ecosystems.
Photo: Rob Massom



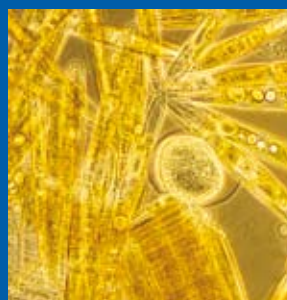
Adaptation to environmental change

The Antarctic is one of Earth's extreme places. Many species, families and other groupings of flora and fauna are unique to Antarctica, suggesting a long period of evolutionary isolation. They live in an environment that is showing signs of rapid change. The extreme conditions have led to remarkable biochemical, physiological and behavioural adaptations, the study of which is leading to the discovery of useful chemicals and genes. Antarctica is a unique natural laboratory for investigating the effects of environmental changes on the structure and function of biological communities and species and on their genetic complexions – upon which their futures depend. Key questions to be addressed are:

What are the consequences of Antarctic environmental change and how do high latitude ecosystems, communities and species respond to change?

What are the consequences of environmental change on biodiversity conservation?

What effect will predicted climate and environmental change have on natural ecosystems?



Top three: Antarctic organisms, including king penguins, marine brittle stars and vegetation on sub-Antarctic islands, are faced with a rapidly changing environment, and are often at the limits of their existence. As a unique natural laboratory, Antarctica allows researchers to investigate how organisms respond to change.
Photos: Kate Kiefer, Martin Riddle

Above: Algae growing on the underside of sea ice provides food for krill. Reduction in the extent of sea ice and changes in marine microbial community structure, driven by environmental change, will affect krill and other grazers.
Photos: Harvey Marchant, Steve Nicol

Left: While penguins, whales and seals are the better known Antarctic wildlife, the most abundant and globally important living things are the single-celled marine microorganisms (such as these diatoms). Marine algae produce about half of the oxygen we breathe.
Photos: Eric Woehler, Harvey Marchant



Impact of human activities in Antarctica

Although commonly portrayed as the last great wilderness, Antarctica is no longer a pristine environment. At some locations, particularly around long-standing research stations, evidence of past human activity is clear and, as Antarctic tourism increases, the pressures on the environment can only grow. Australia, together with other parties to the Antarctic Treaty, has ratified the Protocol on Environmental Protection to the Antarctic Treaty and is committed to valuing and protecting Antarctica. Key questions to be addressed are:

How do the characteristics of high latitude ecosystem processes influence how we best protect the Antarctic environment?

Are Antarctic ecosystems more vulnerable to human activities than those of other regions?

How can science and technology mitigate the impacts of human activities in Antarctica?



Top left: South polar skua drinking at an abandoned waste disposal site.

Photo: Ian Snape

Top right: The wildlife of Antarctica interact with human visitors in many different ways – here an Adélie penguin finds shelter amongst fuel drums.

Photo: Martin Riddle

Middle left: Injecting air into the ground to stimulate bioremediation of fuel spills (Macquarie Island).

Photo: John Rayner

Above: The abandoned waste disposal site at Thala Valley is being used to develop environmental monitoring and remediation techniques for other contaminated sites in polar regions.

Left: Environmental risk assessment and monitoring are essential pre-conditions for the approval of any major new activities in Antarctica, such as the introduction of an air-transport system.



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valued, protected
and understood*